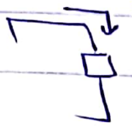
CKT II

* Average Power across a resistor :-

$$P_{avg} = \frac{1}{2} * V_m * I_m$$

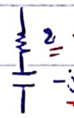
Ex.

Find the average power delivered to the impedance $Z_L = 8 - j11$ if $I = 3 + j4$



$I = 3 + j4 \longrightarrow \sqrt{9+16} \angle +53^\circ = 5 \angle +53^\circ$ A.

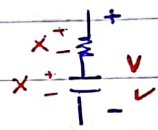
$Z_L = 8 - j11$



$8 \longrightarrow \frac{1}{2} * I_m^2 * R = \frac{1}{2} (5)^2 * 8 = 100$ W

$-j11 \leftarrow P_{avg} = $ zero.

$\longrightarrow$ To find power according to voltage.



$\longrightarrow V_R = 8 * (3 + j4) = 24 + j32 \longrightarrow V_{Rm} = \sqrt{(24)^2 + (32)^2}$

$$P_{avg} = \frac{1}{2} V_{mR}^2 * \frac{1}{R}$$

X wrong.

$\longrightarrow V = (3 + j4)(8 - j11) = 68 - j$ volt.

$V_m = \sqrt{(68)^2 + (-1)^2} = 68.001 \angle -84^\circ$

$$P_{avg} = \frac{1}{2} (68.001)^2 * \frac{1}{8}$$ ✓ right.

* Instantanuos :-

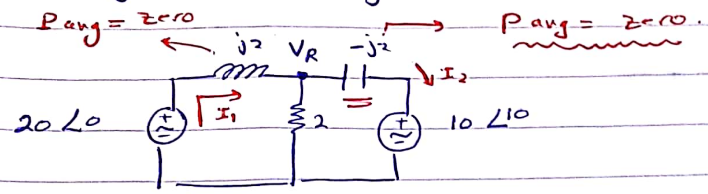
$p(t) = v(t) \cdot i(t)$ } inst. power absorbed by Z_L.

$i(t) = 5 \cos(\omega t + 50^\circ)$

$v(t) = 68.001 \cos(\omega t - 0.84^\circ)$

Ex.

Find the avarge power absorbed by elements and generated by sources.



* "Nodal analysis" "كل الاتجاهات خارجة"

$$\frac{20\angle 0 - V_R}{j2} + \frac{-V_R}{2} + \frac{10\angle 10 - V_R}{-j2} = 0$$

$$V_R = -j10 = 10\angle -90^\circ$$

$$I_1 = \frac{20\angle 0 - V_R}{j2} = 11.8\angle -63.43^\circ$$

$$I_2 = \frac{10\angle -90^\circ - 10\angle 0}{-j2} = 7.071\angle -45^\circ$$

P avg (by R) $= \frac{1}{2} V_m^2 * \frac{1}{R} = \frac{1}{2}(10)^2 * \frac{1}{2} = 25$ w

↳ absorbed.

P avg (by 20 volt source) $= \frac{1}{2} V_m I_m \cos(\theta - \Phi)$

$= \frac{1}{2} * 20 * 11.8 \cos(0 + 63.43)$

$= 50$ w

↳ generated

P avg (by 10 volt source) $= \frac{1}{2} * V_m * I_m * \cos(\theta_V - \Phi_I)$

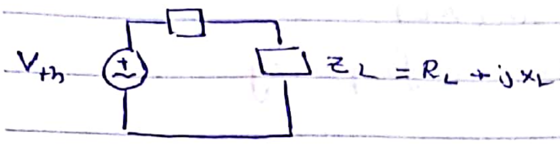
$= \frac{1}{2} * 10 * 7.071 \cos(0 + 45^\circ)$

$= 25$ w

↳ absorbed.

Maximum power transphere :-

$Z_{th} = R_{th} + jX_{th}$



$I = \dfrac{V_m}{Z_L + Z_{th}}$

$V_L = \dfrac{V_{th} * Z_L}{Z_L + Z_{th}}$

$I_L = \dfrac{|V_{th}| \angle 0}{(R_L + R_{th}) + j(X_L + X_{th})}$

$V_L = \dfrac{(R_L + jX_L) * |V_{th}| \angle 0}{(R_L + R_{th}) + j(X_L + X_{th})}$

$P_L = \frac{1}{2} V_m I_m \cos(\theta_v - \Phi_I)$

$= \frac{1}{2} |I_L||V_L| \cos(\theta_v - \Phi)$

$= \cancel{\frac{1}{2} *}$

$= \frac{1}{2} |V_{th}| * \dfrac{1}{\sqrt{(R_L + R_{th})^2 + (X_L + X_{th})^2}} * \cos\left(\left[\tan^{-1}\left(\frac{X_L}{R_L}\right) - \cancel{\tan^{-1}\left(\frac{X_L + X_{th}}{R_L + R_{th}}\right)} + \cancel{\tan^{-1}\left(\frac{X_L + X_{th}}{R_L + R_{th}}\right)}\right]\right)$

" maximum power transphere = reduce absorbed power by Z_{th} "

$\dfrac{dP_L}{dR_L} = 0 \; ; \; R_L = R_{th}$.

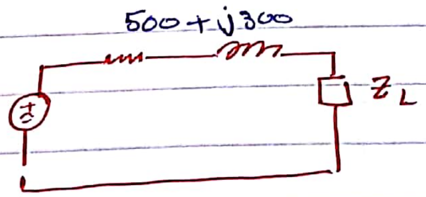
$\dfrac{dP_L}{dX_L} \Rightarrow \; ; \; X_L = -X_{th}$.

* To achieve maximum power transphere (minimize loses)

$\boxed{Z_L = Z_{th}^*}$

Ex.

Find the load value that maximize the power transpher

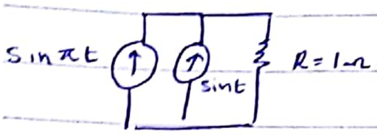


$Z_L = Z_{th}^* = 500 - j300$.

* Ex.

Find the ~~avr~~ ~~avarge~~ avarge power across $R = 1\,\Omega$ if $i(t) = \sin t + \sin(\pi t)$

Different frequency.



$P_{avg} = \frac{1}{2} I_m^2 R$ ✗

$$P_{avg} = \frac{1}{T}\int_0^T p(t)\,.\,dt = \frac{1}{T}\int_0^T i^2(t)\,.\,R\,.\,dt$$

$$= \frac{1}{T}\int_0^T (\sin t + \sin \pi t)^2\,.\,dt = \frac{1}{T}\int_0^T \sin^2 t + 2\sin t \sin \pi t + (\sin \pi t)^2\,.\,dt$$

$$= \frac{1}{T}\int_0^T \sin^2 t \; dt + \frac{1}{T}\int_0^T 2\sin t \sin \pi t \,.\,dt + \frac{1}{T}\int_0^T \sin^2(\pi t)\, dt$$

$\frac{1}{2} - \frac{1}{2}\cancel{\cos 2t}^{\,0}$ $\qquad \frac{1}{2}\cancel{\cos(\pi t - t)}^{\,0} - \frac{1}{2}\cancel{\cos(\pi t + t)}^{\,=0}$ $\qquad \frac{1}{2} - \frac{1}{2}\cancel{\cos 2\pi t}^{\,=0}$

$$= \frac{1}{T} * 1 * T = 1\ W$$

* integral over complete periode of sinusoidal = zero

$P(\text{source } 1) = \frac{1}{2} I_m^2 R = \frac{1}{2}$

$P(\text{source } 2) = \frac{1}{2} I_m^2 R = \frac{1}{2}$

$P_{avg} = P_{s1} + P_{s2} = \frac{1}{2} + \frac{1}{2} = 1\ W$

عشان أجمع ال power
(لأن ال superposition)
لازم average
~~[illegible]~~ ممنوع اذا كانت
Instantaneous

IF we have sources with multiple frequency

$$P_{avg} = \frac{1}{2} R \left[I_{m_1}^2 + I_{m_2}^2 + I_{m_3}^2 + \cdots \right]$$

Ex.

$i(t) = 2\cos(10t) - 3\cos(20t)$, $R = 4\,\Omega$ → Peak value (3 not −3)

Find P avg.

$P_{avg} = \frac{1}{2} R \left[I_{m_1}^2 + I_{m_2}^2 \right] = \frac{1}{2} * 4 * \left[(2)^2 + (3)^2 \right]$

$= 2 * 13 = 26.$

Ex. $i(t) = 2\cos 10t - 3\sin(10 - 40^\circ)$, $R = 4\,\Omega$.

* ما بحول ال sin لأني بدي ال peak value فقط.

$P_{avg} = \frac{1}{2}(2)^2 * 4 + \frac{1}{2}(3)^2 * 4$

Ex.

$i(t) = 2\cos(10t) - 3\cos(10t)$; $R = 4\,\Omega$

same frequency

$i(t) = 2\cos(10t) - 3\cos(10t) = -\cos(10t)$

$P_{avg} = \frac{1}{2}(1)^2 * 4 = 2\ W$

Ex.

$i(t) = 5\cos(\omega t) + 3\sin(\omega t)$, $R = 4\,\Omega$.

$i_1(t) = 5\cos(\omega t) = 5\angle 0$

$i_2(t) = 3\sin(\omega t) = 3\cos(\omega t - \frac{\pi}{2}) = 3\angle -90^\circ$

$i_1 + i_2 = 5\angle 0 + 3\angle -90 = 5 - j3$

Peak value $(I_m) = \sqrt{25 + 9} = \sqrt{34}$

$P_{avg} = \frac{1}{2}(I_m)^2 * R = \frac{1}{2}(\sqrt{34})^2 * 4\ W$

Ex.

$$v(t) = 5\cos(\omega t) + 3\cos(\omega t - \frac{\pi}{4})$$

$$V = 5\angle 0 + 3\angle -45^\circ$$

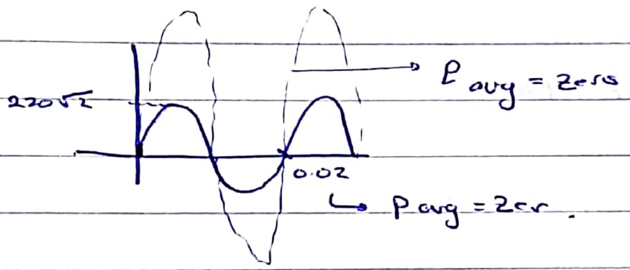
$$= 5 + 3 * \frac{1}{\sqrt{2}} - j3 * \frac{1}{\sqrt{2}}$$

$$= (5 + \frac{3}{\sqrt{2}}) - j\frac{3}{\sqrt{2}}$$

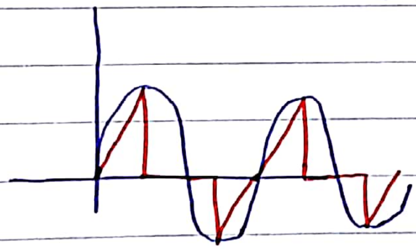
$$|V| = \sqrt{(5+\frac{3}{\sqrt{2}})^2 + (\frac{3}{\sqrt{2}})^2}$$

$$P_{avg} = \frac{1}{2} V_m^2 * \frac{1}{R} = \frac{1}{2}\frac{|V|^2}{R}$$

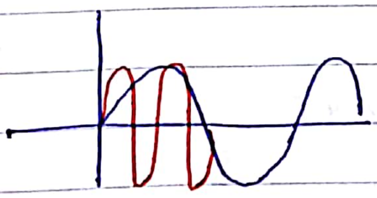
" **Effective values** "



P_{avg} ??? No ✗



Peak value ??? No ✗



frequency ??? No ✗

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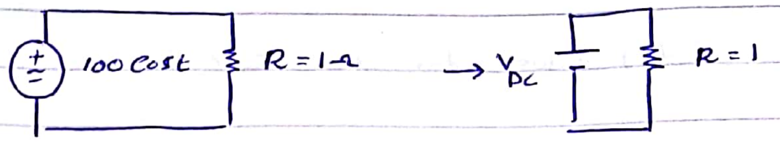


$$P_{ac} = \frac{1}{2}(100)^2 * \frac{1}{1} = 5000 \text{ w}$$

V_{DC} ??

$$P_{DC} = \frac{V^2}{R} \longrightarrow 5000 = V^2$$

$$V_{DC} = \sqrt{5000} = \frac{100}{\sqrt{2}} \text{ volt.}$$

Effective values:

The value of an AC signal that is equivalent in generated power to a DC source that gives the same power.

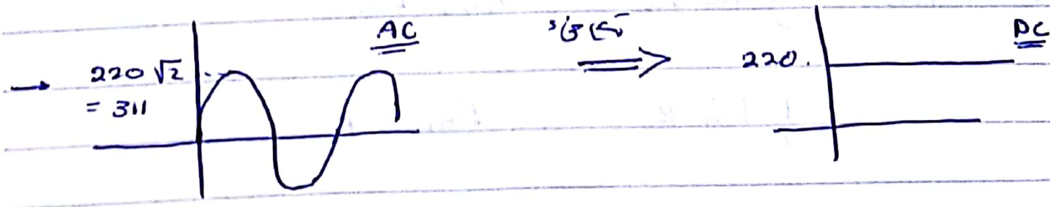
$P_{DC} = P_{AC}$; Consider $R = 1\Omega$

$$V_{DC}^2 = \frac{1}{T}\int_0^T p(t) \cdot dt.$$

$$V_{DC}^2 = \frac{1}{T}\int_0^T v^2(t)\, dt$$

$$V_{DC} = V_{eff} = V_{RMS} = \sqrt{\frac{1}{T}\int_0^T v^2(t) \cdot dt}$$

RMS → Root mean squar value.



Ex.

Find the effective (RMS) value for the current waveform.

$$i(t) = I_m \cos(\omega t + \Phi) \quad ; \quad P_{avg} = \frac{1}{2} I_m^2 * R.$$

$$I_{eff} = I_{RMS} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt} \quad ; \quad T = \frac{\omega}{2\pi}.$$

$$= \sqrt{\frac{1}{T}\int_0^T I_m^2 \cos^2(\omega t + \Phi)\,dt} = \sqrt{\frac{I_m^2}{T}\int_0^T \frac{1}{2} + \cancel{\frac{1}{2}\cos(2\omega t + 2\Phi)}_{=\text{zero}}\,.dt}$$

$$= \sqrt{\frac{I_m^2}{2\cancel{T}} * \cancel{T}} = \frac{I_m}{\sqrt{2}}$$

For sinusoidal (V or I)

$$\rightarrow \quad V_{RMS} = \frac{V_{peak}}{\sqrt{2}} = \frac{V_m}{\sqrt{2}}.$$

$$\rightarrow \quad P_{avg} = \frac{1}{2} \underbrace{V_m}_{\sqrt{2}V_{RMS}} \underbrace{I_m}_{\sqrt{2}I_{RMS}} \cos(\theta - \Phi)$$

$$P_{avg} = V_{rms}\, I_{rms} \cos(\theta - \Phi)$$

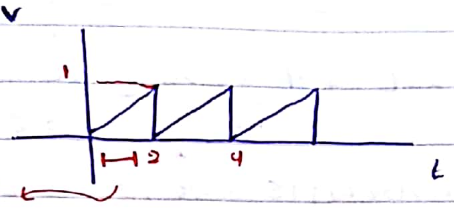
$$\rightarrow \quad P_{avg}\,(\text{resistor}) = \frac{1}{2} V_m I_m = V_{rms} I_{rms}$$

$$= \frac{1}{2} I_m^2 R = I_{rms}^2 . R.$$

$$= \frac{1}{2}\frac{V_m^2}{R} = \frac{V_{rms}^2}{R}.$$

Ex.

Find the RMS value for the signal shown:



$\boxed{T=2}$

معادلة خط مستقيم

$v(t) = \frac{1}{2}t \qquad 0 \leq t \leq 2$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,.dt} = \sqrt{\frac{1}{2}\int_0^2 \left(\frac{1}{2}t\right)^2 .dt} = \frac{1}{\sqrt{3}} \text{ volt.}$$

$$P_{avg} = \frac{V_{rms}^2}{R} = \frac{\left(\frac{1}{\sqrt{3}}\right)^2}{4} = 1/12 \text{ . w}$$

Ex.

Find the RMS value ~~f~~ for : $v(t) = 5\cos\omega t$

$$V_{rms} = \frac{5}{\sqrt{2}}.$$

~~v(t) = 5 sin~~

Ex.

$i(t) = 5\cos(2\omega t + \frac{\pi}{4})$

$$I_{rms} = \frac{5}{\sqrt{2}}.$$

Ex.

$v(t) = 5\sin(\omega t)$

$V_{rms} = \frac{5}{\sqrt{2}}$ phase shift not effect.

Ex.

$v(t) = 5\cos\omega t + 3\cos(2\omega t)$ [multipule frequency]

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,.dt}.$$

$$\rightarrow V_{rms} = \sqrt{\frac{1}{T}\int_0^T \left(5\cos\omega t + 3\cos(2\omega t)\right)^2 . dt}$$

$$= \sqrt{\frac{1}{T}\int_0^T 25\cos^2\omega t + \underbrace{30\cos\omega t\,\cos 2\omega t}_{\int_0^T 15\cos(3\omega t) + 15\cos\omega t\ .dt\ =\ \text{Zero}} + \underbrace{9\cos^2 2\omega t}_{\frac{9}{2} + \cancel{\frac{9}{2}\cos(4\omega t)}} . dt}$$

$= \text{Zero}$

$$25\cos^2\omega t \rightarrow \frac{25}{2} + \cancel{25\cos 2\omega t} \quad = \text{Zero}$$

$$= \sqrt{\frac{1}{T}\int_0^T \frac{34}{2} . dt} = \sqrt{\frac{34}{2}} = \sqrt{17} = \sqrt{(V_{rms1})^2 + (V_{rms2})^2}$$

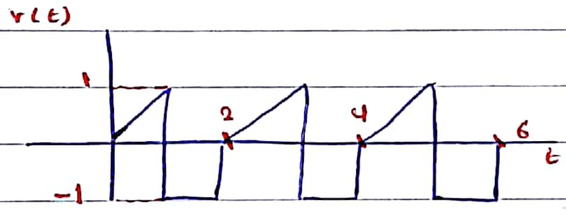
\#

NOTE :-

$$V_{rms} = \sqrt{V_{rms1}^2 + V_{rms2}^2 + V_{rms3}^2 + \dots}$$

Ex.

Find the RMS value.



$T = 4$

$$v(t) = \begin{cases} \frac{1}{2}t, & 0 \le t \le 2 \\ -1, & 2 \le t \le 4 \end{cases}$$

$$V_{rms} = \sqrt{\frac{1}{4}\int_0^4 v^2(t)\, dt}$$

باخذ period وحدة ونشتغل عليه.

$$= \sqrt{\frac{1}{4}\left[\int_0^2 \left(\frac{1}{2}t\right)^2 + \int_2^4 (-1)^2 . dt\right.}$$

⋮

$V_{rms} = 0.816$ volt.

Ex. Find the RMS value

frequency zero

$v(t) = 5 + 3\cos\omega t$.

$$V_{rms} = \sqrt{\underline{\underline{(5)^2}} + \left(\frac{3}{\sqrt{2}}\right)^2}$$

ال DC لا تقسم على $\sqrt{2}$

Ex. H.W

if $v(t) = 5\cos\omega t$ & $i(t) = 3\sin(\omega t + 60°)$
for an element find its P_{avg}.

Ex.

Find the avarge power across a 4Ω resister

~~when $v(t) = 8\sin 200t - 8\cos(200t - 90°)$~~

when $v(t) = \underline{8\sin 200t} - 6\cos(200t - 45°)$

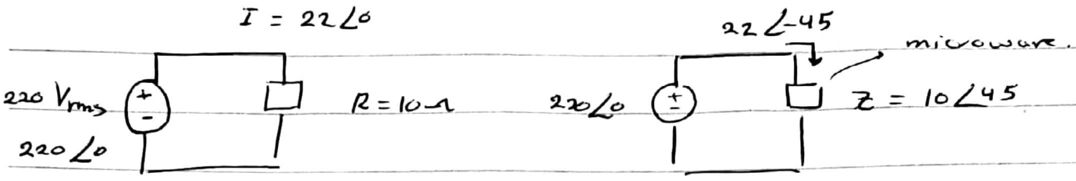
$8\cos(200t - 90°)$

$$v(t) = 8\angle{-90°} - 6\angle{-45°} = -j8 - \left[\frac{6}{\sqrt{2}} - \frac{j6}{\sqrt{2}}\right]$$

$$= -j8 - \frac{6}{\sqrt{2}} + j\frac{6}{\sqrt{2}} = \frac{-6}{\sqrt{2}} - j\left(8 - \frac{6}{\sqrt{2}}\right)$$

$$\text{peak value} = \sqrt{\left(\frac{-6}{\sqrt{2}}\right)^2 + \left(8 - \frac{6}{\sqrt{2}}\right)^2}$$

$$V_{rms} = \frac{\sqrt{\left(\frac{-6}{\sqrt{2}}\right)^2 + \left(8 - \frac{6}{\sqrt{2}}\right)^2}}{\sqrt{2}} \quad ; \quad P_{avg} = \frac{V_{rms}^2}{R} \quad \text{OR} \quad \frac{1}{2}\frac{V_m^2}{R}.$$



$2000\ W \xrightarrow{1h} 2000\ Wh = 2\ KWh$

$P_1 = V_{rms} I_{rms}$

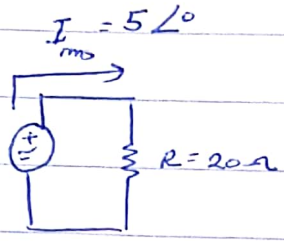
$= 220 * 22 = 4840.$

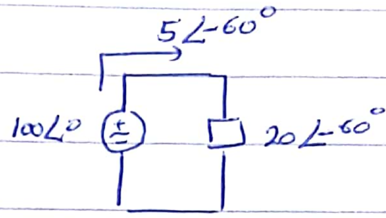
$P_2 = V_{rms} I_{rms} \cos(\theta - \Phi)$

$= 220 * 22 * \cos 45 = \frac{4840}{\sqrt{2}}.$

$V_{rms} =$

$100 \cos \omega t$





$= 100\angle 0°$ $(PF = 1)$ $(PF = \frac{1}{2})$

$P = V_{rms} I_{rms}$

$= 100 * 5 = 500\ W$

$P = V_{rms} I_{rms}$

$= 100 * 5 * \cos(0+60)$

$= 250\ W$

"Same current with diffrent power".

power factor (PF) $= \dfrac{\text{Real power}}{\text{Apparent power}} = \dfrac{\cancel{V_{rms}}\ \cancel{I_{rms}} \cos(\theta - \Phi)}{\cancel{V_{rms}}\ \cancel{I_{rms}}}$

$$\boxed{PF = \cos(\theta - \Phi)}$$

* In general for sinusoidal signals

$PF = \cos(\theta - \Phi)$

→ for pure resistive load.

$PF = \cos(\theta - \Phi) = 1$

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→ **for pure inductive / capacitive loads**

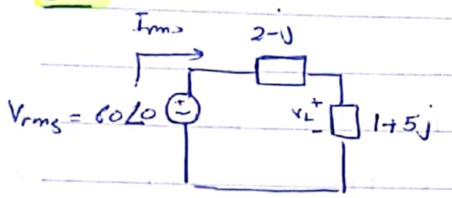
$$PF = \cos(\theta - \Phi) = \underline{zero}.$$

→ **for other loads in general** (impedance)

$$PF = \cos(\theta - \Phi)$$

$$0 \leq PF \leq 1 \quad \rightarrow \quad 0 \leq \theta - \Phi \leq \pi/2.$$

Ex.



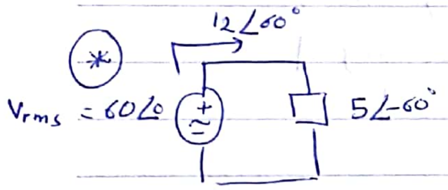
* Find source PF.

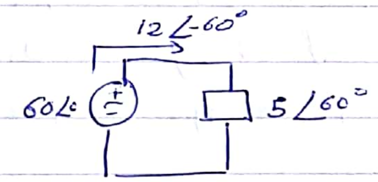
$PF = \cos(\theta - \Phi)$??? $\longrightarrow$ $PF = \cos(0 + 53.13°)$.

$$I_{rms} = \frac{V_{rms}}{Z_L} = \frac{60\angle 0}{(2-j)+(1+j5)} = \frac{60\angle 0}{3+j4} = 12\ \underline{\angle -53.13°}$$

"voltage leads current"

طبيعة ال load → inductive.





$PF = \cos(0 + 60°)$
$= \underline{0.5}$
↓
0.5 leading.
↳ "current lead voltage"

$PF = \cos(0 + -60°)$
$= \underline{0.5}$
↓
0.5 lagging "voltage leads current"

→ **Continue of previous example** :-

$$P_{avg} = V_{rms}\ I_{rms} \cos(\theta - \Phi)$$

$$= 60 * 12 * \cos(0 + 53.13°) = 432\ W$$

Apparent power $= V_{rms}\ I_{rms} = 720\ W$

$PF = \frac{P_{avg}}{App.} = 0.6$ lagging

real power ↑ / Apparent ↓

→ Find load power factor. [PF for source ≠ PF of load]

V_{rms} (load) ⇒ voltage division = $\frac{60\angle 0 * (1+j5)}{(3+j4)} = 61.18\angle 25.5^\circ$

I_{rms} (load) ⇒ $12\angle -53.13^\circ$

$PF = \cos(\theta - \Phi) = \cos(25.5^\circ + 53.13^\circ) = 0.19$ lagging.

Complex power: is defined to represent the power consumption in resistors & (inductors / capacitive)

complex power → Real power [Heat]
→ reactive power [electromagnetic fields]

S → P (power in resistor)
→ Q (power in inductor / capacitor)
[rest of charge & discharge]
[rest of energy trasphere]

→ Suppose.

$V = |V_{rms}| \angle\theta$ & $I = |I_{rms}| \angle\Phi$

→ $|V_{rms}| e^{j\theta}$; $|I_{rms}| e^{j\Phi}$

$P = |V_{rms}| |I_{rms}| \cos(\theta - \Phi)$

→ we know :-

$$e^{j(\theta-\Phi)} = \underbrace{\cos(\theta-\Phi)}_{Re\{e^{j(\theta-\Phi)}\}} + j\underbrace{\sin(\theta-\Phi)}_{\to Im\{e^{j(\theta-\Phi)}\}}$$

$$P = |V_{rms}||I_{rms}| * Re\{e^{j(\theta-\Phi)}\}$$

$$= Re\{\underbrace{|V_{rms}| e^{j\theta}}_{V} * \underbrace{|I_{rms}| e^{-j\Phi}}_{I^*}\} = Re\{V I^*\}$$

conject.

$P = Re\{S\}$; $S = V I^*$

$S \rightarrow P$ (real power)
$\quad \rightarrow Q$ (reactive power)

$\cancel{S = P + Q}$

$Q = \operatorname{Im}\{S\}$

$$\boxed{S = P + jQ}$$

S → VA (Volt, Ampere)
P → Watt
Q → VAR → reactive

$$S = P + jQ = V_{rms} I_{rms}^{*} = \frac{1}{2} V_m I_m^{*}$$

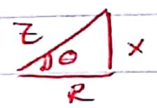
$$= V_{rms} I_{rms} e^{j(\theta - \Phi)}$$

$$= V_{rms} I_{rms} [\cos(\theta - \Phi) + j \sin(\theta - \Phi)]$$

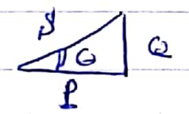
$$= \underbrace{V_{rms} I_{rms} \cos(\theta - \Phi)}_{P} + j \underbrace{V_{rms} I_{rms} \sin(\theta - \Phi)}_{Q}$$

$$P = |V_{rms}||I_{rms}| \cos(\theta - \Phi) = \frac{1}{2} |V_m||I_m| \cos(\theta - \Phi)$$

$$Q = |V_{rms}||I_{rms}| \sin(\theta - \Phi) = \frac{1}{2} |V_m||I_m| \sin(\theta - \Phi)$$



$\Rightarrow$



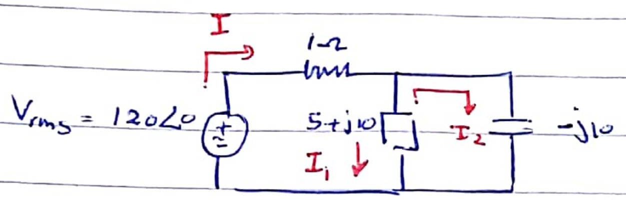
$Z = R + jX$
$|Z| = \sqrt{R^2 + X^2}$
$\theta = \tan^{-1}\left(\frac{X}{R}\right)$

complex power → $S = P + jQ$
Apparent power → $|S| = \sqrt{P^2 + Q^2}$
$\theta = \tan^{-1}(Q/P)$

Scanned by CamScanner

Ex.

Find the Complex power absorbed /produced by every element in the ckt.



$$I_{rms} = \frac{120\angle 0}{1 + (5 + j10 \;//\; -j10)} = \frac{120}{1 + \left(\frac{(5+10j)(-j10)}{5}\right)} = 5.16\angle 25.46^\circ \text{ A}$$

$$S\,(\text{source}) = V_{rms}\, I_{rms}^{*}$$
$$= 120\angle 0 * 5.16\angle -25.46^\circ = 558.98 - j\,266.14 \text{ VA}$$

$P = 552.98 \text{ w}$

$Q = -266.14 \text{ VAR}$

$$S\,(1\Omega) = V_{rms}\, I_{rms}^{*}$$
$$\rightarrow V_{rms}(1\Omega) = 1 * 5.16 * \angle 24.46 \text{ volt.}$$
$$S = 5.16\angle 25.46^\circ * 5.16\angle -25.46^\circ = \underbrace{26.6}_{P} + \underbrace{0j}_{Q} \text{ VA}$$

(pure real power)

$P(1\Omega) = \frac{V_{rms}^2}{R}$

oR

$I_{rms}^2 * R$

$= 26.6 \text{ w}$

(No reactive power in Resistor)

$$* \; I_2 = \frac{I * (5+10j)}{5} = 11.53\angle 88.89$$

$$V(-j10) = I * X_c = -j10 * 11.53\angle 88.89 = 115.3\angle -1.11^\circ$$

$$S(-10j) = V_{rms} * I_{rms}^{*} = 115.3\angle -1.11 * 11.53\angle 88.89$$
$$= 1331\angle -90$$
$$= 0 - j1331 \text{ VA}$$

the capacitor work as agenerator of reactive power (يولد مجال مغناطيسية تدعم المصدر)

$\rightarrow$ $Q = V_{rms} I_{rms} \sin(\theta - \phi)$

$= 115.3 * 11.53 \sin(-1.11 - 88.89)$ -ve $\rightarrow$ generated. } Source

$= -1331$ VAR. +ve $\rightarrow$ absorbed.

$\rightarrow$ $I_1 = I - I_2$ -ve $\rightarrow$ absorbed. } load

$I_1 = 10.31 \angle -64.53$. +ve $\rightarrow$ generated.

$S(5+j10) = 115.3 \angle -1.11 * 10.31 \angle 64.53$

$= 531.48 + j1062$.

Real power

S (source) $= V_{rms} I_{rms}^* = 120 \angle 0 * 5.16 \angle -25.46°$

$= 558.98 - j266.14$

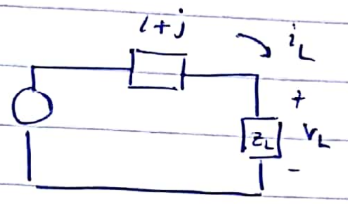
* E.x.

given → Capacitive load (current leads voltage)

$V_L = 60 \cos(\omega t - 10)$ volt.

$i_L = 1.5 \cos(\omega t + 50)$ A.

} peak values (because of time domain)



[1] find load complex power

$S = V_{rms} * I_{rms}^*$ OR $\frac{1}{2} V_m I_m$

$\frac{60}{\sqrt{2}} \angle{-10} * \frac{1.5}{\sqrt{2}} \angle{-50}$ $= \frac{1}{2} * 60 \angle{-10} * 1.5 \angle{50}$

$S_L = 45 \angle{60°} = 22.5 - j\,38.97$

دليل على ال

Capacitive load.

load Apparent power $= |S_L| = \cancel{\ }$

$= |V_{rms}|\,|I_{rms}|$

$= \frac{60}{\sqrt{2}} * \frac{1.5}{\sqrt{2}} = 45$ VA.

→ load pF $= \cos(\theta - \phi)$

$= \cos(-10 - 50)$

$= 0.5$ leading.

$Z_L = \frac{60 \angle{-10}}{1.5 \angle{50}} = 40 \angle{-60}$

→ to find pF & source complex power

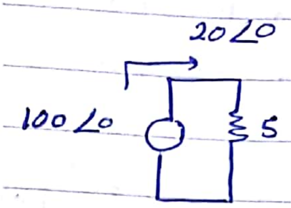
$V_s = 60 \angle{-10} + (1+j) * 1.5 \angle{50}$

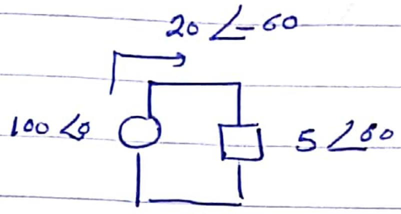
$V_{rms} = \frac{60}{\sqrt{2}} \angle{-10} + (1+j) * \frac{1.5}{\sqrt{2}} \angle{50} = 42 \angle{-8°}$

$pF\,(source) = \cos(\theta - \phi) = \cos(-8 - 50) = 0.53$ leading.

$S\,(source) = V_{rms} * I_{rms}^* = 42 \angle{-8} * \frac{1.5}{\sqrt{2}} \angle{-50°}$.

* power Factor correction





$P = 2000$ W

$P = 100 * 20 * 10 * \cos(60)$

$= 1000$ W

$PF = \cos(\theta - \phi)$

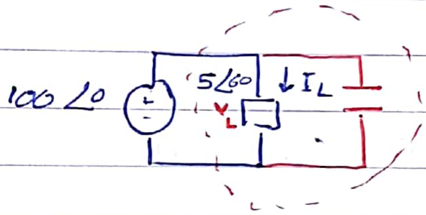
$= 1$

$PF = \cos(\theta - \phi) = \cos(60) = \frac{1}{2}$ lagging.

لازم يكون قريب من ال 1

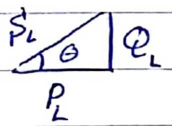
PF Correction:

increasing PF without altering the voltage & current of the actual load.



ال V_L و ال I_L
ظلو زي ما هما بعد
اضافة ال Capacitor

* Befor adding the Capacitor :-

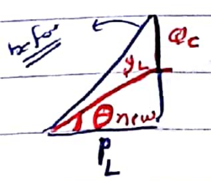


$$\boxed{I_S = I_L}$$

$$\theta = \tan^{-1}\left(\frac{Q_L}{R_L}\right)$$

$PF = \cos\theta$ → the angle differeance between ∠voltage & ∠current ($\theta - \phi$ اختصار)

* After adding the capacitor:



$$\boxed{I_S = I_L + I_C}$$

$$\theta_{new} = \tan^{-1}\left(\frac{Q_L - Q_c}{P_L}\right)$$

تقل θ
↓
يزداد $\cos\theta$
↓
يزداد PF

وصلنا للمطلوب.