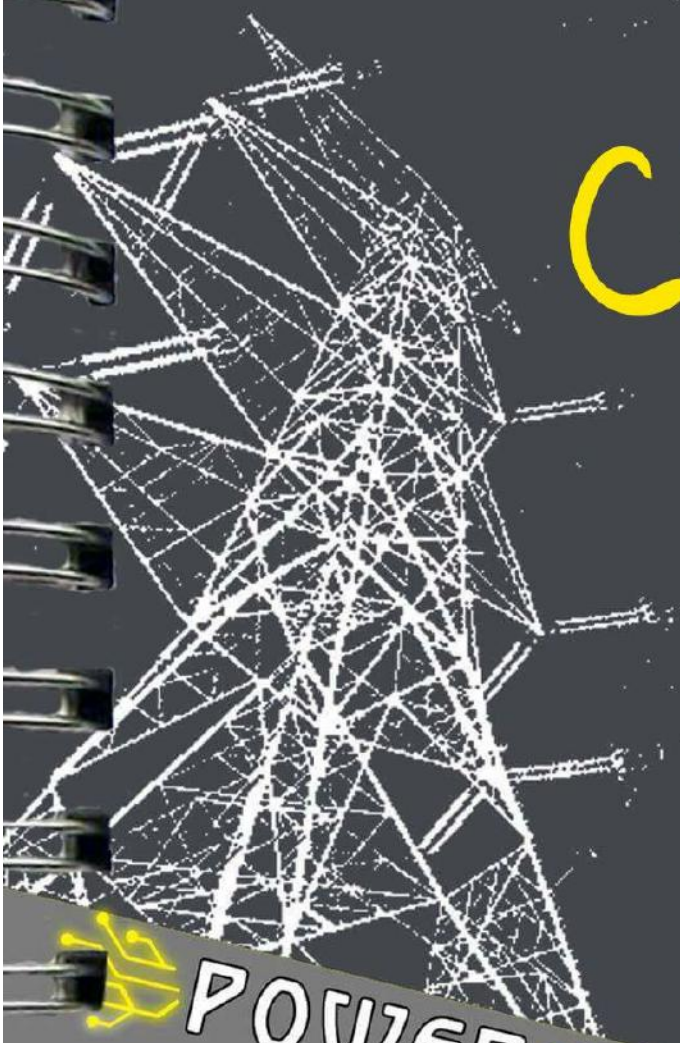
Circuits2



POWER UNIT

By: Maen Mahadeen

Dr. Mohd Al-haj

Spring 16

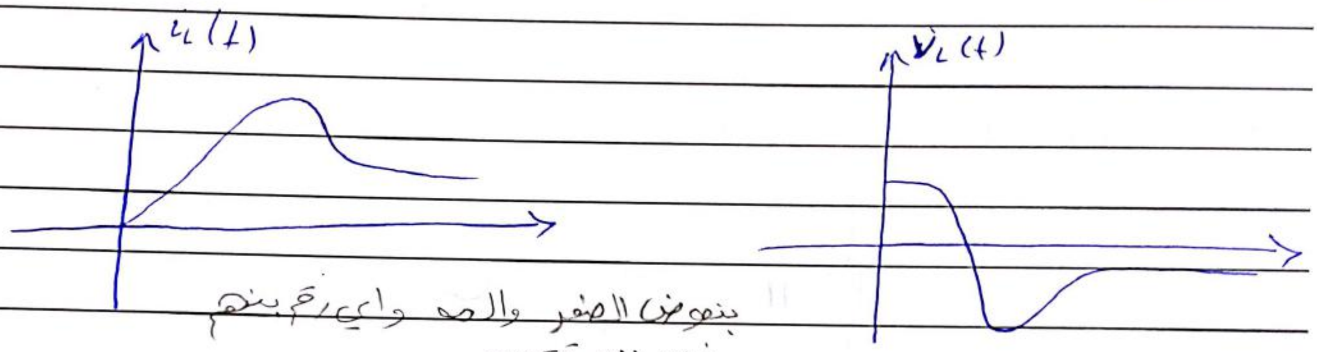
Scanned by CamScanner

No

* Calculate & sketch $V_L(t)$ when ~~$V(t)$~~ $i_L(t) = 20te^{-2t}$ & $L = 0.1\,H$?

$$V_L(t) = L\frac{di_L(t)}{dt} = 0.1 * \frac{d(20te^{-2t})}{dt}$$

$$V_L(t) = 0.1\,(20e^{-2t} - 40te^{-2t}) = 2e^{-2t}(1-2t)$$



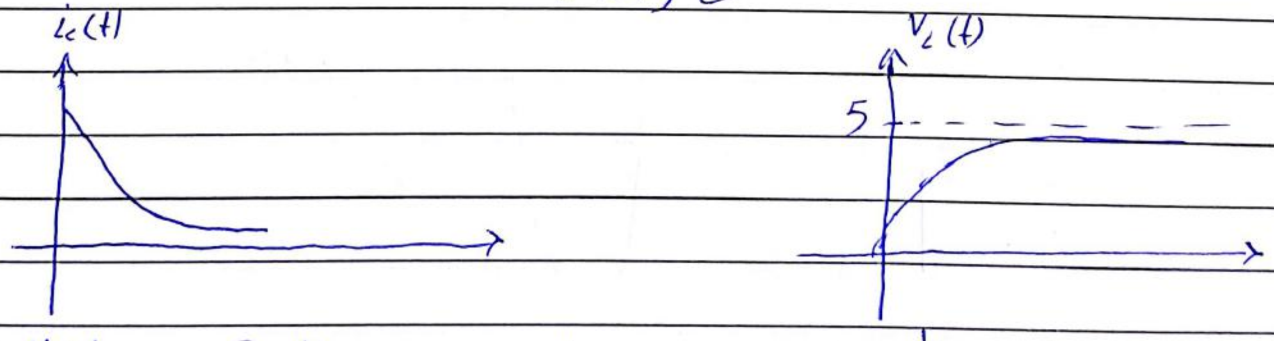
بنعوض الصفر والصح وايي رقم بنعم ونرسم رسم تقريبي .

* Inductor voltage can be changed instantaneously, Inductor current could not.

* Calculate & sketch $i_C(t)$ when $V_C(t) = 5(1 - e^{-t/10^{-6}})$

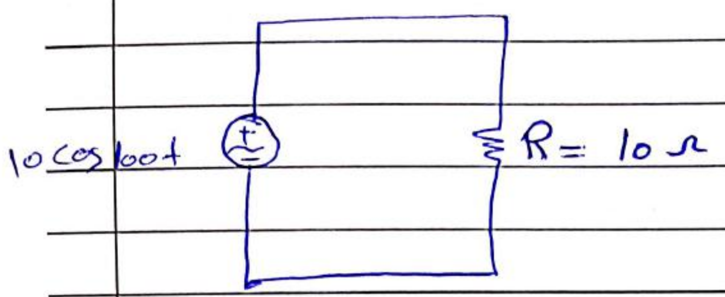
$$i_C(t) = C\frac{dV_C(t)}{dt} = 10^{-7} * \left[5 * \frac{1}{10^{-6}}\,e^{-t/10^{-6}}\right]$$

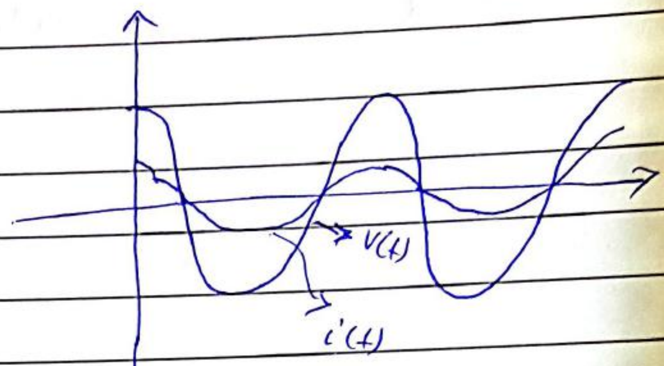
$$= 0.5\,e^{-t/10^{-6}}$$



* Voltage of the capacitor can not be changed instantaneously, the current can

No

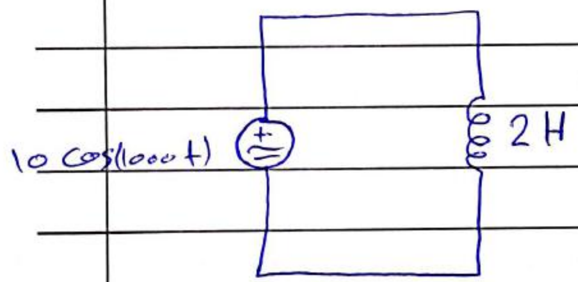




$i_R(t) = \frac{V_R(t)}{R} = \cos(100t)$

Voltage and current across a resister are inphase

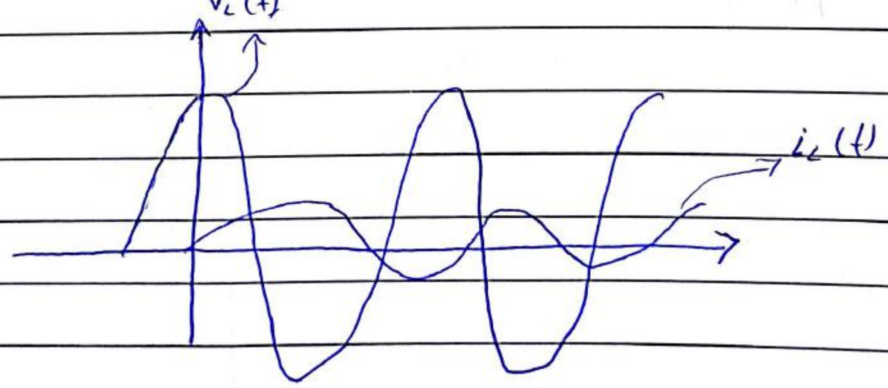
$i_L(t) = ?$ $\quad i_L(0^-) = 0$



$V_L(t) = L \frac{d i_L(t)}{dt} \Rightarrow i_L(t) = \frac{1}{L} \int_0^t 10\cos(1000t)\,dt$

$i_L(t) = \frac{1}{200} \sin(1000t)$

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

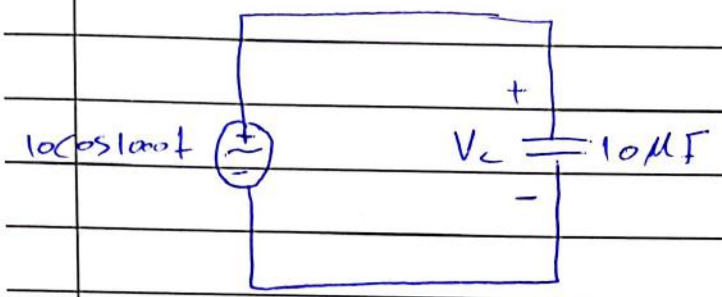


V(t) Leads $i_L(t)$ by 90°

Scanned by CamScanner

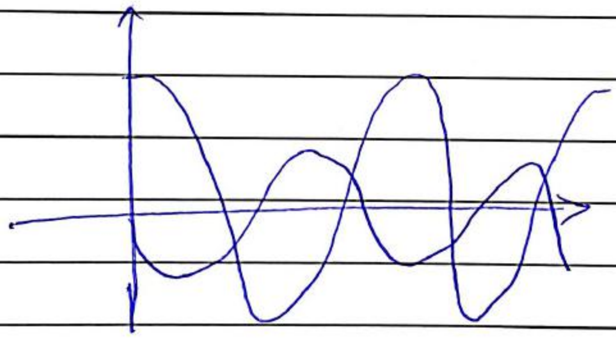
No

$i_L(0^-) = 0 \qquad V_L(0^-) = 0$



$i_c = C\frac{dv_c}{dt} = 10^{-5} * 10 * -1000 * \sin(1000t)$

$$i_c(t) = \frac{-1}{10}\sin(1000t)$$



$i_c(t)$ Leads $v_c(t)$ by $90°$

in capacitor $v(t) = L\frac{di}{dt}$

in inductor $i(t) = C\frac{dv}{dt}$

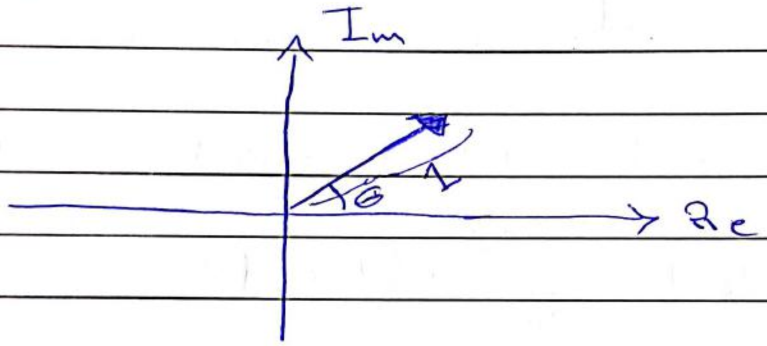
deffrential form

No

Euler's :

$$e^{j\theta} = \cos\theta + j\sin\theta$$

$$\cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2} \quad , \quad \sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2}$$



$$Re\{e^{j\theta}\} = \cos\theta$$
$$Im\{e^{j\theta}\} = \sin\theta$$

Scanned by CamScanner

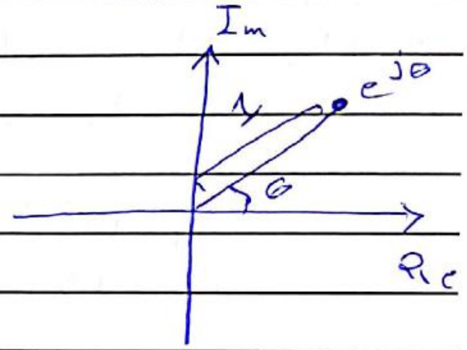
No

$e^{j\theta} = \cos\theta + j\sin\theta$ (معادلة اويلر)

$R_e\{e^{j\theta}\} = \cos\theta$

$I_m\{e^{j\theta}\} = \sin\theta$

$e^{j(wt+\theta)} = \cos(wt+\theta) + j\sin(wt+\theta)$



$e^{j(wt+\phi)} = \cos(wt+\phi) + j\sin(wt+\phi)$

$e^{j(wt+\delta)} = \cos(wt+\delta) + j\sin(wt+\delta)$

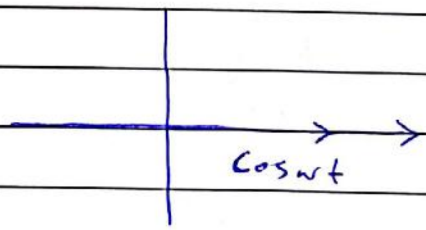
$e^{j(wt+\theta)} = e^{j\theta}\, e^{jwt}$

$e^{j(wt+\phi)} = e^{j\phi}\, e^{jwt}$

$e^{j(wt+\delta)} = e^{j\delta}\, e^{jwt}$

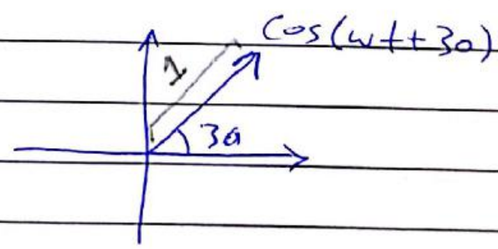
① $\cos wt$

$\Rightarrow \cos(wt+0) = \boxed{e^{j0}} = R_e\{e^{j0}\} = 1$



② $1\cos(wt+30)$

$= \boxed{e^{j\pi/6}}$

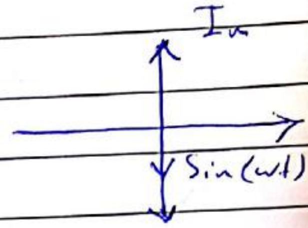


Scanned by CamScanner

No ________

③ $\sin(\omega t) = \cos(\omega t - \pi/2)$

$= -j$



$V_1(t) = 15\cos(377t + \pi/4)$

$V_2(t) = 15\cos(377 + \pi/6)$

find $V_1 + V_2$?? ep [illegible]

Sol

$V_1 = 15\angle^{\pi/4} = 15\cos\frac{\pi}{4} + j15\sin\pi/4$

$V_2 = 15\angle\frac{\pi}{6} = 15\cos\frac{\pi}{4} + j15\sin\frac{\pi}{6}$

$V_1 + V_2 = (15\cos\pi/4 + 15\cos\pi/6) + j15(\sin\pi/4 + \sin\pi/6)$

Time	phasor domain
$10\cos(\omega t)$	$10\angle 0$
$10\cos(\omega t - 30)$	$10\angle -30$
$10\sin\omega t$	$10\angle -90$
$10\sin(\omega t + 40)$	$10\angle -50$

for $v(t) = R\,i(t)$ — $V = RI$

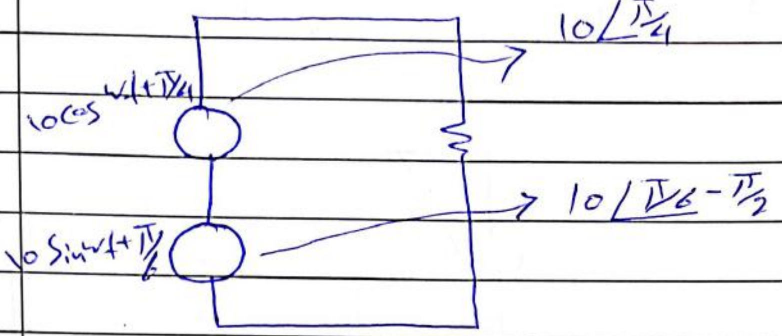
for $L \Rightarrow v(t) = L\frac{d\,i(t)}{dt}$ — $V = j\omega L I$

for $C \Rightarrow i(t) = C\frac{d\,v(t)}{dt}$ — $I = j\omega C V$

Scanned by CamScanner

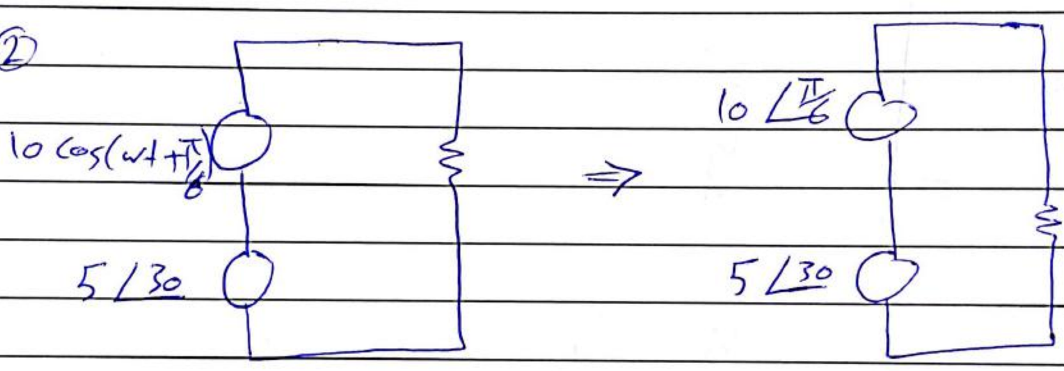
No

Note ①

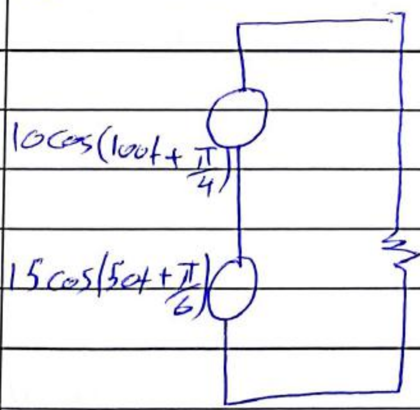


مرجعيتنا هي ال cos
وليس ال Sin

Note ②



Note ③

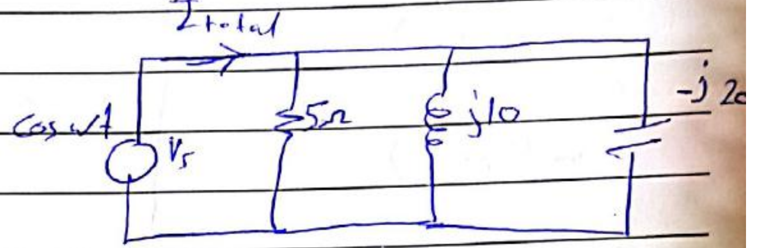


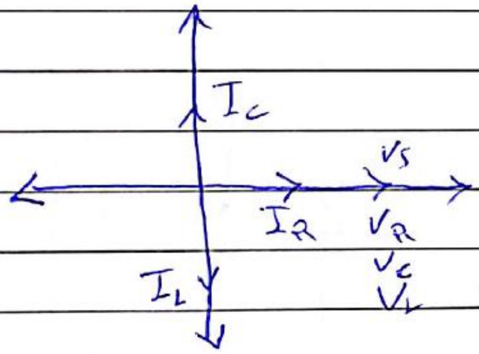
We use superposition

Scanned by CamScanner

No

Draw the phasors for Voltages & currents :-





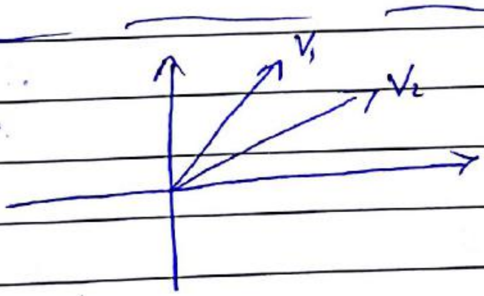
$I_{total} = I_R + I_c + I_L$
$= 0.2 - j0.05$

$I_R = \dfrac{V_R}{5} = \dfrac{V_s}{5} = \dfrac{1\angle 0}{5} = 0.2\angle 0$

$I_L = \dfrac{V_L}{X_L} = \dfrac{1\angle 0}{j10} = -0.1\,j$

$\boxed{Z = jX + R}$

$I_c = \dfrac{V_c}{X_c} = \dfrac{1\angle 0}{-j20} = j0.05$



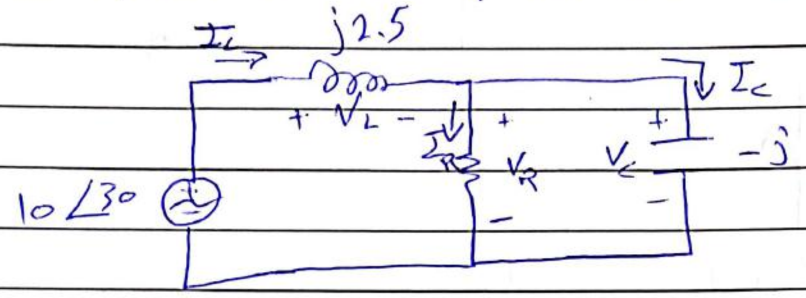
V_1 Leads V_2

Scanned by CamScanner

الثلاثاء ٤/١٢

No

ex: Draw all the phasors :-



Sol :

$$I_L = \frac{10\angle 30}{j2.5 + \frac{-j2}{2-j}}$$

$$I_L = 3.92 - j4.17 \qquad \angle \tan^{-1}\left(\frac{-4.17}{3.92}\right) \neq \left(\frac{4.17}{-3.92}\right)$$

$$= \left|\sqrt{(3.92)^2 + (-4.17)^2}\right.$$

$$= 5.72 \angle -46.75$$

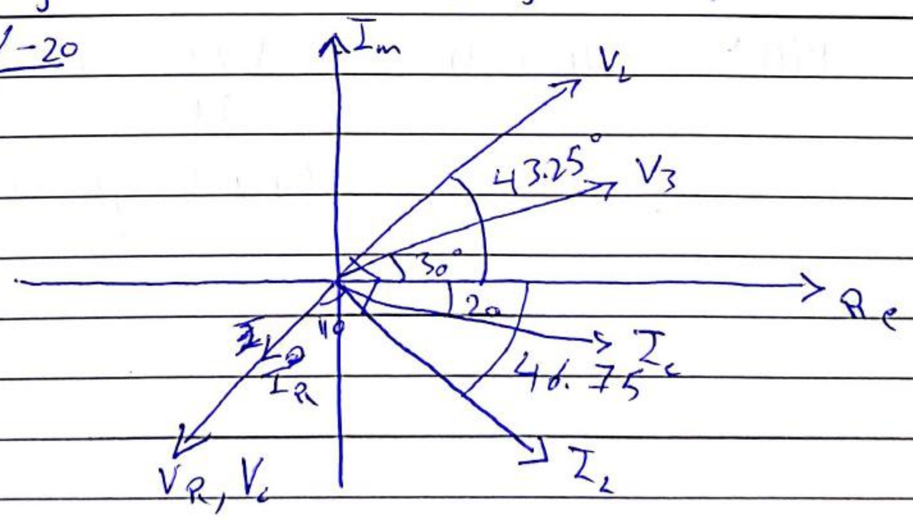
$$V_L = j2.5 * I_L = 14.3 \angle 43.25$$

$$I_R = \left(\frac{-j}{2-j}\right)(3.92 - j4.17) = 2.56 \angle -110$$

$$V_R = I_R * R = 5.12 \angle -110 \quad , \quad V_C = V_R$$

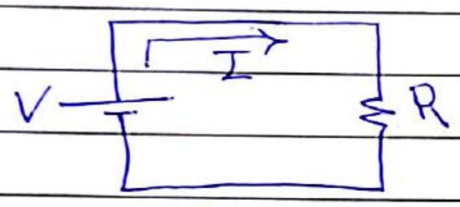
$$I_C = \frac{V_C}{-j} \quad , \quad I_C = \frac{2}{2-j} \times I_L \quad , \quad I_C = I_L - I_R$$

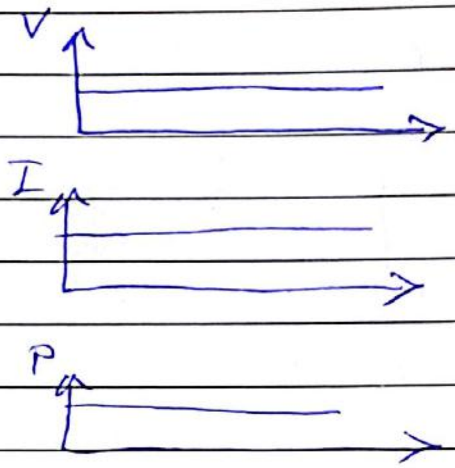
$$I_C = 5.12 \angle -20$$



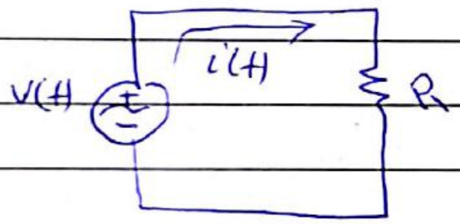
Scanned by CamScanner

Power :-





$\cancel{P} = P = VI$



$$P(t) = i^2(t)\,R = \frac{V^2(t)}{R}$$
$$= i(t)\,v(t)$$

In Inductor :

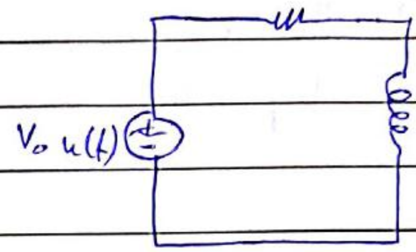
$$P(t) = i(t)\;v(t)$$
$$= i(t)\;L\frac{d\,i(t)}{dt}$$
$$= v(t) * \frac{1}{L}\int_{-\infty}^{t} v(T)\,dT$$

In capacitor :-

$$P(t) = i(t)\;v(t) = C\frac{d\,v_c(t)}{dt} * v(t)$$
$$= i(t) * \frac{1}{C}\int_{-\infty}^{t} i(T)\,dT$$

No

ex. $i(t) = \frac{V_o}{R}\left(1 - e^{-\frac{tR}{L}}\right) u(t)$



Power generated by the source

$P(t) = i(t)\, v(t)$

$= \frac{V_o}{R}\left(1 - e^{-tR/L}\right) u(t) \times V_o\, u(t)$ $\quad \boxed{u(t) \times u(t) = u(t)}$

Power dissipated by R :- or delivered to the resistor :

مهم

$P(t) = i^2(t)\, R = \frac{V_o^2}{R}\left(1 - e^{-tR/L}\right)^2 u(t)$

Power stored in the inductor :- or absorbed by

$P_L(t) = v(t)\, i(t)$

$= L \frac{d\, i(t)}{dt} \times i(t)$

بالمثال السابق $\Rightarrow$ $P_L(t) = L\left(\frac{V_o}{R}(-1)\left(\frac{R}{L}\right) e^{-tR/L}\right)\left(\frac{V_o}{R}\left(1 - e^{-tR/L}\right)\right)$

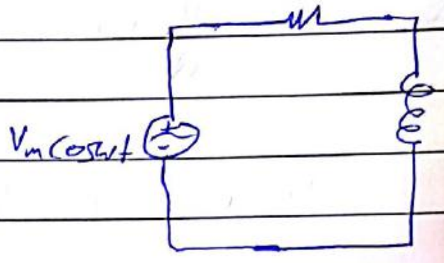
$= \frac{V_o^2}{R}\, e^{-tR/L}\left(1 - e^{-tR/L}\right) u(t)$

$\Rightarrow$ Instantaneous Power $\quad \boxed{\frac{du(t)}{dt} = 0}$

Scanned by CamScanner

No

(ex) The Power generated by the Source :-



$$P(t) = V_m \cos(wt) * I_m \cos(wt+\phi)$$

$$= \frac{V_m I_m}{2}\left[\cos(2wt+\phi) + \cos\phi\right]$$

$v(t) = V_m \cos wt$

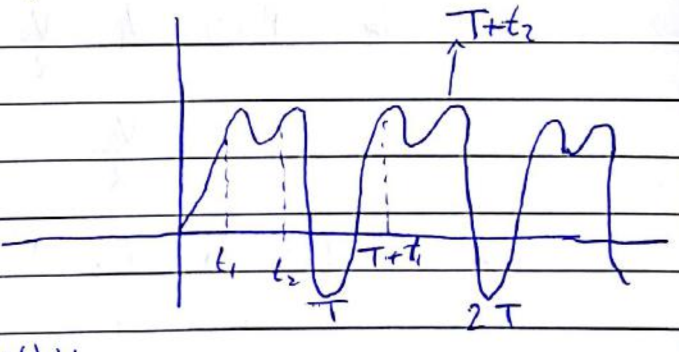
$i(t) = I_m \cos(wt+\phi)$

⇒ we need more efficient & accurate Power representation :-

⇒ average Power :-

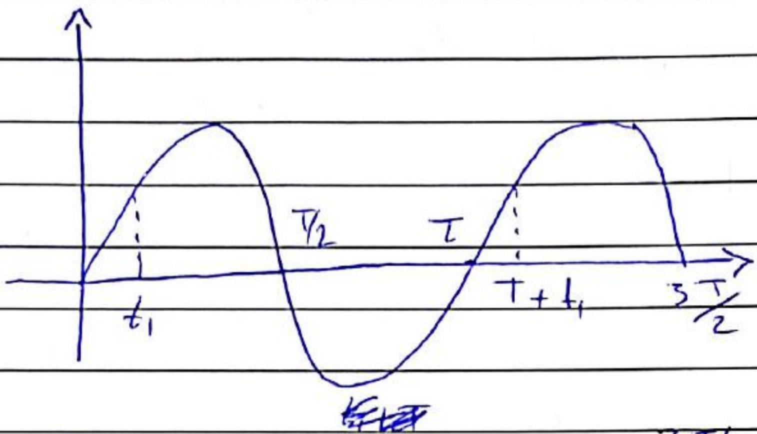
$$P = \frac{1}{t_2 - t_1}\int_{t_1}^{t_2} P(t)\, dt$$

For a periodic Signal :-



$$\frac{1}{T}\int_{t_1}^{t_2} P(t)\,dt = \frac{1}{T}\int_{T+t_1}^{T+t_2} P(t)\,dt$$

No



$$\int_0^T P(t)\,dt = \int_{t_1}^{t_1+T} P(t)\,dt = \int_{T/2}^{3T/2} P(t)\,dt$$

912 ⇒ Lets assume : (for any element $V(t) = V_m \cos(wt+\theta)$
$i(t) = I_m \cos(wt + \phi)$)

$$P(t) = V(t)\, i(t)$$
$$= I_m V_m \cos(Wt+\theta)\ \cos(wt+\phi)$$
$$\boxed{P(t) = \frac{1}{2} V_m I_m \cos(\theta-\phi) + \frac{1}{2} V_m I_m \cos(2wt+\theta+\phi)}$$

$$P = \frac{1}{T}\int_0^T P(t) = \frac{1}{T}\int_0^T \frac{1}{2} V_m I_m \left[\cos(\theta-\phi) + \cancel{\cos(2wt+\theta+\phi)}\right] dt \quad \to 0$$

$$= \frac{1}{T}\int_0^T \frac{1}{2} V_m I_m \cos(\theta-\phi)\,dt$$

$$= \frac{1}{T} * T * \frac{1}{2} V_m I_m \cos(\theta-\phi)$$

$$\boxed{P = \frac{1}{2} V_m I_m \cos(\theta-\phi)}$$

Scanned by CamScanner

No

ex: $V(t) = 4\cos\left(\frac{\pi t}{6}\right)$, $Z = 2\angle 60^\circ$

$\Rightarrow v(t) \Rightarrow 4\angle 0$

$I = \frac{4\angle 0}{2\angle 60} = 2\angle -60^\circ$

$P = \frac{1}{2} * 4 * 2 * \cos(0 - -60)$

$P = 2W$

$\cos a \cos b = \frac{\cos a+b}{2} + \frac{\cos(a-b)}{2}$

$P(t) = v(t)\, i(t)$

$= 4\cos\left(\frac{\pi}{6}t\right) * 2\cos\left(\frac{\pi}{6}t - 60\right)$

$P(t) = 2 + \cos\left(\frac{\pi}{3}t - 60\right)$

---

* The average Power absorbed by a resistor is :-

$P = \frac{1}{2} V_m I_m \underbrace{\cos(\theta - \phi)}_{\text{for Sinosoidal}}$ ⟶ 1 ⟶ because V & I are inphase

$= \boxed{\frac{1}{2} V_m I_m}$ for R

$= \frac{1}{2} I_m^2 R$

$= \frac{V_m^2}{2R}$

* average Power "absorbed" by an inductor :-

$P = \frac{1}{2} V_m I_m \cancel{\cos(\theta - \phi)} \to 0$

$P_{avg} = 0$ for Inductor

* for a capacitor :

$P = \frac{1}{2} V_m I_m \cancel{\cos(\theta - \phi)} \to 0$

$P_{avg} = 0$ for C

Scanned by CamScanner

ex: find the average power delivered to an impedence

$Z = 8 - j11$ & $I = 3 + j4$

$\rightarrow p = 0$

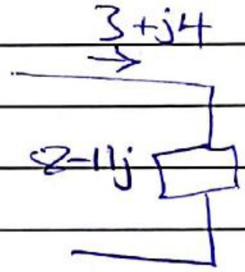
$P_{avg} = \frac{1}{2} V_m I_m \cos(\theta - \phi)$

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

$I = \sqrt{3^2 + 4^2} \angle \tan^{-1}(\frac{4}{3})$

$\hookrightarrow 5$

$P = \frac{1}{2} 5^2 * 8 = 100$ W



$V = (3 + j4)(8 - j11)$

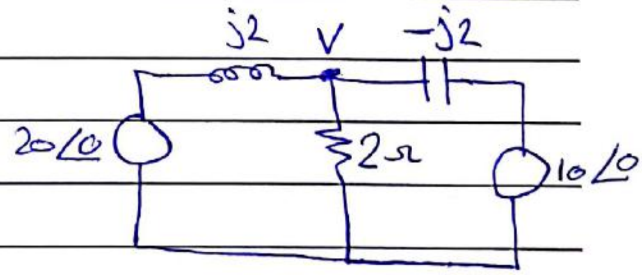
$= (68 - j)$ V

$= 68.1 \angle 0.84$

$P(t) = v(t) \cdot i(t)$

$= 68.1 \cos(wt - 0.84) * 5 \cos(wt + 53°)$

find the average power absorbed by the elements & generated by sources:-



at node V:-

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

$-j10 + \cancel{j10}\ \cancel{j0.5V} - 0.5V + j5 - \cancel{0.5V} = 0$

$V = \frac{j5}{-0.5} = 10 \angle -90°$

Scanned by CamScanner

No

$P_R = \frac{1}{2}\frac{V_m^2}{R} = \frac{1}{2}(10)^2 * \frac{1}{2} = 25$ W (absorbed)

$P_{20} = \frac{1}{2} V_m I_m \cos(\theta - \phi)$

$I_1 = \frac{20\angle 0 - 10\angle -90}{j2} = 5 - j10$

$= 11.18 \angle -63.43$

$P_{20} = \frac{1}{2} * 20 * 11.18 \cos(0 + 63.43) = 50$ W

(generated)

$P_{10} = \frac{1}{2} V_m I_m \cos(\theta - \phi)$

$I_2 = 5 - j5 = 7.071 \angle -95$

$P_{10} = \frac{1}{2} * 10 * 7.071 * \cos(0 + 45) = 25$ W (absorbed)

Scanned by CamScanner

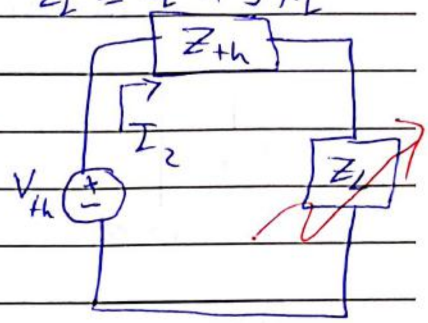
14/2

No

Maximum Power transfer:- given: $Z_{th} = R_{th} + jX_{th}$ & V_{th}

$Z_L = R_L + jX_L$

V_{oc} ?? I_{sc} ?? Z_{th} ??



$$I_L = \frac{V_{Th}}{Z_{th} + Z_L}$$

$$= \frac{V_{th}\angle 0}{R_{th} + jX_{Th} + R_L + jX_L}$$

$$V_L = V_{th} * \frac{Z_L}{Z_L + Z_{th}} = V_{th} * \frac{R_L + jX_L}{R_L + jX_L + R_{th} + jX_{th}}$$

$$|I_L| = \frac{|V_{th}|}{\sqrt{(R_L + R_{th})^2 + (X_{th} + X_L)^2}}$$

$$\angle I_L = \angle V_{th} - \tan^{-1}\left(\frac{X_{th} + X_L}{R_{th} + R_L}\right)$$

$$|V_L| = \frac{|V_{th}| * \sqrt{(R_L)^2 + (X_L)^2}}{\sqrt{(R_L + R_{th})^2 + (X_L + X_{th})^2}}$$

$$\angle V_L = \angle V_{th} + \tan^{-1}\left(\frac{X_L}{R}\right) - \tan^{-1}\left(\frac{X_L + X_{th}}{R_L + R_{th}}\right)$$

$$P = \frac{1}{2} I_m V_m \cos(\theta - \phi)$$

$$P = \frac{1}{2} |V_L| |I_L| \cos(\theta - \phi)$$

→ follow

No

$$P = \frac{\frac{1}{2} V_{th}^2 \sqrt{R_L^2 + X_L^2}}{(R_{th} + R_L)^2 + (X_{th} + X_L)^2} \cos\left(\tan^{-1} \frac{X_L}{R_L}\right)$$

$$\left.\frac{dP}{dR_L}\right|_{\boxed{R_L = 0}} \Rightarrow \boxed{R_L = R_{th}}$$

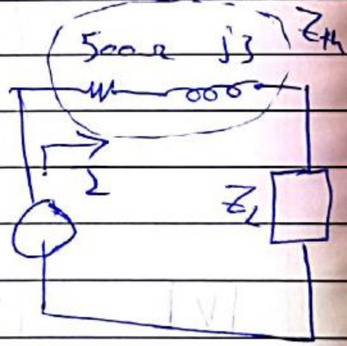
$$\left.\frac{dP}{dX_L}\right|_{\boxed{X_L = 0}} \Rightarrow X_{th} = -X_L$$

In conclusion :-

[illegible] Max Power [illegible] $\boxed{Z_L = Z_{th}^*}$ $\rightarrow$ to have maximum power transfer

الـ Z_L يـ الـ Conj لـ Z_{th}

(ex) what value of Z_L to have Maximum Power transfer



$Z_L = 500 - j3$

Max Power transfer current

$$I = \frac{V_{th}}{Z_L + Z_{th}} = \frac{V_{th}}{2R_L} = \frac{V_{th}}{2R_{th}}$$

$$I = \frac{V_{th}}{R_L + jX_L + R_L - jX_L}$$

Power for signals with multiple frequancie

$i(t) = \sin t + \sin \pi t$, $R = 1$

find the average dissipated by R ?

$$P = \frac{R}{T_1} \int_{T_1} \sin^2 t \, dt + \frac{R}{T_2} \int_{T_2} \sin^2 \pi t \, dt$$ follow

Scanned by CamScanner

No

Sol: $T_1 = 2\pi$, $T_2 = \frac{2\pi}{w} = \frac{2\pi}{\pi} = 2$

$$P = \frac{1}{2\pi}\int_0^{2\pi} \sin^2 t \, dt + \frac{1}{2}\int_0^{2} \sin^2 \pi t \, dt$$

$$= \cancel{\frac{1}{2\pi}\int_0^{2\pi} \sin^2 t} = \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2} - \underbrace{\frac{1}{2}\cos 2t}_{0} + \frac{1}{2}\int_0^{2} \frac{1}{2} - \underbrace{\frac{1}{2}\cos 2\pi t}_{0}$$

$$= 2\pi * \frac{1}{2\pi} * \frac{1}{2} + \frac{1}{2} * \frac{1}{2} * 2 = 1W = \left(\frac{1}{2}(1)^2 + \frac{1}{2} * (1)^2\right) R$$

⇒ for sources with multiple frequency

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

ex $i(t) = 2\cos 10t - 3\cos 20t$ $R = 4$

find the average Power:-

Sol:

$$P_{avg} = \frac{1}{2} I_{m_1}^2 R + \frac{1}{2} I_{m_2}^2 R$$

$$= \frac{1}{2}(2)^2 4 + \frac{1}{2}(\pm 3)^2 4 = 26\ W$$

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

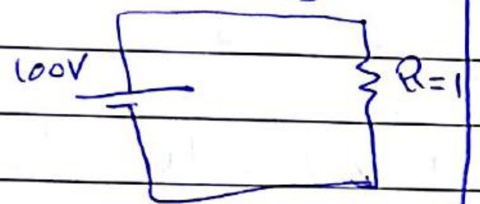
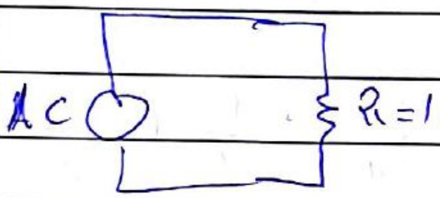
$= -\cos 10t$

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

Scanned by CamScanner

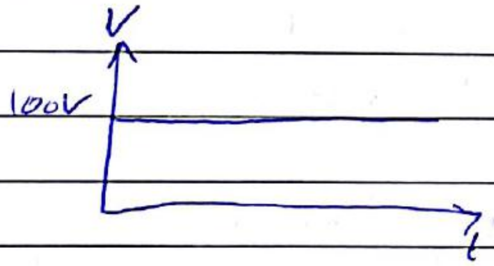
Effective values :-

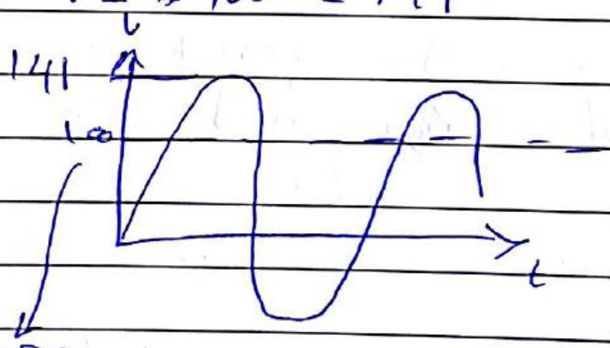
220 V

DC system	AC system
	
$P = \frac{(100)^2}{1} = 10^4 W$	AC ?? $\Rightarrow 10^4$ W
	$P = \frac{1}{2} \frac{(V_m)^2}{R}$

$$10^4 = \frac{1}{2}(V_m)^2 \Rightarrow (V_m)^2 = 2 \times 10^4$$

$$V_m = \sqrt{2} \times 100 = 141$$





Effective value
(Root mean square value)
جذر ← متوسط ← جذر ← قيمة
الحالي
$\frac{1}{T}$

$$P_{av(DC)} = \frac{(V_{DC})^2}{R}$$

$$P_{av(AC)} = \frac{1}{TR} \int_0^T v^2(t)\, dt$$

Follow

16/12 الاثنين

No

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

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

⇒ RMS Value for a sinosoidal Signal.

$$i(t) = I_m \cos(\omega t + \phi) \qquad T = \frac{2\pi}{\omega}$$

sol

$$I_{rms} = \sqrt{\frac{\omega}{2\pi} \int_0^{\frac{2\pi}{\omega}} I_m^2 \underbrace{\cos^2(\omega t + \phi)}_{\frac{1}{2} + \frac{1}{2}\cos(2\omega t + 2\phi)} \, dt}$$

$$= \sqrt{\frac{\omega}{2\pi} \int_0^{\frac{2\pi}{\omega}} \frac{I_m^2}{2} + \cancel{\frac{I_m^2}{2} \cdot \cos(2\omega t + 2\phi)}^{\,0} \, dt}$$

$$= \sqrt{\frac{\omega}{2\pi} \int_0^{\frac{2\pi}{\omega}} \frac{I_m^2}{2} \, dt} = \sqrt{\frac{\omega}{2\pi} * \frac{2\pi}{\omega} * \frac{I_m^2}{2}}$$

$$\boxed{I_{rms} = \frac{I_m}{\sqrt{2}}} \Rightarrow$$ ورح يجي ال $\frac{\text{Peak Value}}{2}$

For Sinosoidal &

$$R: \quad P_{avg} = \frac{1}{2} V_m I_m = \frac{1}{2} (\sqrt{2} V_{rms})(\sqrt{2} I_{rms}) = V_{rms} I_{rms}$$

$$= \frac{1}{2} \frac{V_m^2}{R} = \frac{(V_{rms}^2)}{R} = \frac{1}{2} I_m^2 R = (I_{rms})^2 R \quad \star$$

$$P_{avg} = \frac{1}{2} V_m I_m \cos(\theta - \phi) = V_{rms} I_{rms} \cos(\theta - \phi)$$

$$= V_{eff} I_{eff} \cos(\theta - \phi)$$

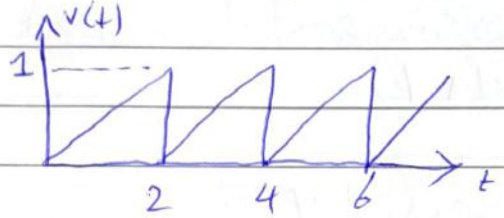
Scanned by CamScanner

No

$$v(t) = 310\cos(\omega t - 30^\circ)$$
$$= \underline{\sqrt{2}\,220}\cos(\omega t - 30^\circ)$$

↳ RMS Value

ex) Find the RMS Value :-



$$\boxed{v(t) = \frac{1}{2}t}$$

↳ معادلة خط مستقيم

$\underline{T = 2}$

$$V_{eff} = \sqrt{\frac{1}{2}\int_0^2 \left(\frac{1}{2}t\right)^2 dt}$$

$$= \sqrt{\frac{1}{2}\int_0^2 \frac{1}{2}t^2\, dt} = \sqrt{\frac{1}{2} * \frac{1}{12} t^3 \Big]_0^2} = \frac{1}{\sqrt{3}}$$

In general :- for smooth Signals : $V_{rms} = \frac{V_m}{\sqrt{3}}$

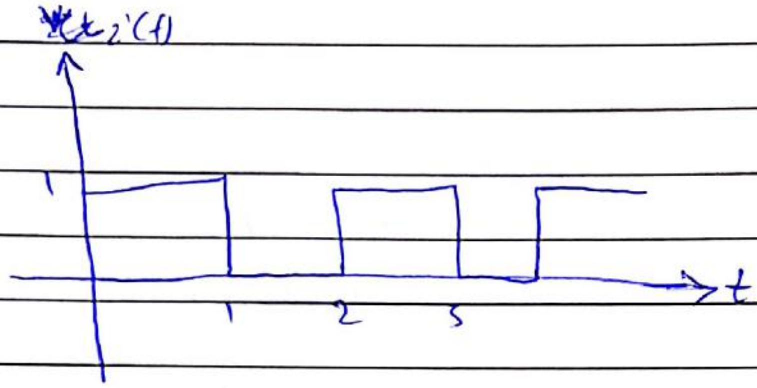
$$P_{avg} = \left(\frac{1}{2}I_{m_1}^2 + \frac{1}{2}I_{m_2}^2 + \frac{1}{2}I_{m_3}^2 + \cdots\right)R$$

$$= \left(\underset{eff_1}{I_{rms_1}^2} + \underset{eff_2}{I_{rms_2}^2} + \underset{eff_3}{I_{rms_3}^2} + \cdots\right)R$$

$$I_{eff} = \sqrt{(I_{eff_1})^2 + (I_{eff_2})^2 + (I_{eff_3})^2}$$

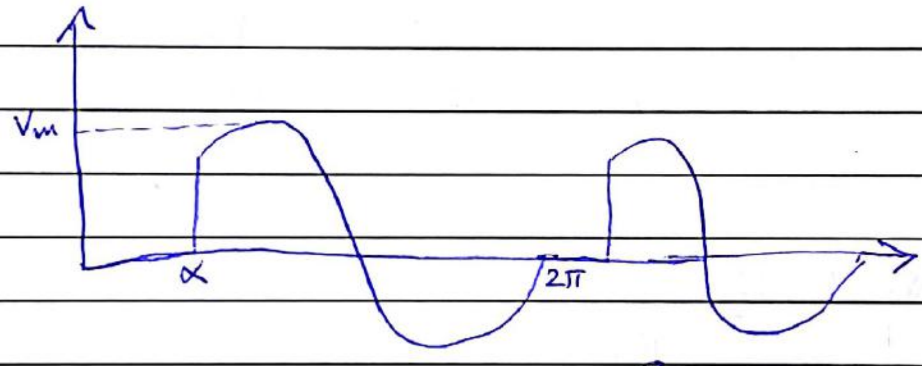
Scanned by CamScanner

No



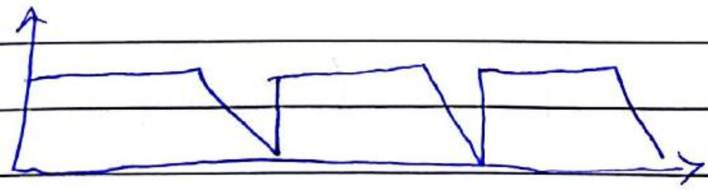
$$i(t) = \begin{cases} 1 & 0 \leq t < 1 \\ 0 & 1 \leq t \leq 2 \end{cases}$$

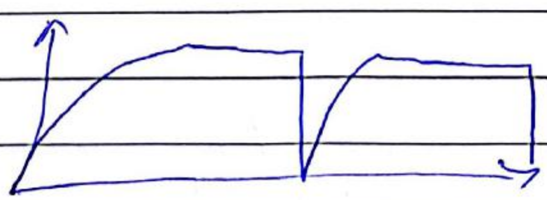
$$I_{eff} = \sqrt{\frac{1}{2} \int_0^1 (1)^2 \, dt} \, .$$



$T = 2\pi$, $v(t) = \begin{cases} 0 & , 0 < t < \alpha \\ V_m \sin wt & , \alpha < t < 2\pi \end{cases}$

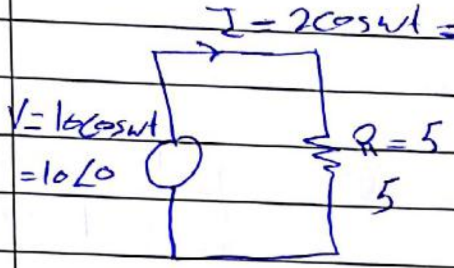
$$V_{rms} = \sqrt{\frac{1}{2\pi} \int_\alpha^{2\pi} V_m^2 \sin^2 wt \, dt}$$

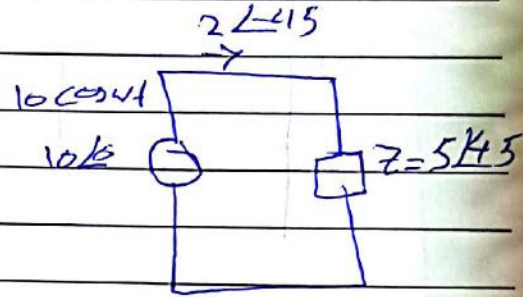




T ?? $f(t)$?

* The Power Factor :-





$P = \frac{1}{2} V_m I_m = \frac{1}{2}(10)(2) = 10W$

$P = \frac{1}{2} * 10 * 2 * \cos(45)$

$= \frac{10}{\sqrt{2}}$ W

صرفت نار اكاي بس بواط اي فينا نعرف قيمة اخرى ال Power

$PF \triangleq \frac{\text{Real Power}}{\text{Apparent Power}}$

$= \frac{V_{rms} I_{rms} \cos(\theta - \phi)}{V_{rms} I_{rms}} = \boxed{\cos(\theta - \phi)}$

Apparent Power $= V_{rms} I_{rms} = \frac{1}{2} V_m I_m$

$(\theta - \phi) \rightarrow$ PF angle

$\Rightarrow$ R Loads $\Rightarrow PF = \cos(\theta_r - \theta_I) \Rightarrow PF = 1$

$\Rightarrow X_L$ Loads $\Rightarrow PF = \cos(\theta - \phi) = 0$

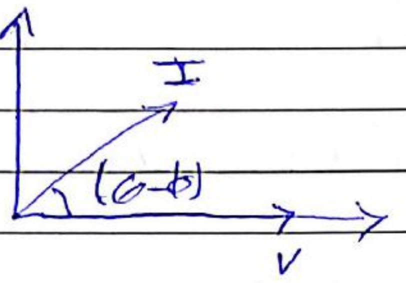
$\Rightarrow$ RX Loads $\Rightarrow PF = \cos(\theta - \phi)$

$0 \leq PF \leq 1$

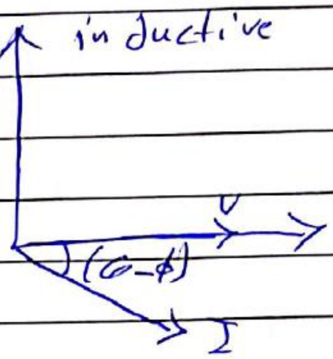
Scanned by CamScanner

No

Capacitive



inductive



$PF = \cos(\theta - \phi)$
(Leading)
- capacitive case

$PF = \cos(\theta - \phi)$
(lgging)
- inductive case

$$PF = \frac{\text{Real Power } (P)}{\text{Apparent Power } (|S|)}$$

$$= \frac{V_{rms} I_{rms} \cos(\theta - \phi)}{V_{rms} I_{rms}} = \cos(\theta - \phi)$$

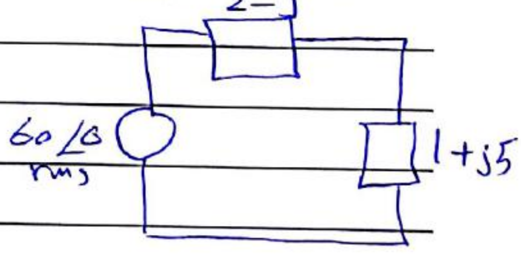
$R \rightarrow PF = 1$

$X_L, X_C \rightarrow PF = 0$

$RL, RC \Rightarrow 0 < PF < 1$

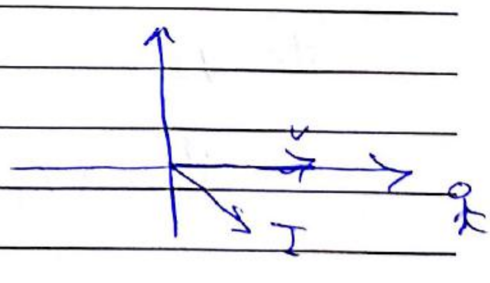
$V = 60 \angle 0$

$v(t) = \sqrt{2}\, 60 \cos(\omega t)$



PF of the source

$$I_{rms} = \frac{60 \angle 0}{(2-j) + 1 + j5}$$
$$= 12 \angle -53.13$$



NO

$P_{avg(2-j)} = (I_{rms})^2 R = (12)^2 * R = (12)^2 * 2 = 288 W$

$P_{avg(1+j5)} = (I_{rms})^2 R = (12)^2 * 1 = 144 W$

Apparent Power Produced by the source :-

$|S| = V_{rms} I_{rms} = 60 * 12 = 720$ (Voltrampere) (VA)

$PF_{(1+j5)}$

$V_{(1+j5)} = (1+j5)(12 \angle -53.13) = 61 \angle 25.56 V$

$PF_{(1+j5)} = \cos(25.56 + 53.13) = 0.19$

Complex Power (S)

↳ in introduced to represent the Power in both R & X

Complex Power → Real Power (P)
→ Reactive Power (Q)

is introduced
to represent the charging & dischanging in L & C
[rate of energy exchange]

$V = V_{eff} \angle \theta$ $I = I_{eff} \angle \phi$

$P = |V_{eff}| |I_{eff}| \cos(\theta - \phi)$

⟹ follow

No

$$P = |V_{eff}||I_{eff}| \, Re\left[e^{j(\theta-\phi)}\right]$$

$$= Re\left[|V_{eff}| e^{j\theta} * |I_{eff}| e^{-j\phi}\right]$$

$$= Re\{VI^*\}$$

$$\boxed{S = V_{eff} I_{eff}^*}$$

follow

$$S = V_{eff} I_{eff} e^{j(\theta-\phi)} = P + jQ$$

$$= \underbrace{|V_{eff}||I_{eff}|\cos(\theta-\phi)}_{P} + \underbrace{j|V_{eff}||I_{eff}|\sin(\theta-\phi)}_{Q}$$

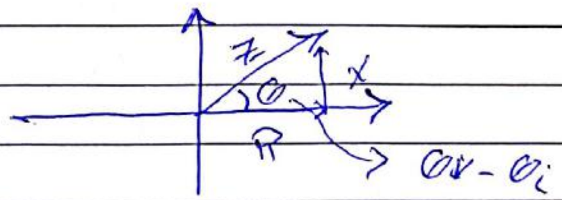
$S = P + jQ \rightarrow$ Reactive Power $|V_{eff}||I_{eff}|\sin(\theta-\phi)$
(Volts ampere reactive
$\boxed{(VAR)}$

Complex Power
$V_{eff} I_{eff}$
$\boxed{(VA)}$

Real Power (average Power)
$|V_{eff}||I_{eff}|\cos(\theta-\phi)$
$\boxed{(W)}$

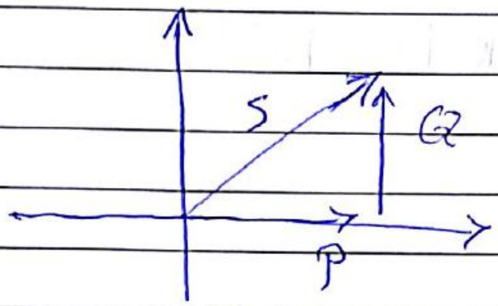
$$|S| = |I_{eff}||V_{eff}|$$

$$Z = R + jX$$



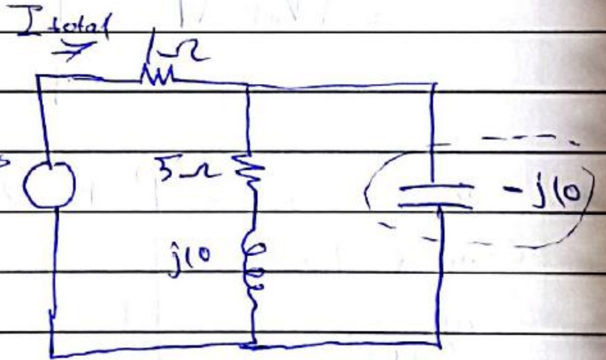
No

⇒ Power triangle :-



$S = P + jQ$

(ex) Find the complex Power produced / absorbed by the sources & the elements :-



$$I_{total} = \frac{120\angle 0}{1 + \frac{-j10(5+j10)}{5}}$$

$= 5.16\angle 25.46$ A

$P_{avg(1\Omega)} = (I_{rms})^2 R$
$= (5.16)^2 (1) = 26.6$ W

$S_{(1\Omega)} = V_{rms} I_{rms}^*$
$= 5.16\angle 25.46 * 5.16\angle -25.46$

$= 26.6\angle 0$
$\Rightarrow 26.6 + j0$ (VA)

Scanned by CamScanner

No

$S_{(-j10)} = ?? \rightarrow V_{rms}, I_{rms}$

$I_{(-j10)} = 5.16 \angle 25.46 * \frac{5+j10}{5}$ } Current devegen

$= 11.53 \angle 88.89$ A

$V_{(-j10)} = (-j10)\ 11.53 \angle 8.89 = \cancel{...}\ 11.53 \angle 8.89$

$= 115.3 \angle -1.11$

ohm's Law $V = IZ$

$S_{(-j10)} = V_{eff} I_{eff}^*$

$= 115.3 \angle -1.11 * 11.53 \angle -88.89$

$= 1331 \angle -90 = 0 - j1331$ VA

$S_{(5+j10)} = ??\ V_{rms}, I_{rms}$

$I_{rms} = 5.16 \angle 25.46 * \frac{-j10}{5} = 10.31 \angle -64.53$ A } Current devegen

$V_{rms} = (5+j10)(10.31 \angle -64.53)$

$= 115.27 \angle -1.095$ V

} ohm's Law $V = IZ$

$S = 115.27 \angle -1.095 * 10.31 \angle 64.53$

$= 531.48 + j1062.96$ VA

الأربعاء 21/2

No

$S_{source} = V_{rms} I_{rms}^{*}$

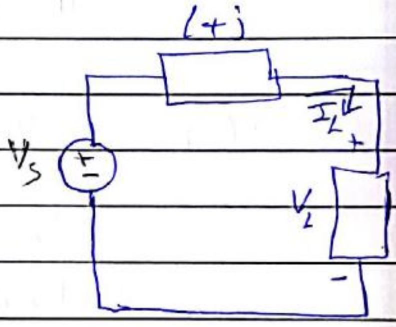
$= (120 \angle 0)(5.16 \angle -25.46)$

$= 558.98 - j266$

$P_{(1)} = 26.6\ W$

$V_L = 60 \cos(wt - 10)\ V$

$i_L = 1.5 \cos(wt + 50)\ A$



complex Power :-

$S = V_{rms} I_{rms}^{*}$

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

$= 45 \angle -60$

$= 45 \cos(-60) + j45 \sin(-60)$

$= 45 \cos(-60) + j45 \sin(-60)$

$= (22.5 - j45 \frac{\sqrt{3}}{2})\ VA \rightarrow -39j$

سالب $Q < 0 \Rightarrow$ capacitive load

موجب $Q > 0 \Rightarrow$ Inductive load

$PF = \cos(-10-50) = 0.5$ Leading

$\Rightarrow$ find complex power (S) source :-

KVL $\Rightarrow V_s = \frac{60}{\sqrt{2}} \angle 10 + (\frac{1.5}{\sqrt{2}} \angle 50) * (1+j) = 42 \angle -8.01$

$S = 42 \angle 8 * \frac{1.5}{\sqrt{2}} \angle -50 = 44.5 \angle -58$

$PF_{source} = \cos(-8 - 50) = 0.53$ Leading

No

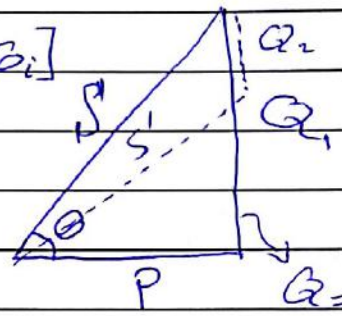
* PF correction :-

its an Increasing of the load PF while while maintaining Same load Voltage & current

$PF = \cos(\theta)$ $\quad [\theta = \theta_v - \theta_i]$

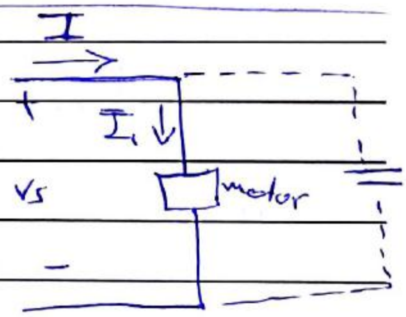
$PF' = \cos(\theta')$

$\underbrace{PF' > PF}$



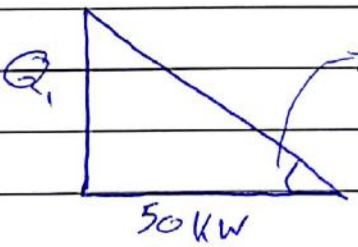
Induction motor operating at 50 KW & 0.8 lagging PF & $V_s = 230\ V_{rms}$.

We need to make the PF = 0.95



Sol :

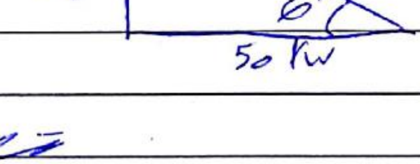
⇒ add a corrective device [capacitor]



$\cos^{-1}(0.8) = 36.9°$

$\frac{Q_1}{P} = \tan(36.9°)$

$Q_1 = 37.5\ KVAR$



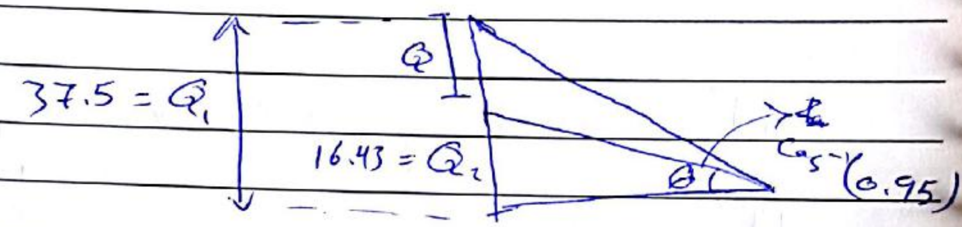
$\cos^{-1}(0.95)$

follow

No

$$\frac{Q_2}{50kw} = \tan\left(\cos^{-1}(0.95)\right) = \tan(18.19)$$

$$Q_2 = 16.43 \ kVAR$$



$$S_1 = P_1 + jQ_1 \quad , \quad |S_1| = \sqrt{P_1^2 + Q_1^2}$$

$$|Q_c| = Q_1 - Q_2$$

$C = ??$

$$|Q_c| = |V_{rms}||I_{rms}| \sin(\theta - \phi)$$

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

$$= |V_{rms}||V_{rms} WC|$$

$$= |V_{rms}|^2 WC$$

$$|V_{rms}| = |I_{rms}||X_c|$$

$$= |I_{rms}|\left|\frac{1}{WC}\right|$$

وحدة ال W هي rad/sec

1 HZ = 2π rad/sec

$$C = \frac{|Q_c|}{|V_{rms}|^2 W} = \frac{P(\tan\theta_1 - \tan\theta_2)}{|V_{rms}|^2 W}$$

Review

$$V(t) = 5 + 5\sin(314t)$$

(هذا لازم نحل اسئلة كثير)

find V_{avg} & V_{rms} ??

sol :

$$T = \frac{2\pi}{W} = \frac{2\pi}{314}$$

$$V_{rms} = \left(\frac{314}{2\pi}\int_0^{\frac{2\pi}{314}} (5 + 5\sin(314t))^2 \, dt\right)^{\frac{1}{2}}$$

$$V_{rms} = \sqrt{25 + \frac{25}{2}}$$

Scanned by CamScanner

الثلاثاء 23/2

No

Suggested Problems : (hyat 7adith)

14, 16, 20, 26, 31, 36, 39, 42, 44, 45, 52

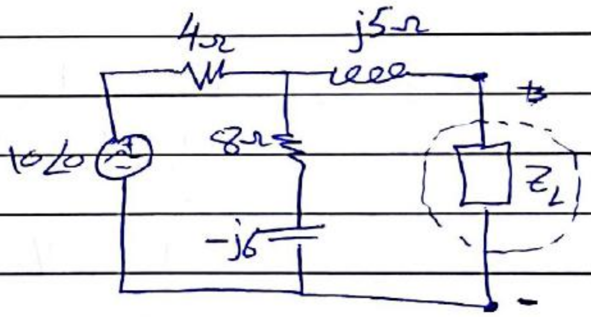
$v(t) = 5 + 5\sin(31.4t)$

$$\boxed{V_{eff} = \sqrt{V_{eff_1}^2 + V_{eff_2}^2}} = \sqrt{25 + \left(\frac{5}{\sqrt{2}}\right)^2}$$

$V_{avg} = 5$

* Determine the load impedence that maximize the average power drawn from the ckT & what is the maximum average power:

sol

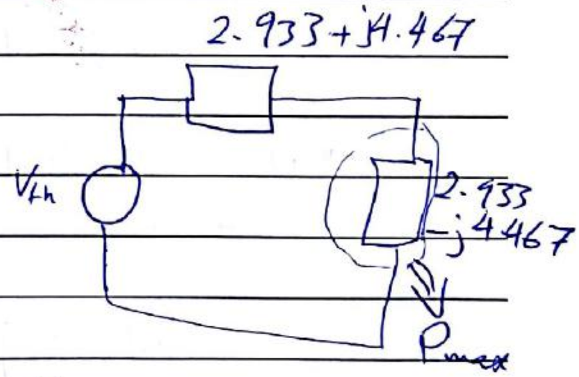


Z_{th} :

$$Z_{th} = j5 + \frac{4(8-j6)}{4+8-j6}$$

$$= 2.933 + j4.467\ \Omega$$

$$Z_L = Z_{th}^* = 2.933 - j4.467\ \Omega$$



$$V_{th} = 10\angle 0 * \frac{(8-j6)}{8-j6+4}$$

$$= 7.454\angle -10.3$$

(average power)

$$P_{max} = \frac{1}{2} V_L I_L \overbrace{\cos(\phi - \phi)}^{1} = \frac{1}{2} * \frac{V_{th}}{2} * \frac{V_{th}}{2R}$$

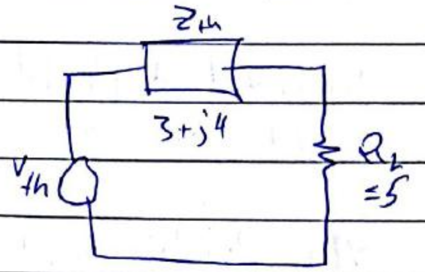
$$= \boxed{\frac{|V_{th}|^2}{8R}} = 2.368\ W.$$

Scanned by CamScanner

No

$\frac{dP}{dX_L} \Rightarrow X_{th} = -X_L$

$\frac{dP}{dR_L} \Rightarrow \boxed{R_{th} = R_L}$



$R_L = \sqrt{R_{th}^2 + (X_{th} + X_L)^2}$

if Z_L is Pure resistive:

$R_L = \sqrt{R_{th}^2 + X_{th}^2} = \|Z_{th}\|$

---

ex) Find the average power across a $4\,\Omega$ resistor when:

① $V(t) = 8\sin(100t) + 6\cos(200t - 45°)$

Sol:

$P_{total} = P_{avg_1} + P_{avg_2}$

$= \frac{1}{2}(I_{m_1}^2 + I_{m_2}^2) R$

$* = \frac{1}{2}(V_{m_1}^2 + V_{m_2}^2 + \dots)/R = \frac{1}{2}\frac{(8)^2}{4} + \frac{1}{2}\frac{(6)^2}{4} = 12.5\,W$

② $V(t) = 8\sin 200t - 6\cos(200t - 45)$

sol:

$v(t) = 8\sin 200t - 6[\cos 200t \cos 45 + \sin 200t \sin 45]$

$= 8\sin 200t - \frac{6}{\sqrt{2}}\cos 200t - \frac{6}{\sqrt{2}}\sin 200t$

$= \left(8 - \frac{6}{\sqrt{2}}\right)\sin 200t - \frac{6}{\sqrt{2}}\cos 200t$

$= 3.75\sin 200t - 4.24\cos 200t$

$= \sqrt{(3.75)^2 + (4.24)^2}\ \cos\left(200t - \tan^{-1}\left(\frac{-4.24}{3.75}\right)\right)$

$P_{avg} = \frac{((3.75)^2 + (4.24)^2)}{4} = 4.01$

$A\sin\omega t + B\cos\omega t = C\cos(\omega t - \phi)$

$C = \sqrt{b^2 + A^2}$

$\phi = \tan^{-1}\left(\frac{B}{A}\right)$

$\cos(A-B) = \cos A\cos B + \sin A\sin B$

Scanned by CamScanner

No

(3) $v(t) = \underbrace{8 \sin 200t - 6\cos(200t - 45)}_{4.01\,W} + 4$

$= \frac{V^2}{R} = \frac{16}{4} = 4$

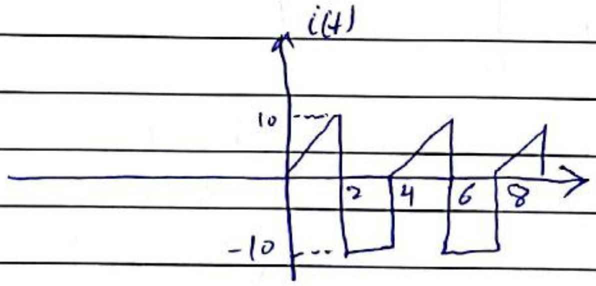
$4.01 + 4 = 8.01\,W$

$V(t) = 100 \cos(wt - 10)$

$i(t) = 2 \sin(wt + 30) = 2\cos(wt + 30 - 90^\circ) = 2\cos(wt - 60)$

$PF = \cos(-10 + 60) = \cos(50)$ lagging

Find the rms value :-



Sol :

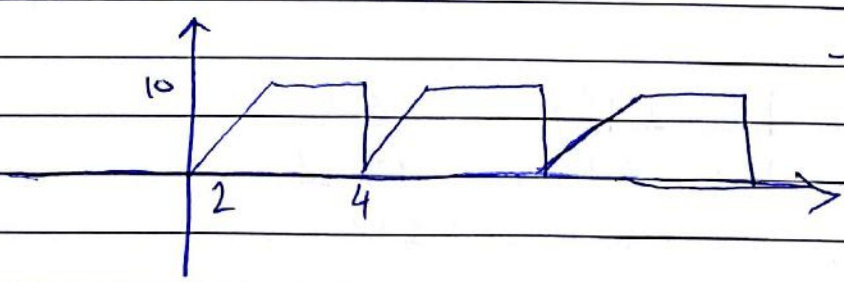
$T = 4$

$$i(t) = \begin{cases} 5t, & 0 < t < 2 \\ -10, & 2 < t < 4 \end{cases}$$

$$I_{rms} = \sqrt{\frac{1}{4}\left[\int_0^2 (5t)^2\,dt + \int_2^4 (-10)^2\,dt\right]}$$

$= 8.165\ A$

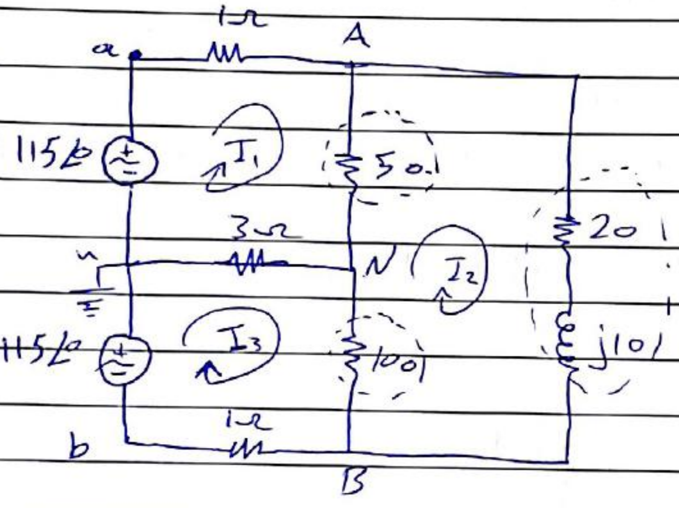
نفكر هاي :-



دوائر متعددة الأوجه

Poly phase systems :-

Single phase 3-wire system :-



$$-115\angle 0 + I_1 + 50(I_1 + -(I_2)) + 3(I_1 - I_3) = 0$$
$$(20+j10)I_2 + 100(I_2 - I_3) + 50(I_2 - I_1) = 0$$
$$-115\angle 0 + 3(I_3 - I_1) + 100(I_3 - I_2) + I_3 = 0$$

mesh currents
$$\begin{cases} I_1 = 11.24\angle -19.83 \text{ A} \\ I_2 = 9.38\angle -24.47 \text{ A} \\ I_3 = 10.37\angle -21.8 \text{ A} \end{cases}$$

I_{aA} = current flows from a to A $= I_1 = 11.24\angle -19.83$

I_{bB} = " " " b " B $= -I_3 = 10.37\angle 158.20$

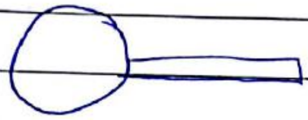
I_{nN} = " " " n " N $= I_3 - I_1 = 0.9454\angle -177$

$$P_{(50)} = |I_1 - I_2|^2 R = 206 \text{ W}$$
$$P_{(100)} = |I_3 - I_2|^2 R = 117 \text{ W}$$
$$P_{(20+j10)} = I_2^2 * R = 1763 \text{ W}$$

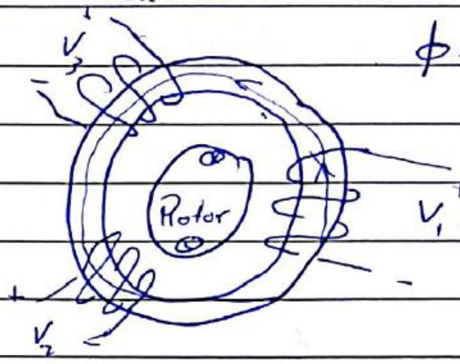
Scanned by CamScanner

No

Prime mover



Generator



$\phi = \sin \omega t$

$V_1 \rightarrow$ قوة دافعة محثية

$$V = -\frac{d N\phi}{dt}$$

$$|V_1| = |V_2| = |V_3|$$

STATOR: Non-moving part

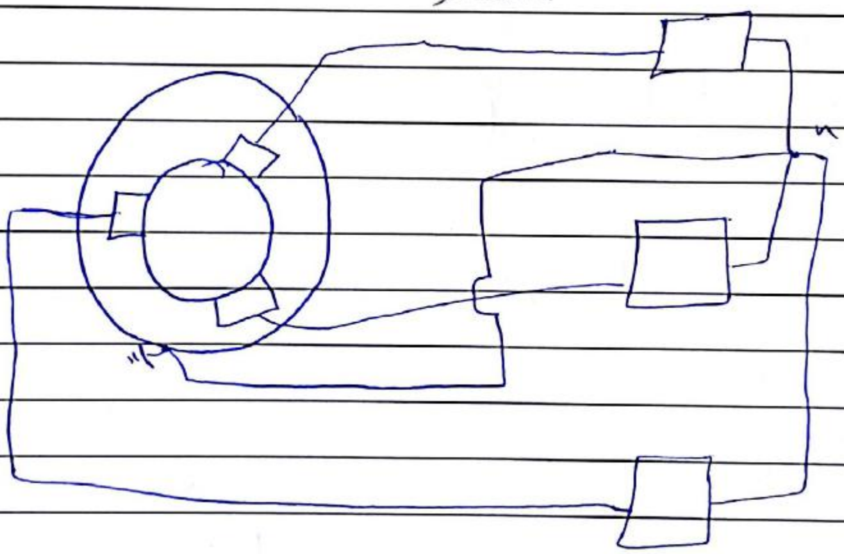
3 phase system :-

① overall system is more economical

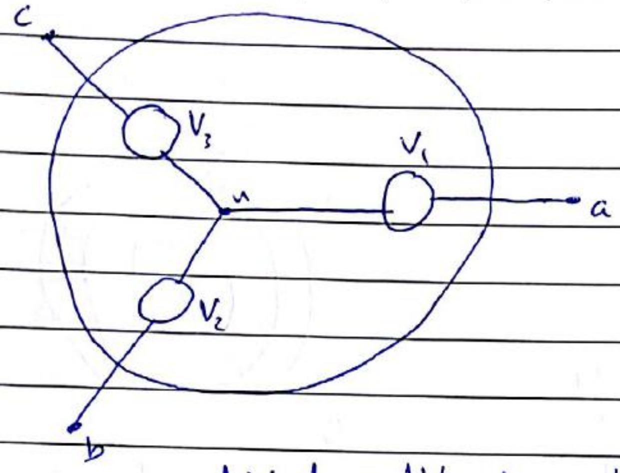
② Less generates Vibration (net torque = 0)

$\Rightarrow$ more stabe system

مستقر



No



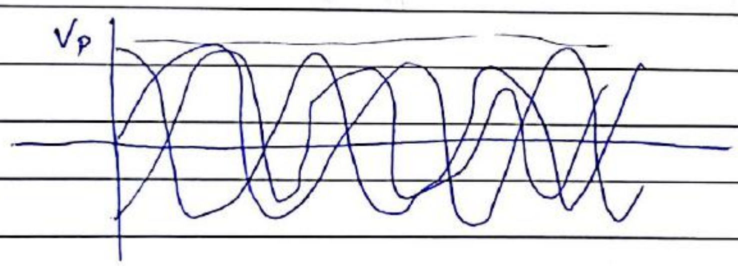
$|V_{an}| = |V_{bn}| = |V_{cn}|$

$V_{an} = V_p \sin \omega t$

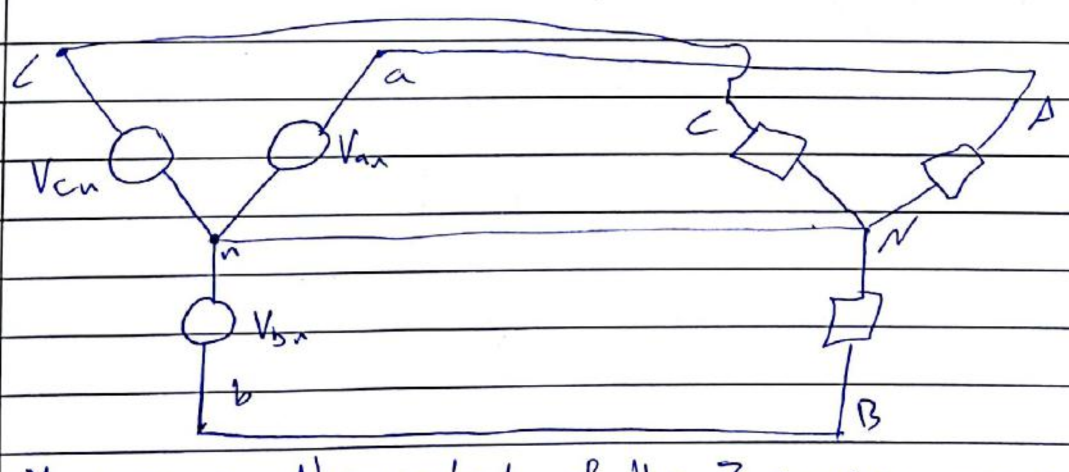
$V_{bn} = V_p \sin(\omega t - 120°)$

$V_{cn} = V_p \sin(\omega t - 240) = V_p \sin(\omega t + 120°)$

phase shift between them is 120°



Y_Y Balanced 3ϕ system :-



Y_source : the neutral of the 3 sources are connected together.

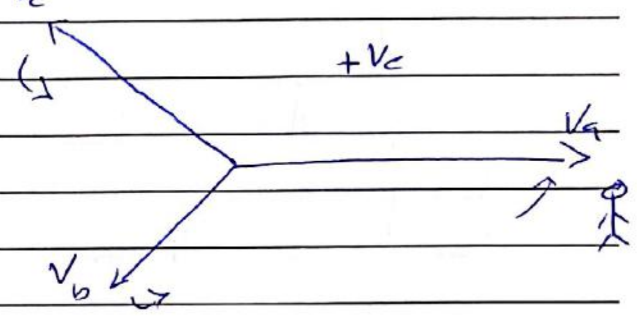
Y_load : the neutral of the 3 loads are connected together

28/12 الأحد

No

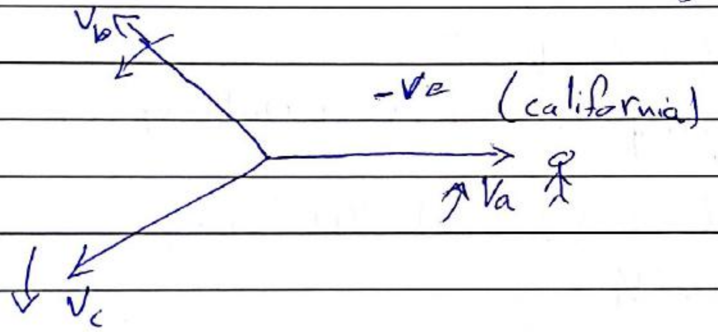
$V_a = V_p \angle 0$
$V_b = V_p \angle -120$
$V_c = V_p \angle +120$

(the rest of the world)



$|V_a| = |V_b| = |V_c|$

$V_a + V_b + V_c = 0$

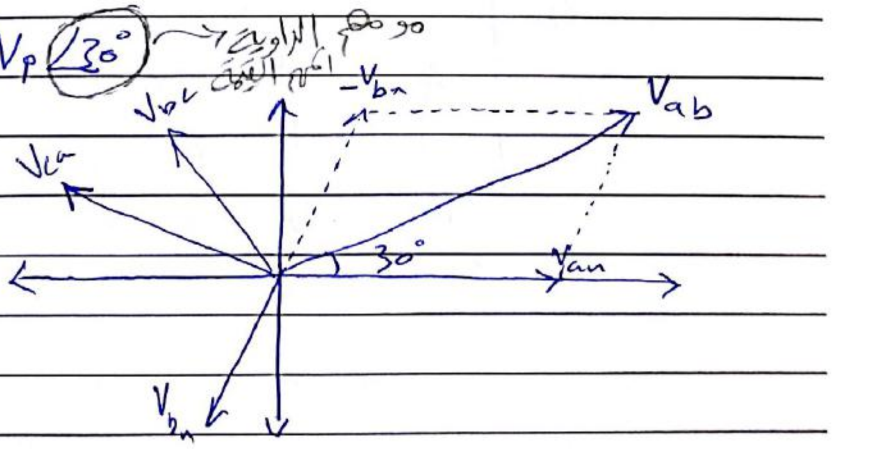


$V_{an} = V_p \angle 0$ $\quad V_{bn} = V_p \angle -120$ $\quad V_{cn} = V_p \angle 120$

$$V_{ab} = V_{an} - V_{bn} = V_p \angle 0 - V_p \angle -120$$
$$= V_{an} + (-V_{bn}) \quad = V_p - V_p [\cos(-120) + j \sin(-120)]$$
$$= V_p \left[1 + \frac{1}{2} + j \frac{\sqrt{3}}{2}\right] = V_p \left[\frac{3}{2} + j\frac{\sqrt{3}}{2}\right]$$
$$= \sqrt{3}\, V_p \left[\frac{\sqrt{3}}{2} + j \frac{1}{2}\right] = \sqrt{3}\, V_p [\cos 30 + j \sin(30)]$$
$$= \sqrt{3}\, V_p \angle 30^\circ$$

هو مهم الزاوية اكم العيب

صارت أكبر
مرات ~~...~~ منوصل عالي الـ Load
العالية على طول Vab لأنو قيمة
الجهد الها اكبر
مثل الـ elevator



No ____________

V_{an} } phase Voltages Phase-to-neutral Voltages
V_{bn}
V_{cn}

V_{ab} } phase - to - Phase
V_{ca} } Line - to - line
V_{bc} } Voltages

$V_{bc} = V_{bn} - V_{cn} = V_p\angle{-120} - V_p\angle{120}$

$= V_p[\cos(-120) + j\sin(-120)] - V_p[\cos(120) + j\sin(120)]$

$= V_p(-\frac{1}{2}) - jV_p(\frac{\sqrt{3}}{2}) - V_p(-\frac{1}{2}) - jV_p(+\frac{\sqrt{3}}{2})$

$= -j\sqrt{3}V_p$

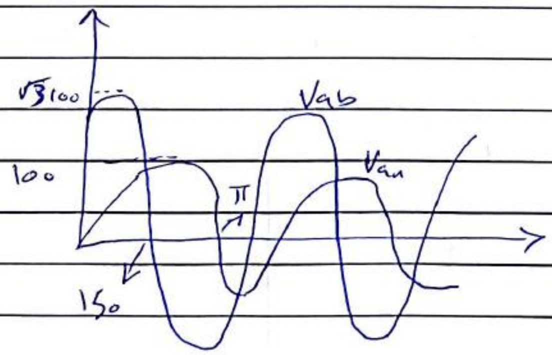
$= \sqrt{3}V_p\angle{-90}$

$V_{ca} = V_{cn} - V_{an} = V_p\angle{+120} - V_p\angle{0} = V_p\angle{120} - V_p\angle{0}$

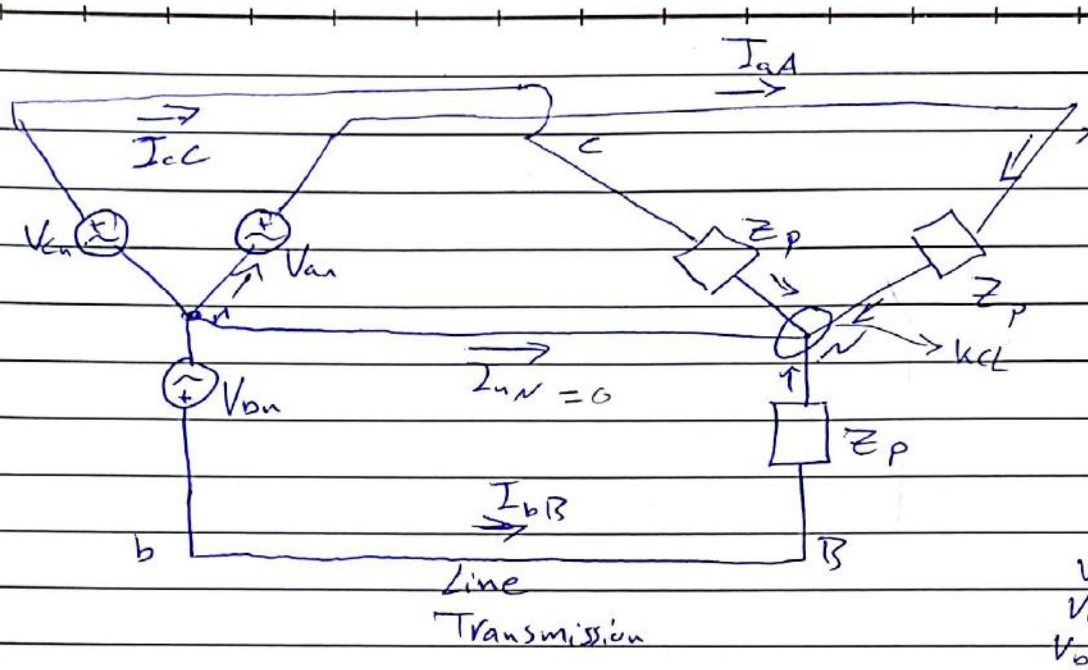
$= V_p[\cos 120 + j\sin 120] - V_p$

$= -\frac{1}{2}V_p + j\frac{\sqrt{3}}{2}V_p - V_p = \sqrt{3}V_p[\frac{-\sqrt{3}}{2} + j\frac{1}{2}]$

$= \sqrt{3}V_p\angle{150°}$



No



$V_{an} = V_p \angle 0$
$V_{bn} = V_p \angle -120$
$V_{bn} = V_{an} \angle \pm 120$

$V_{an} = I_{aA} Z_p$

$I_{aA} = \frac{V_{an}}{Z_p}$

$I_{bB} = \frac{V_{bn}}{Z_p} = \frac{V_{an} \angle -120}{Z_p} = I_{aA} \angle -120$

$I_{cC} = \frac{V_{cn}}{Z_p} = \frac{V_{an} \angle +120}{Z_p} = I_a \angle +120$

$\frac{V_p}{Z_p}$

$I_{aA} = I_{max} \angle 0 \quad | \quad I_{bB} = I_{max} \angle -120 \quad | \quad I_{cC} = I_{max} \angle +120$

$I_{nN} = -(I_{aA} + I_{bB} + I_{cC}) = -(I_{max} + I_{max} \angle -120 + I_{max} \angle +120)$

$= -[I_{max} + I_{max} \cos(-120) + j I_{max} \sin(-120) + I_{max} \cos(120) + j I_{max} \sin(120)]$

$= 0$ [for Balanced system $I_{nN} = 0$]

ex) A balanced 3ϕ Y-Y connected System with $V_{an} = 200\angle 0$ (RMS) $Z_p = 100\angle 60$, find the line and Phase current & the line & phase voltages:

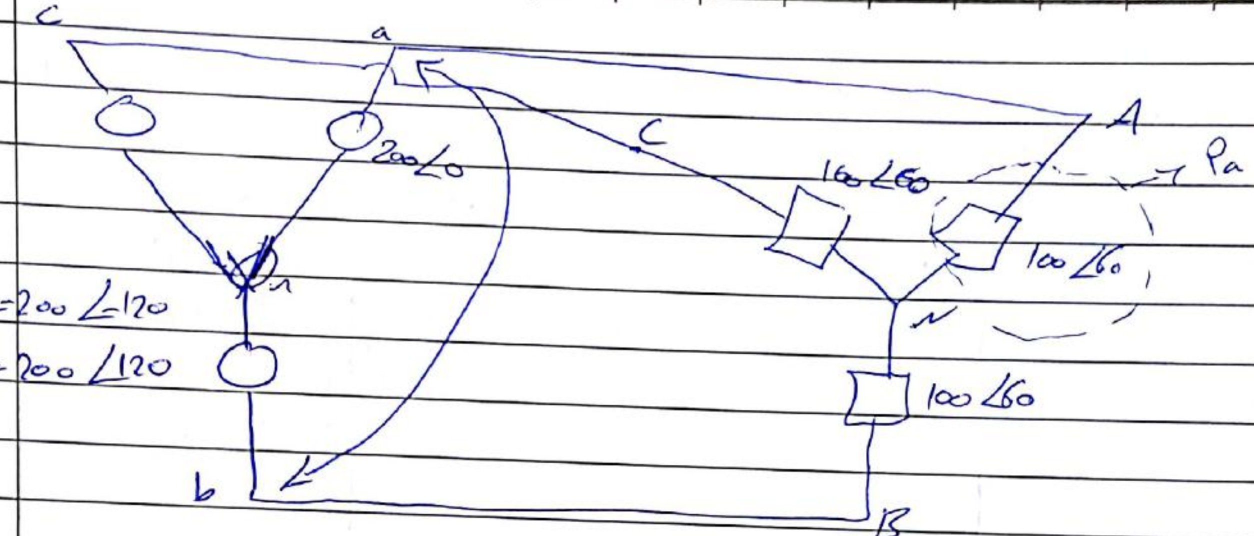
follow

Scanned by CamScanner

No

$V_{bn} = 200 \angle -120$

$V_{cn} = 200 \angle 120$



$V_{ab} = \sqrt{3} V_{an} \angle 30 = \sqrt{3} * 200 \angle 30 = 346 \angle 30°$

$V_{bc} = 346 \angle -90$, $V_{ca} = 346 \angle +150$

بنا خذ زاوية اول رمز ونجمعها 30° وكلها الهي نفس الـ Mag.

line current / phase current for Y-Y connection

$I_{aA} = \frac{V_{an}}{Z_p} = \frac{200 \angle 0}{100 \angle 60} = 2 \angle -60 A$

$I_{bB} = \frac{V_{bn}}{Z_p} = \frac{200 \angle -120}{100 \angle 60} = 2 \angle -180 = I_{aA} \angle -120$

$I_{cC} = I_{aA} \angle +120 = 2 \angle +60 A$

$= \frac{V_{cn}}{Z_p} = \frac{200 \angle 120}{100 \angle 60} = 2 \angle 60 A$

نفس القيمة بس بيتغير phase فيفرق 120 يعني لو عطاك I_{aA} وكان +ve

بتكون I_{bB} -120 و I_{cC} بتزيد 120

No

$P_a = V_{rms} I_{rms} \cos(\theta - \phi)$
$= 200 * 2 * \cos(\cancel{60} - (-60)) = 200\,W$ avelge Power

$P_b = 200 * 2 * \cos(-120 - (-180)) = 200\ W$
$P_c = 200\ w$

$P_{3\phi} = P_a + P_b + P_c = 600\,W = 3P_{1\phi}$

$V_{AN}(t) = 200\sqrt{2}\cos(wt)$
$\cancel{\#}\ i_{AN}(t) = 2\sqrt{2}\cos(wt - 60)$

$P_{AN}(t) = V_{AN}(t)\, i_{AN}(t) = 800\cos wt \cos(wt - 60)$
$= 200 + 400\cos(2wt - 60)\ w$

$P_{BN}(t) = V_{bn}(t)\, i_{bn}(t) = 200\sqrt{2}\cos(wt - 120) * 2\sqrt{2}\cos(wt - 180)$
$= 200 + 400\cos(2wt + 60°)\ w$

$P_{CN}(t) = V_{cn}(t)\ i_{cn}(t) = 200 + 400\cos(2wt + 180)$

$P_{3\phi}(t) = P_A(t) + P_B(t) + P_C(t) = 600 + 400\cos(2wt - 60) + 400\cos(2wt + 60)$
$+ 400\cos(2wt + 180)$
$= 600\ w \}$ $\Rightarrow$ less generator Vibration

for comparison :-
if it wes single phase system:
$600 = 200 * I_{rms} * \cos(60) \Rightarrow I_{rms} = 6$

$P_{losses\,3\phi} = I_a^2 R + I_b^2 R + I_c^2 R =$
$4 * R + 4 * R + 4 * R = 12\,R\,W$

Scanned by CamScanner

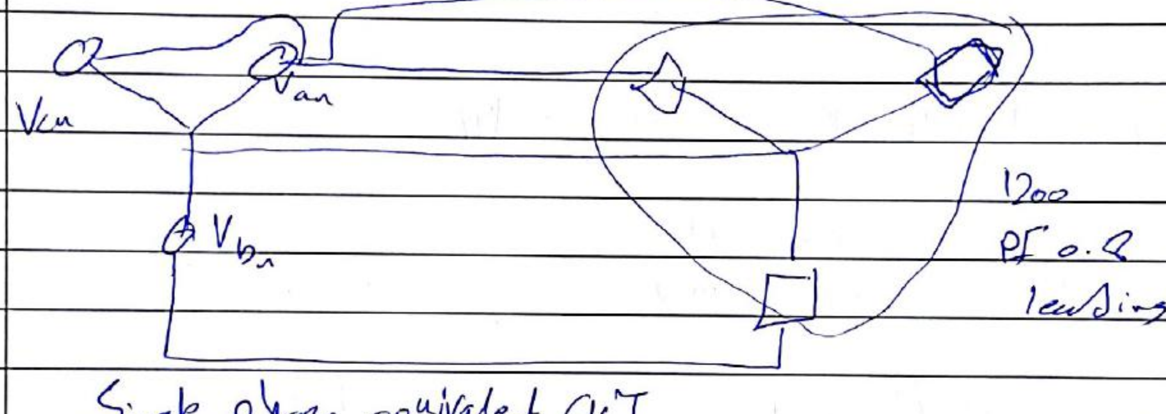
No

$P_{losses\,1\phi} = I^2 R = 36R$

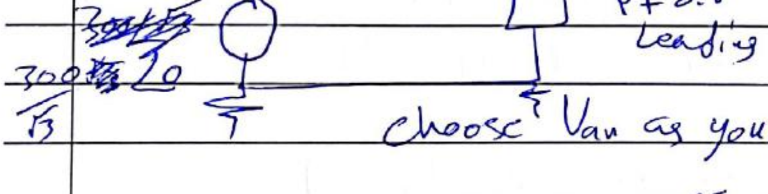
(if not spacified in Q) {Line-to-line}

(Q) a balanced 3ϕ system with $V_L = 300\,V$ & supplying a balanced Y connected load with 1200 W, Leading PF of 0.8. Find the line current & the per-phase load impedence

3ϕ (if not spacified)



Single phase equivalent Ckt



choose V_{an} as your reference

$P = V_{rms}\, I_{rms} \cos(\theta) \rightarrow PF$

$400 = \frac{300}{\sqrt{3}} * I_{rms} * 0.8 \Rightarrow |I_{rms}| = 2.89\,A$

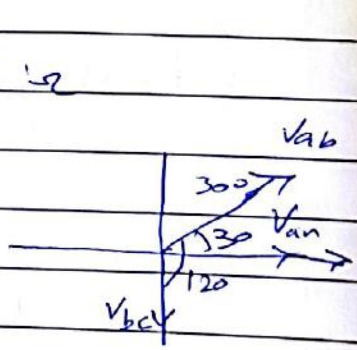
$I_{aA} = I_{rms} = 2.89 \angle +\cos^{-1}(0.8) \rightarrow 36.87$

$Z = \frac{V_{an}}{I_{an}} = \frac{300/\sqrt{3} \angle 0}{2.89 \angle 36.87} = 60 \angle -36.9\ \Omega$

$I_{bB} = 2.89 \angle 36.9 - 120$ ليه اعتبرنا زاوية ال V ال صفر

$I_{cC} = 2.89 \angle 36.9 + 120$

$V_{bn} = \frac{300}{\sqrt{3}} \angle -120 \quad V_{bc} = 300 \angle -90$



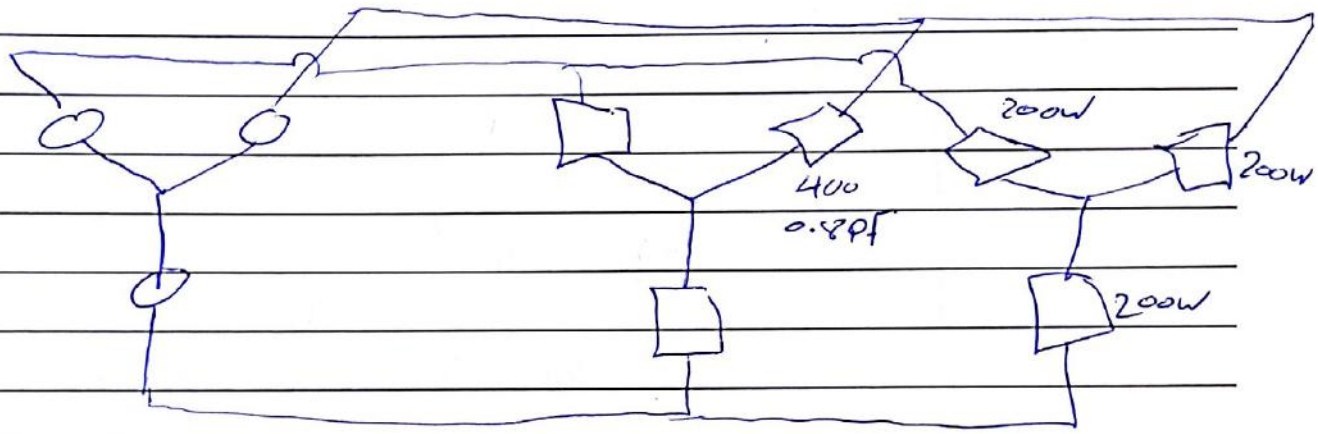
الخميس 3/3 لعيون الفيرست

No

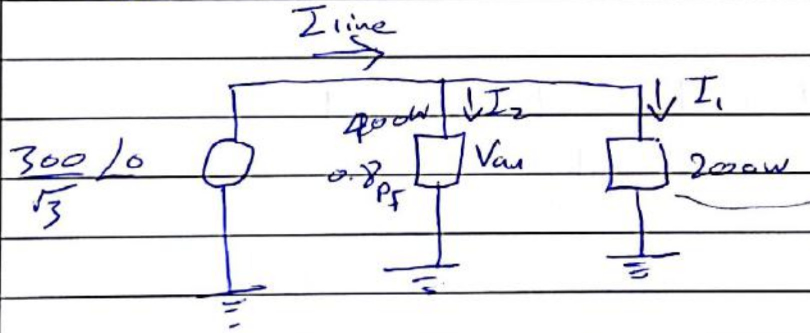
⇐ روابدة

($P_{3\phi}$)

(ex) a balanced 600 W is added in parallel to the system, find the new line current. (للنزال السابق v.t)



sol :



(Resistor load وإضاءة انو)

(لأنو [W] وما حكالي عن Pf)

$$I_{line(aA)} = I_1 + I_2 = 2.89\angle 36.9 + I_1$$

$$I_1 = \frac{P}{V} = \frac{200}{300/\sqrt{3}} = 1.155\angle 0$$

$$P = IV\cos\theta \sim 1$$

$$200 = \frac{300}{\sqrt{3}} I$$

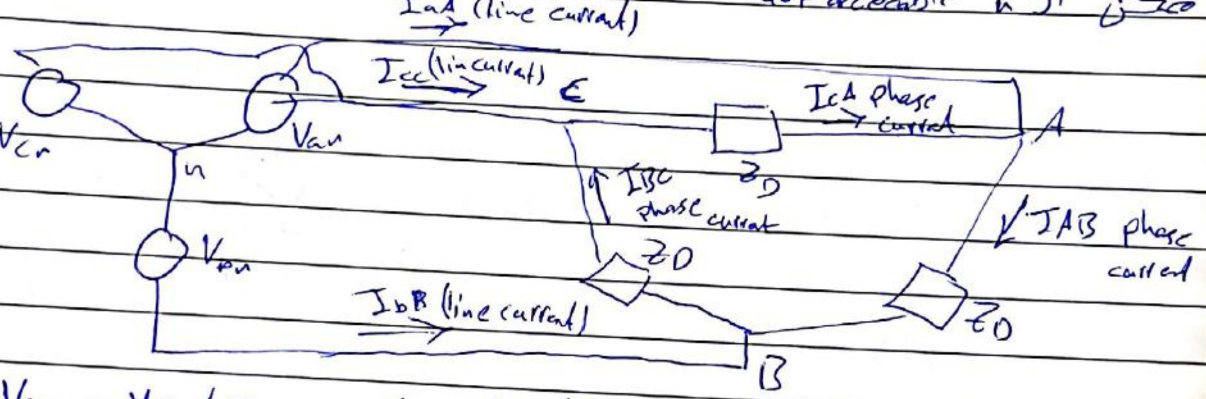
$$I_{line(aA)} = 2.89\angle 36.9 + 1.155 = 3.87\angle 26.6\ A$$

$$I_{bB} = 3.87\angle -93.4\ A \quad , \quad I_{cC} = 3.87\angle 146.6\ A$$

No

Y-source Delta load :-

١- زيادة الفولتج على load
٢- ممكن الـ n ال not accessable



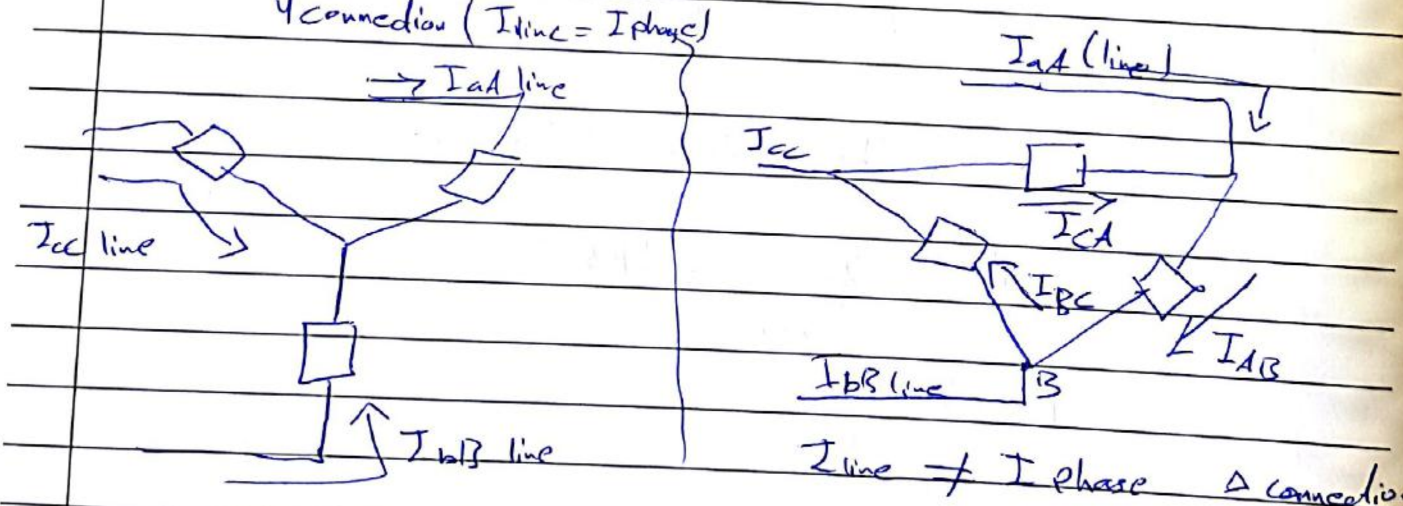
$V_{an} = V_p \angle 0$, $V_{bn} = V_p \angle -120$, $V_{cn} = V_p \angle +120$

$V_{AB} = \sqrt{3}\, V_p \angle +30$

We use Δ-load :-

→ if the neutral point is not accessible

→ Increase the load Voltage



⇒

No

$|V_L| = |V_{AB}| = |V_{BC}| = |V_{CA}|$ V_L ← الاختصار الاول

$|V_p| = |V_{an}| = |V_{cn}| = |V_{bn}|$

& $V_L = \sqrt{3}\, V_p \angle +30$ [Y & Δ]

$I_{AB} = \dfrac{V_{AB}}{Z_\Delta}$, $I_{BC} = \dfrac{V_{BC}}{Z_\Delta}$ → هذا ال phase current

[p ≡ phase]

$I_{CA} = \dfrac{V_{CA}}{Z_\Delta}$

$I_{AB} = I_p \angle 0$

$I_{BC} = I_p \angle -120$

$I_{CA} = I_p \angle +120$

$I_{aA} = I_{AB} - I_{CA} = I_p \angle 0 - I_p \angle +120$

$= I_p - I_p \cos(120) - j I_p \sin(120)$

$= I_p + \frac{1}{2} I_p - j \frac{\sqrt{3}}{2} I_p$

$= \left(\frac{3}{2} I_p - j \frac{\sqrt{3}}{2} I_p\right)$

current line ال ← $= \sqrt{3}\, I_p \left(\frac{\sqrt{3}}{2} - j\frac{1}{2}\right) = \sqrt{3}\, I_p \angle -30$

$I_{aA} = \sqrt{3}\, I_p \angle -30$, $I_{bB} = \sqrt{3}\, I_p \angle -150$, $I_{cC} = \sqrt{3}\, I_p \angle 90$

Y Connections (loads)	Δ Connections: (loads)
$V_{LL} = \sqrt{3}\, V_p \angle +30$	$V_{L(\text{line})} = V_{p\,\text{phase}}$
$I_{L\,\text{line}} = I_{p\,\text{phase}}$	$I_L = \sqrt{3}\, I_p \angle -30°$

rp

No

⇒ 4 types of connections :-

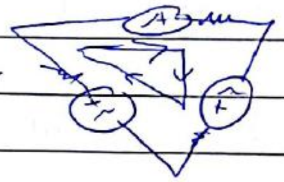
① YY Connection

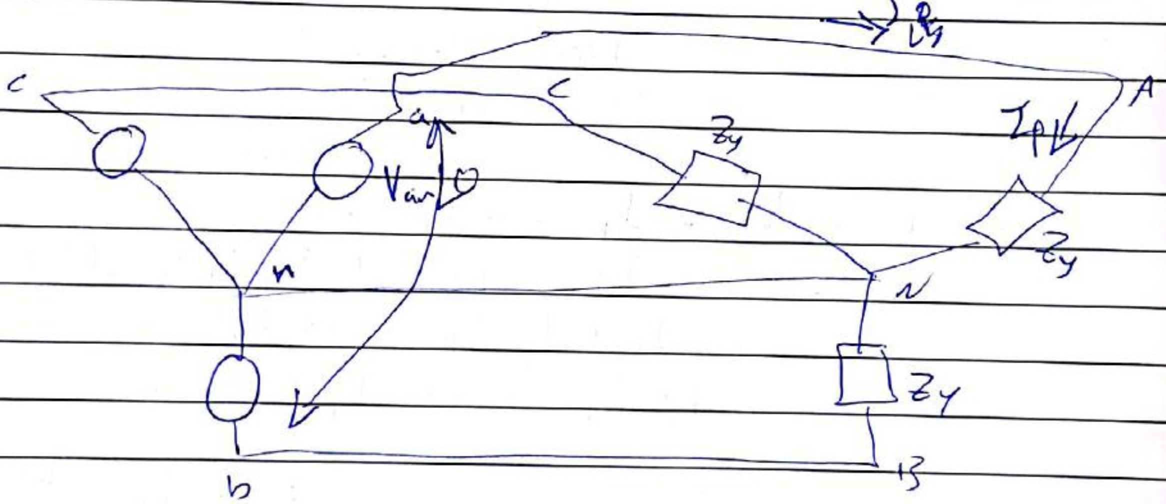
② YΔ //

③ ΔY } circulating

④ ΔΔ currents داخل الـsource

Load source



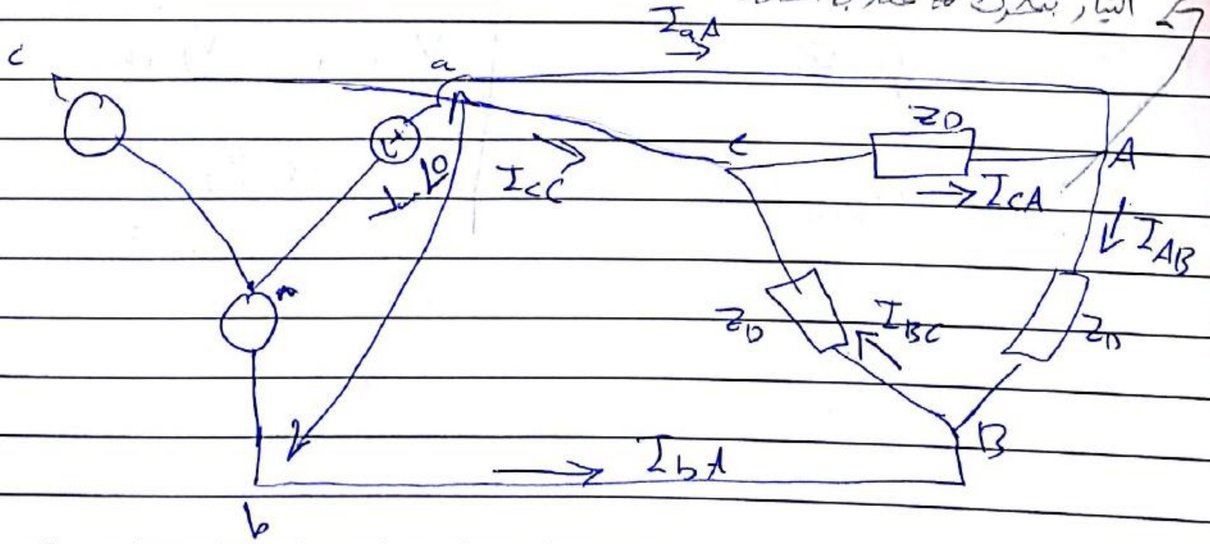


$$I_{line} = I_{phase}\,(load) = \frac{V_{an}}{Z_y}$$

$$|V_{AB}| = \sqrt{3}\, V_{an} \angle +30$$

$$|V_{LL}| = \sqrt{3}\, V_p \angle +30$$

التيار بتحرك مع عقارب الساعة



No ______________

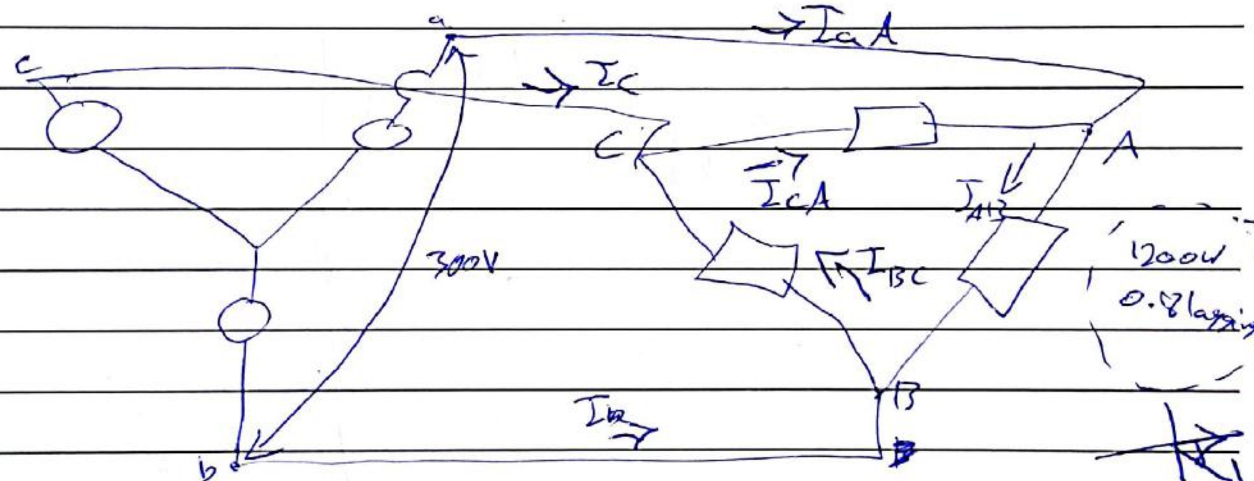
$V_{LL} = V_P \, (Load) \Rightarrow V_{line} = V_{phase}$

$I_L = \sqrt{3} \, I_P \angle -30$

$I_{aA} = \sqrt{3} \, I_{AB} \angle -30$

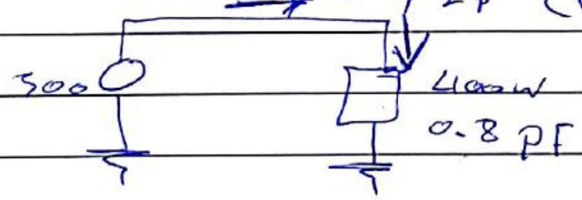
$I_{AB} = \frac{V_{AB}}{Z_D}$ $\qquad$ $I_{aA} = \sqrt{3} \left(\frac{V_{AB}}{Z_D} \right) \angle -30$

ex) what are the line currents in a 3φ system with line voltage of 300 V & supplies 1200W to a Δ load at lagging PF of 0.8, & the find the phase impedence



$I_L \neq I_P$ (Decieving CKT)

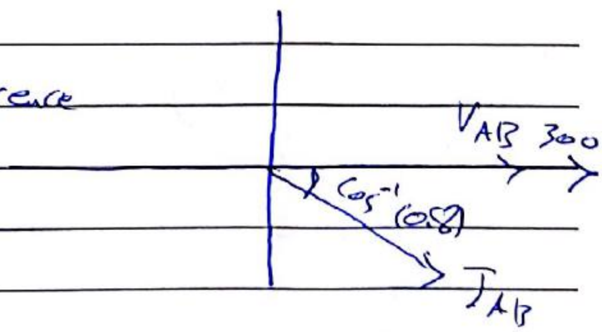
~~Phase current~~



$P = V_{AB} \, I_{AB} \cos(\theta) \Rightarrow 400 = 300 \times I_{AB} \times 0.8$

$\Rightarrow \boxed{I_{AB} = 1.667 \, A}$

⇒ taking V_{AB} as your reference



Scanned by CamScanner

No

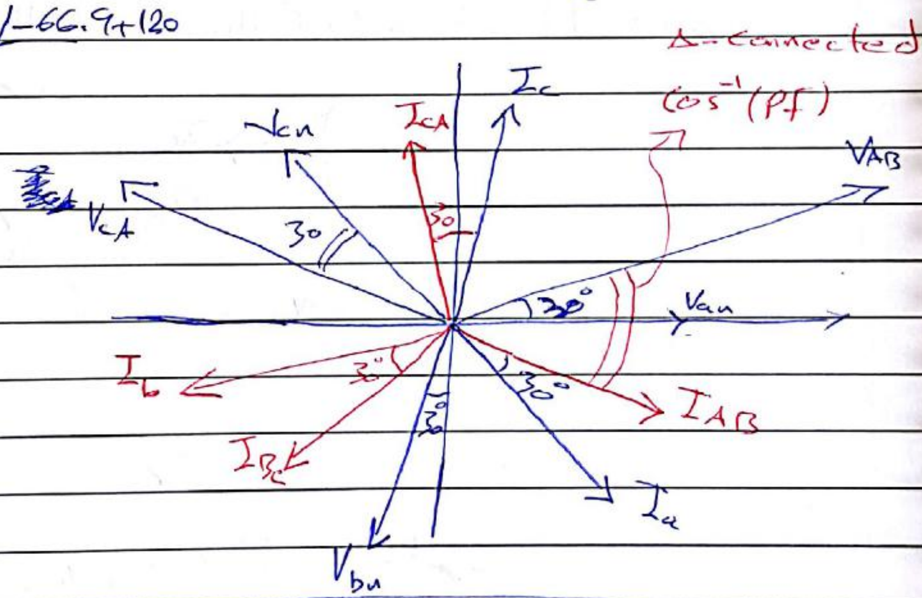
$$I_{AB} = 1.667 \angle -36.9^\circ$$
$$I_{BC} = 1.667 \angle -36.9-120 = 1.667 \angle -156.9$$
$$I_{CA} = 1.667 \angle -36.9+120 = 1.667 \angle +83.1 = 1.667 \angle -277.9$$

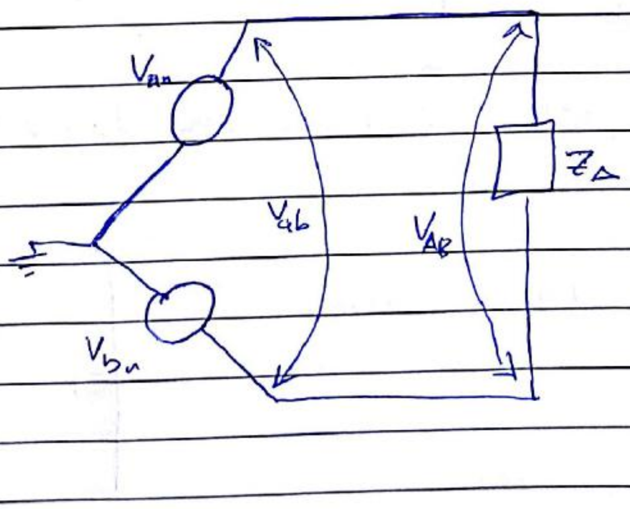
} phase currents

Line currents :-

$$I_l = \sqrt{3}\, I_P \angle -30^\circ$$
$$I_a = \sqrt{3}\, I_{AB} \angle -30^\circ = \cancel{\neq} I_{aA}$$
$$= 2.89 \angle -66.9^\circ$$
$$I_b = 2.89 \angle -66.9-120$$
$$I_c = 2.89 \angle -66.9+120$$

خذ رسمه كامل

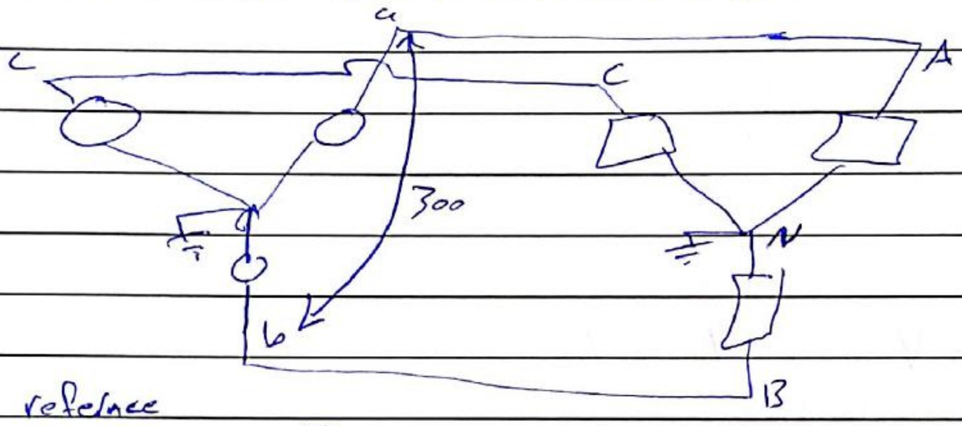




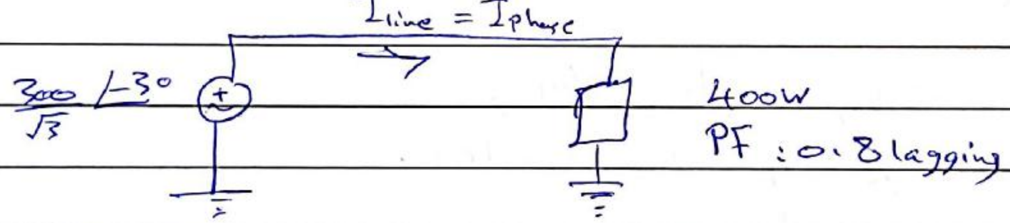
No

$Z_p = \frac{V_{AB}}{I_{AB}} = \frac{300\angle 0}{1.667\angle -36.9} = 180\angle 36.9$

⇒ what if the load in connected Y



V_{AB} is reference

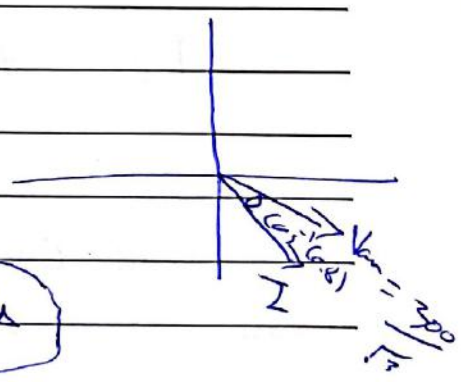


$P = V_{an} I_{a} \cos(\theta) \Rightarrow 400 = \frac{300}{\sqrt{3}} I_a (0.8)$

$I_a = 2.89$ (phase) = (line)

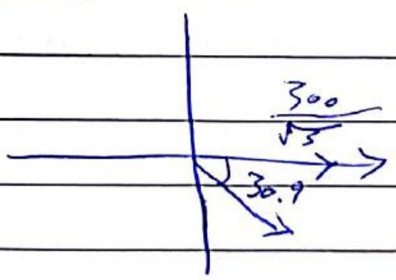
$I_a = 2.89 \angle -30 - 36.9°$

$Z_Y = \frac{V_{AN}}{I_{aA}} = \frac{300/\sqrt{3}\angle -30}{2.89\angle -66.9} = 60\angle 36.9$



$Z_\Delta = 3Z_Y$ OR $Z_Y = \frac{1}{3} Z_\Delta$

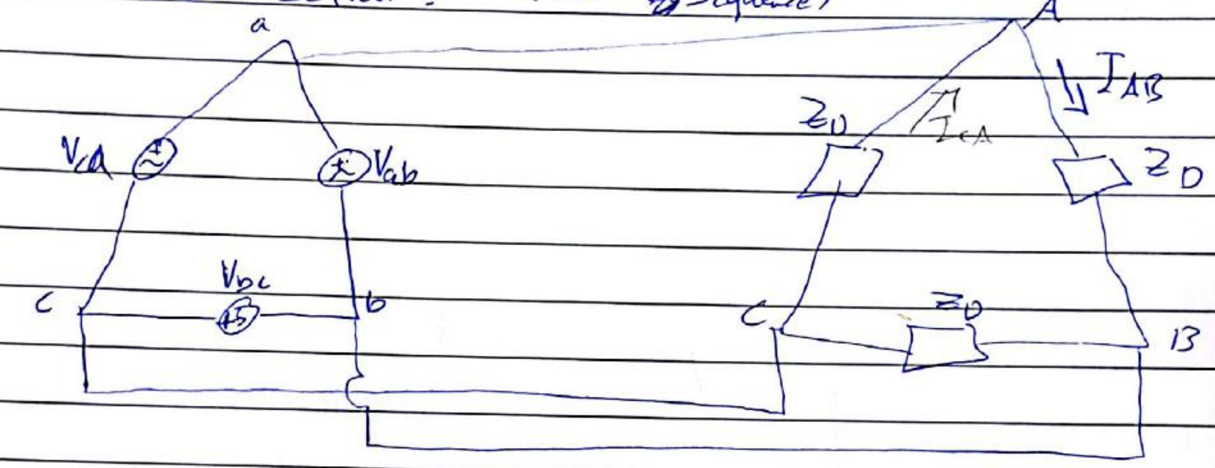
if V_{an} is the reference



10/3 الخميس

No

Δ - Δ connection : (+ve sequence)



انا دايماً بهمني تيار ال load والفولتيج

$V_{ab} = V_{AB}$, $V_{bc} = V_{BC}$

$V_{cA} = V_{CA}$

⇒ line voltage = phase voltage

line-line ⇐ $\underset{Load}{V_L = V_P}$!! (phase neutral)

phase current

$I_{AB} = \frac{V_{AB}}{Z_\Delta}$ $\quad I_{BC} = \frac{V_{BC}}{Z_\Delta} = I_{AB} \angle -120$

$I_{CA} = \frac{V_{CA}}{Z_\Delta} = I_{AB} \angle +120$ } phase current

line currents :-

$$\boxed{I_L = \sqrt{3}\, I_P \angle -30}$$

$I_a = \sqrt{3}\, I_{AB} \angle -30$

$I_b = \sqrt{3}\, I_{BC} \angle -30 = I_a \angle -120$

$I_c = \sqrt{3}\, I_{CA} \angle -30 = I_a \angle +120$

Scanned by CamScanner

No

(ex) A Δ system with a load impedence = 20−j15 in connected to a source of with $V_{ab} = 330\angle 0$, find I_{phase} & I_{line}

Sol: phase currents :-

$$I_{AB} = \frac{V_{AB}}{Z_D} = \frac{330\angle 0}{20-15j} = 13.2\angle 36.87 \text{ A}$$

$$I_{BC} = 13.2\angle \cancel{-83.2}\ \angle -83.13^\circ \text{ A}$$

$$I_{CA} = 13.2\angle 156.87^\circ$$

Line currents :-

$$I_a = I_{aA} = \sqrt{3}\, I_{AB}\angle -30$$

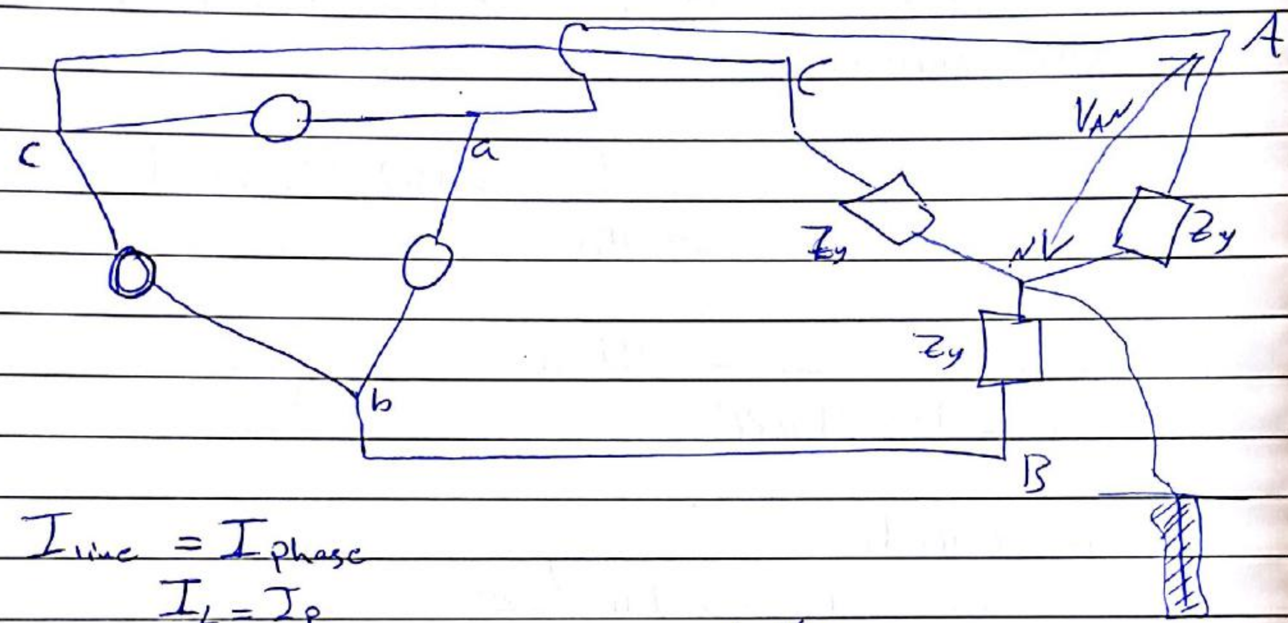
$$= 22.86\angle 6.87$$

$$I_b = 22.86\angle -113.13$$

$$I_c = 22.86\angle +126.87$$

Scanned by CamScanner

Δ-Y Connections :-



$I_{line} = I_{phase}$

$I_L = I_p$

$I_a = I_{an} = \frac{V_{AN}}{Z_y}$

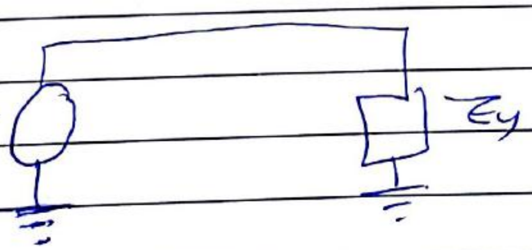
⇒ if given $V_L - V_{ab} \angle 0$

$$V_p = \frac{V_{ab}}{\sqrt{3}} \angle -30$$

taking V_{AB} as your reference:

$$I_a = \frac{V_{AN}}{Z_y} = \frac{V_{AB}/\sqrt{3} \angle -30}{Z_y}$$

$V_{an} = \frac{V_{ab}}{\sqrt{3}} \angle -30$



ex) A balanced Y connected load with $Z_Y = 40 + j25$ is supplied by Δ-source with a line voltage of 210V. calculate the phase currents $\Rightarrow$ use V_{AB} as your reference

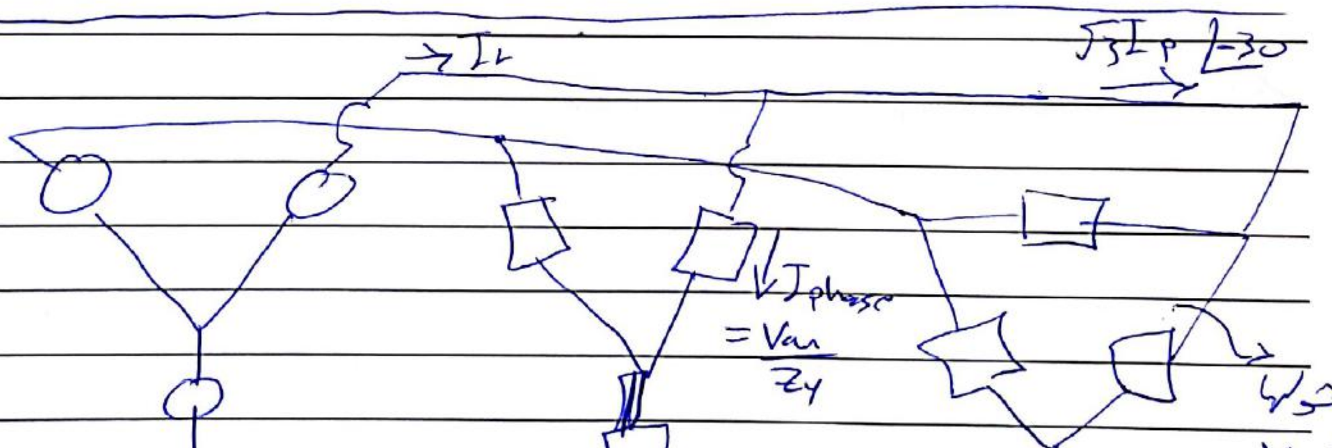
sol :

$\Rightarrow V_L = V_{AB} = 210 \angle 0$

$\Rightarrow V_{AN} = \frac{210}{\sqrt{3}} \angle -30 = 121.2 \angle -30^\circ$ V

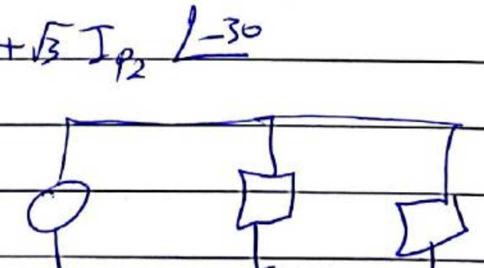
$$\left.\begin{aligned} I_a &= \frac{V_{AN}}{Z_Y} = \frac{121.2 \angle -30}{40 + j25} = 2.57 \angle -62^\circ \\ I_b &= 2.57 \angle +178 \text{ A} \\ I_c &= 2.57 \angle 58^\circ \text{A} \end{aligned}\right\} \text{phase currents}$$

$I_{line} = I_{phase}$

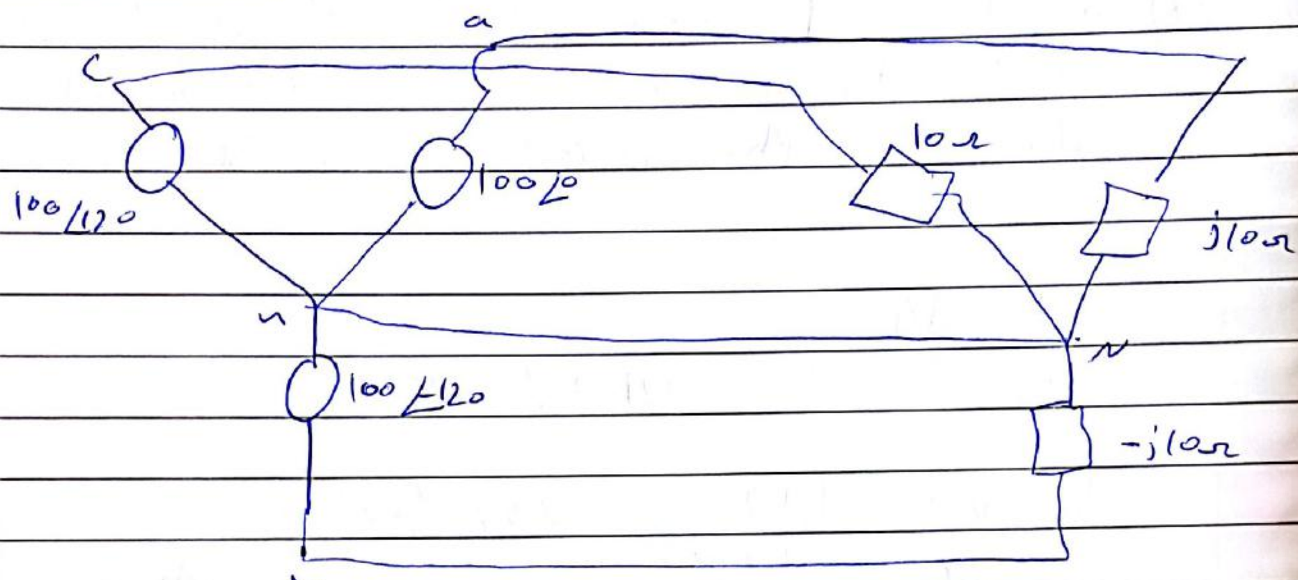


$\Rightarrow I_L = I_{p_1} + \sqrt{3} I_{p_2} \angle -30$

$\Rightarrow$



No



$I_a = \dfrac{V_{an}}{j10}$ $\quad I_b = \dfrac{V_{bn}}{-j10}$ $\quad I_c = \dfrac{V_{cn}}{10}$

$I_{Nn} = I_a + I_b + I_c$

~~#2 2 Power~~

Scanned by CamScanner

No

Power in 3ϕ systems :-

$V_{AN} = \sqrt{2}\, \overset{rms}{V_p} \cos wt \qquad V_{BN} = \sqrt{2}\, V_p \cos(wt - 120)$

$V_{CN} = \sqrt{2}\, V_p \cos(wt + 120)$

assume :- $Z_Y = Z\angle\theta$

$i_{AN} = \sqrt{2}\, I_p \cos(wt - \theta) \qquad i_{BN} = \sqrt{2}\, I_p \cos(wt - 120 - \theta)$

$i_{CN} = \sqrt{2}\, I_p \cos(wt + 120 - \theta)$

average =

$P_A = \overbrace{V_p I_p}^{rms} \cos\theta$

$P_B = V_p I_p \cos\theta$

$P_C = V_p I_p \cos\theta$

$P_{3\phi} = P_A + P_B + P_C = 3 V_p I_p \cos\theta$

$P_{3\phi} = 3\, P_{1\phi}$

Scanned by CamScanner

Power calculations in 3ϕ system:-

$P_A = V_p I_p \cos\theta = P_B = P_c$

$Q_A = V_p I_p \sin\theta = Q_B = Q_c$

$S_A = V_p I_p^* = S_B = S_c = P_p + j Q_p$

$S_{3\phi} = 3 S_{1\phi} = 3 V_p I_p^*$

$P_{3\phi} = 3 P_{1\phi} = 3 V_p I_p \cos\theta$

$Q_{3\phi} = 3 Q_{1\phi} = 3 V_p I_p \sin\theta$

$|S_A| = \|V_p\| \|I_p\|$

$P_{3\phi} = 3 V_p I_p \cos\theta$ (Δ & Y)

But

in Y connections $V_L = \sqrt{3} V_p$

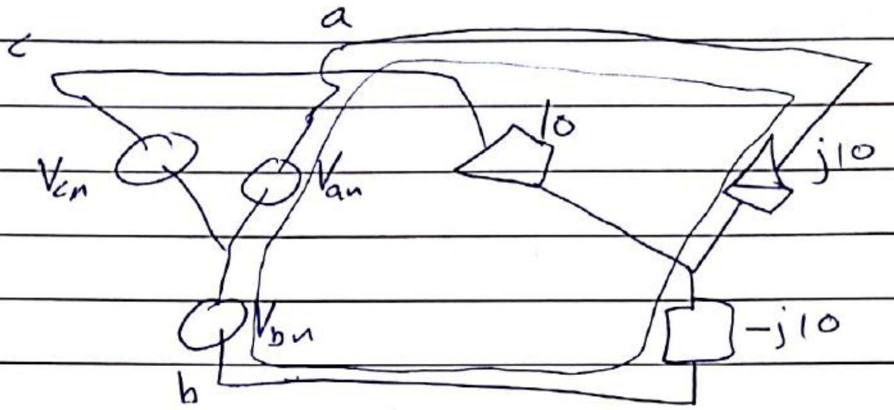
in Δ " $I_L = \sqrt{3} I_p$

$\rightarrow$ $P_{3\phi} = \sqrt{3} V_L I_L \cos\theta$ (Δ & Y)

$Q_{3\phi} = \sqrt{3} I_L V_L \sin\theta$

$S_{3\phi} = \sqrt{3} V_L I_L^*$

Scanned by CamScanner



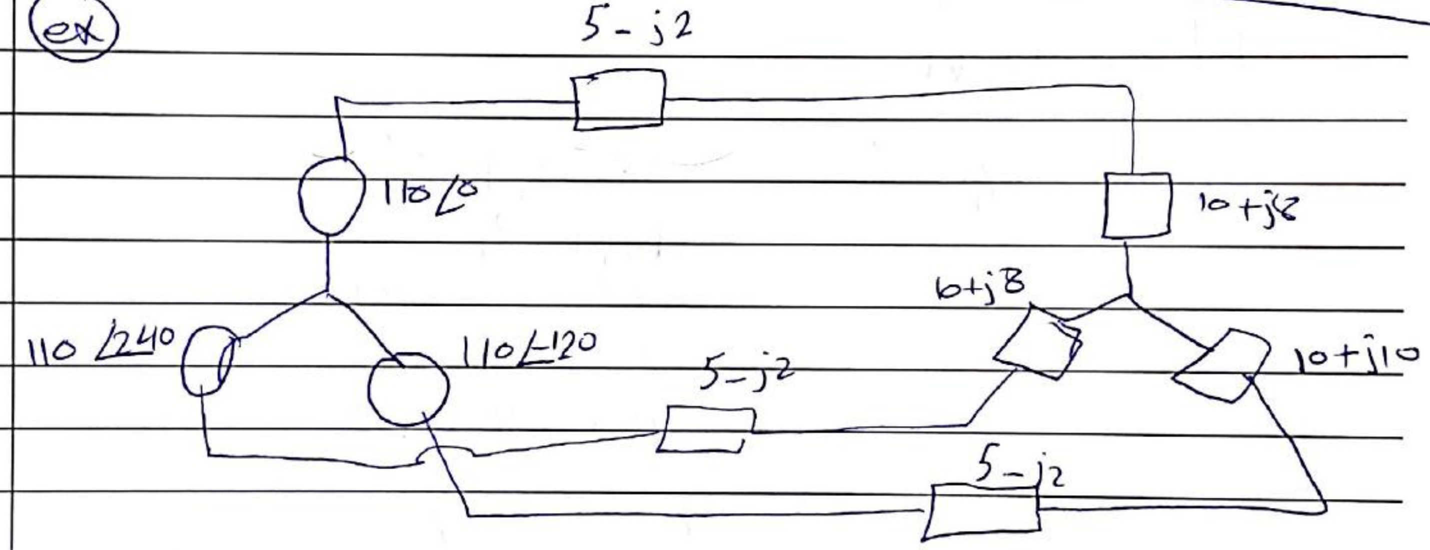
$I_a = \dfrac{V_{an}}{j10}$

$I_b = \dfrac{V_{bn}}{-j10}$

$I_c = \dfrac{V_{cn}}{10}$

$$-V_{an} + j10\, I_a - -j10\, I_b + V_{bn} = 0$$

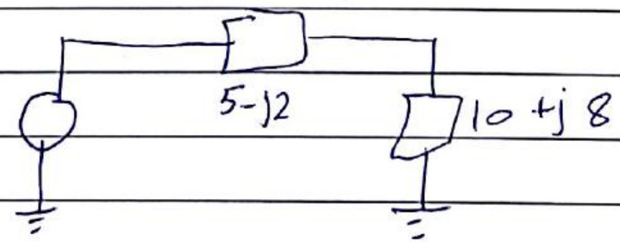
ex



Find total complex Power supplied by source & drawn by load 5-j2. 3-source

sol: 3ϕ متزن = متساوية 3load هو ذ

Single phase equ. ckt.



follow

No

$$I_p = I_{line} = \frac{110 \angle 0}{5 - j2 + 10 + j8} = 6.8 \angle -21.8 A$$

$$S_{source} = 3 V_p I_p^* = \sqrt{3} V_L I_L^*$$

$$= 3 * 110 \angle 0 * 6.8 \angle +21.8^\circ$$

$$= 2247 \angle 21.8 = \underbrace{2087}_{P_{3\phi}} + j \underbrace{834.6}_{Q_{3\phi}}$$

$$|S| = 2247 \ VA$$

$$S_{load} = 3 V_{p_{load}} I_{p_{load}}^* = 3 (Z_p I_p) I_p^*$$

$$= 3 |I_p|^2 Z_p$$

$$= 3 * (6.8)^2 * (10 + j8)$$

$$= 1782 \angle 38.66 \ VA$$

$$= \underbrace{1392}_{P_{3\phi}} + j \underbrace{1113}_{Q_{3\phi}} \ VA \ (load)$$

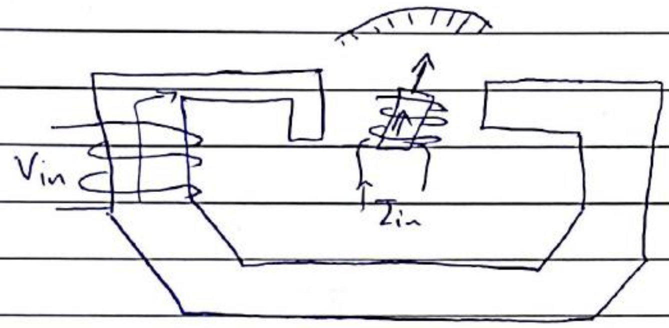
$$S_{losses} = 3 |I_L|^2 Z_{TL} = S_{source} - S_{load}$$

$$= 695.6 - j278.3$$

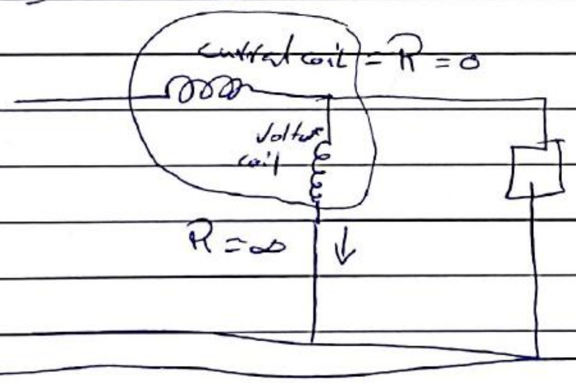
No

* Power measurment :-

⇒ Wattmeter : device that is used to measure that average power.

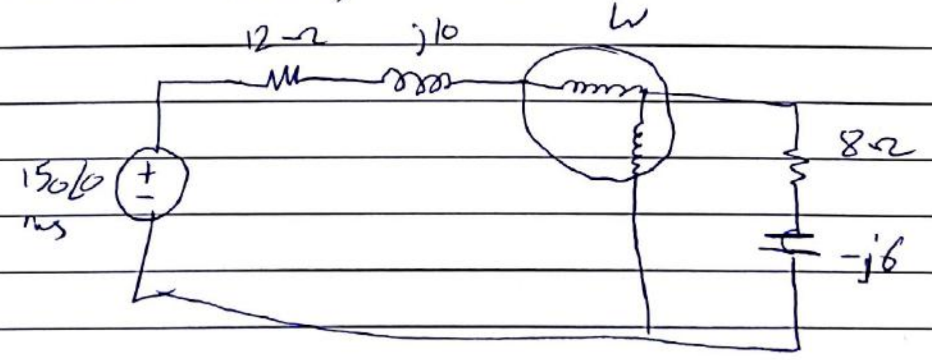


$P \simeq VI\cos\theta$



$P = |V_{rms}||I_{rms}|\cos(\theta_V - \theta_I)$

(ex) Find the wattmeter reading



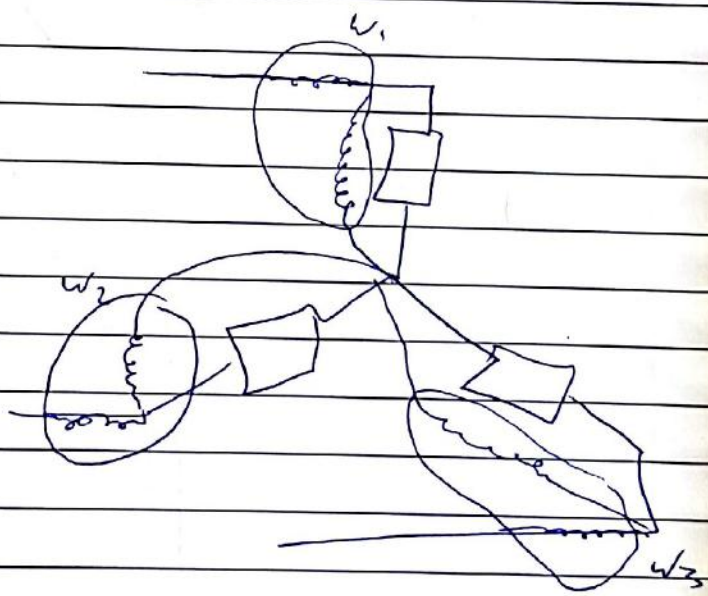
⇒ Solution

No

$$I_{rms} = \frac{150\angle 0}{12+j10+8-j6} = \cancel{7.35\angle 11.3}\ 7.35\angle -11.3$$

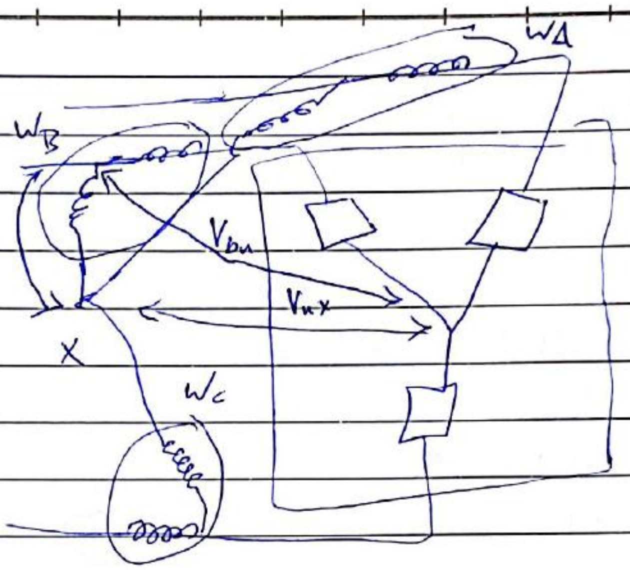
$$V_{rms} = 150\angle 0 * \frac{8-j6}{12+8+j10-j6} = 73.5\angle -48$$

$$P = |V_{rms}||I_{rms}| \cos(\theta_v - \theta_I) = 432.1\,W \rightarrow 8 * |I_{L\,rms}|^2$$



اﻻﺣﺪ 15/3

No



$$P_A = \frac{1}{T_o}\int_0^{T_o} V_{ax}\, i_{aA}\, dt$$

$$P_B = \frac{1}{T_o}\int_0^{T_o} V_{bx}\, i_{bB}\, dt$$

$$P_c = \frac{1}{T_o}\int_0^{T_o} V_{cx}\, i_{cc}\, dt$$

$$\begin{cases} V_{ax} = V_{an} + V_{nx} \\ V_{bx} = V_{bn} + V_{nx} \\ V_{cx} = V_{cn} + V_{nx} \end{cases}$$

$$P_{3\phi} = P_A + P_B + P_c = \frac{1}{T_o}\int_0^{T_o} (V_{ax} i_{aA} + V_{bx} i_{bB} + V_{cx} i_{cc})\, dt$$

$$= \frac{1}{T_o}\int_0^{T_o} (V_{an} i_{aA} + V_{nx} i_{aA} + V_{bn} i_{bB} + V_{nx} i_{bB} + V_{cn} i_{cc} + V_{nx} i_{cc})\, dt$$

$$P_{total} = \frac{1}{T_o}\int (V_{an} i_{aA} + V_{bn} i_{bB} + V_{cn} i_{cc})\, dt$$

$$+ \frac{1}{T_o}\int_0^{T_o} V_{nx} \underbrace{(i_{aA} + i_{bB} + i_{cc})}_{0}\, dt$$

$$= \frac{1}{T_o}\int_0^{T_o} V_{an}\, i_{aA} + V_{bn}\, i_{bB} + V_{cn}\, i_{cc}$$

Scanned by CamScanner

No

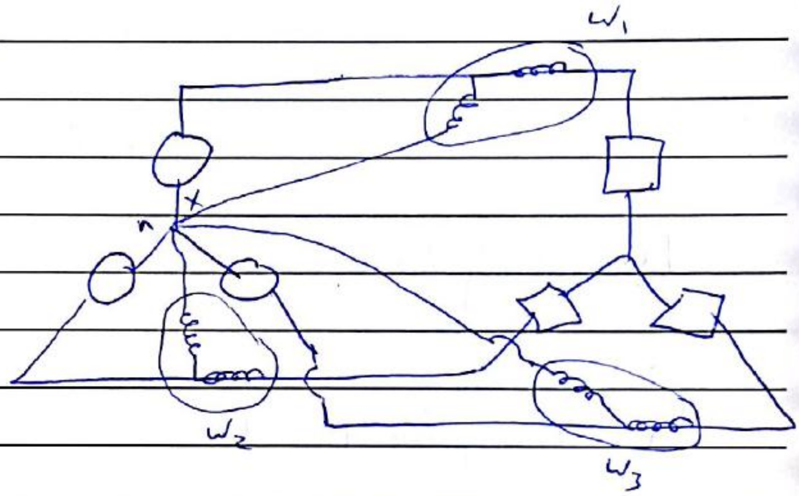
Conclusion: choice of location of point X will not change the total power measured.

(ex) Find the 3 wattmeters readings when X is at the neutral of the source.

$V_{ab} = 100 \angle 0$

$V_{bc} = 100 \angle -120$

$V_{ca} = 100 \angle +120$



sol:

$I_{aA} = 19.32 \angle 15$

$I_{bB} = 19.32 \angle 165$

$I_{cC} = 10 \angle -90$

or: $\dfrac{V_{an} - V_N}{j10} + \dfrac{V_b - V_N}{-j10} + \dfrac{V_c - V_N}{10} = 0$

Find $V_N \Rightarrow I_a = \dfrac{V_a - V_N}{j10}$, $I_b = \dfrac{V_b - V_N}{-j10}$

$I_c = \dfrac{V_c - V_N}{10}$

$W_A = P_A = V_{an} i_{aa} \cos(\theta_v - \theta_i)$

$= \dfrac{100}{\sqrt{3}} * 19.32 \cos(-30 - 15)$

$= 788.7\ W$

$W_B = P_B = \dfrac{100}{\sqrt{3}} * 19.32 \cos(-150 - 165)$

$= 788.7\ W$

~~$V_{ab} = 100 \angle 0$~~

~~V_{bc}~~

$V_{an} = \dfrac{100}{\sqrt{3}} \angle -30$

$V_{bn} = \dfrac{100}{\sqrt{3}} \angle -150$

$V_{cn} = \dfrac{100}{\sqrt{3}} \angle +90$

Scanned by CamScanner

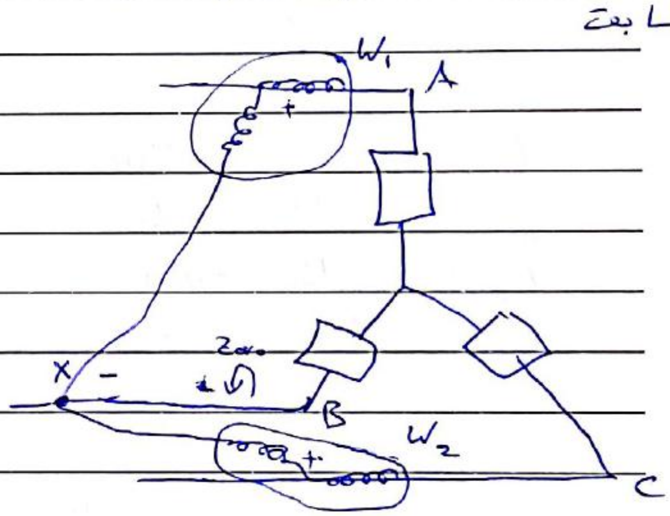
No

$$W_C = P_C = \frac{100}{\sqrt{3}} * 10 * \cos(90+90) = -577.4\,W$$

$$P_T = P_A + P_B + P_C = 1000\,W$$

* **2-wattmeter method :-**

What if we put X on one of the phases. من السؤال السابق



$W_1 : I_{aA}, V_{AB}$

$W_2 : I_{cC}, V_{CB}$

$$W_1 = P_1 = 100 * 19.32 * \cos(0-15)$$
$$= 1866\,W$$

انتبه

$V_{CB} = 100 \angle +60$

$$W_2 = P_2 = 100 * 10 \cos(60+90)$$
$$= -866\,W$$

$$P_T = P_1 + P_2 = 1000\,W$$

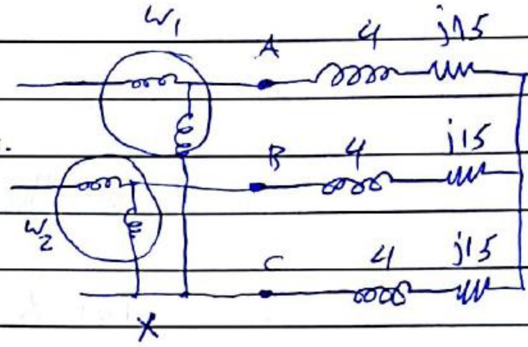
* Conclusion:- ~~For~~ For Power measurments in 3 phase systems, 2 wattmeters are enough to measure the total Power. #

Scanned by CamScanner

No

(e) given $V_{ab_{rms}} = 230 \angle 0$

Find the total Power using the readings at the two wattmeters.



Sol:

$W_1 = I_{aA} , V_{AC}$

$W_2 : I_{bB} , V_{BC}$

$V_{ab} = 230 \angle 0 = V_{AB}$

$V_{bc} = 230 \angle -120 = V_{BC}$

$V_{ca} = 230 \angle +120 = V_{CA}$

$V_{AC} = 230 \angle -60$

$$I_{aA} = \frac{V_{an}}{Z_Y} = \frac{\frac{230}{\sqrt{3}} \angle -30}{4 + j15}$$

$I_{aA} = 8.554 \angle -105.1$

$I_{cC} = 8.554 \angle +14.9$

$I_{bB} = 8.554 \angle -226.1$

$= 8.554 \angle +134.9$

$P_1 = V_{AC} I_{aA} \cos(\theta_{V_{AC}} - \theta_{I_{aA}})$

$= 230 * 8.554 \cos(-60 + 105.1) = 1389 \text{ W}$

$P_2 = V_{BC} * I_{Bb} * \cos(\theta_{V_{BC}} - \theta_{I_{bB}})$

$= 230 * 8.554 * \cos(-120 - 134.9) = -512 \text{ W}$

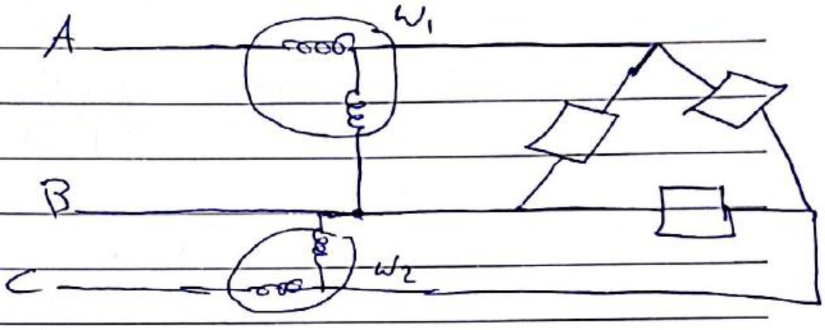
$P_T = P_1 + P_2 = 876.5 \text{ W}$

No

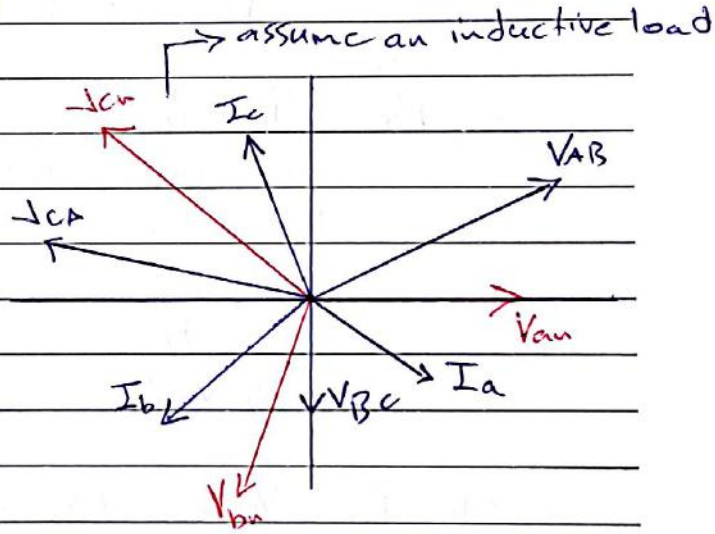
* How to calculate power factor from the readings of the two wattmeters:

W_1 : V_{AB} , I_a

W_2 : V_{CB} , I_c



$$P_1 = V_{AB} I_a \cos(\theta - \phi)$$
$$P_2 = V_{CB} I_c \cos(\theta - \phi)$$



$$P_1 = V_{AB} I_a \cos(30+\theta)$$
$$= V_L I_L \cos(30+\theta)$$

$$P_2 = V_L I_L \cos(30-\theta)$$

$$\frac{P_1}{P_2} = \frac{\cancel{V_L}\cancel{I_L} \cos(30+\theta)}{\cancel{V_L}\cancel{I_L} \cos(30-\theta)}$$

$$= \frac{\cos(30+\theta)}{\cos(30+\theta)}$$

$$= \frac{\cos 30 \cos\theta - \sin 30 \sin\theta}{\cos 30 \cos\theta + \sin 30 \sin\theta}$$

$$= \frac{\frac{\sqrt{3}}{2}\cos\theta - \frac{1}{2}\sin\theta}{\frac{\sqrt{3}}{2}\cos\theta + \frac{1}{2}\sin\theta} * \frac{\frac{2}{\cos\theta}}{\frac{2}{\cos\theta}} = \frac{\sqrt{3} - \tan\theta}{\sqrt{3} + \tan\theta}$$

Scanned by CamScanner

No

$\Rightarrow$ cont.... $\sqrt{3}\,P_1 + \tan\theta P_1 = \sqrt{3}\,P_2 - P_2 \tan\theta$

$\tan\theta (P_1 + P_2) = \sqrt{3}\,(P_2 - P_1)$

$\therefore \boxed{\tan\theta = \frac{\sqrt{3}\,(P_2 - P_1)}{(P_2 + P_1)}} \Rightarrow$ $P_2 > P_1$ inductive; $P_2 < P_1$ capacitive; $P_2 = P_1$ Resistive

$\hookrightarrow$ you can find θ by this equation, then you can find PF

$$\boxed{P_T = \sqrt{3}\,V_L I_L \cos\theta}$$

$\Rightarrow P_T = P_1 + P_2$

$= V_L I_L \cos(30+\theta) + V_L I_L \cos(30-\theta)$

$= V_L I_L \cos 30 \cos\theta - \cancel{V_L I_L \sin 30 \sin\theta}$

$+ V_L I_L \cos 30 \cos\theta + \cancel{V_L I_L \sin 30 \sin\theta}$

$= 2 V_L I_L \cos\theta \cancel{\cos 30}^{\sqrt{3}}$

$= \sqrt{3}\,V_L I_L \cos\theta$

$\Rightarrow P_1 - P_2 = V_L I_L \cos(30+\theta) - V_L I_L \cos(30-\theta)$

$= V_L I_L (\cos 30 \cos\theta - \sin 30 \sin\theta) - \cos 30 \cos\theta - \sin 30 \sin\theta$

$= -2 V_L I_L \underbrace{\sin 30}_{\hookrightarrow 1/2} \sin\theta$

$P_1 - P_2 = -V_L I_L \sin\theta$

$P_2 - P_1 = V_L I_L \sin\theta$

$\sqrt{3}\,(P_2 - P_1) = \sqrt{3}\,V_L I_L \sin\theta = Q_T$

$\boxed{Q_T = \sqrt{3}\,(P_2 - P_1)}$ $\boxed{S_T = \sqrt{P_T^2 + Q_T^2}}$

Scanned by CamScanner

2013 ‎81‎

No

(ex) the two wattmeters produce reading of $P_1 = 1560\,W$ & $P_2 = 2100\,W$ when connected to a Δ load Find $P_{1\phi}$, $Q_{1\phi}$, PF

Sol :

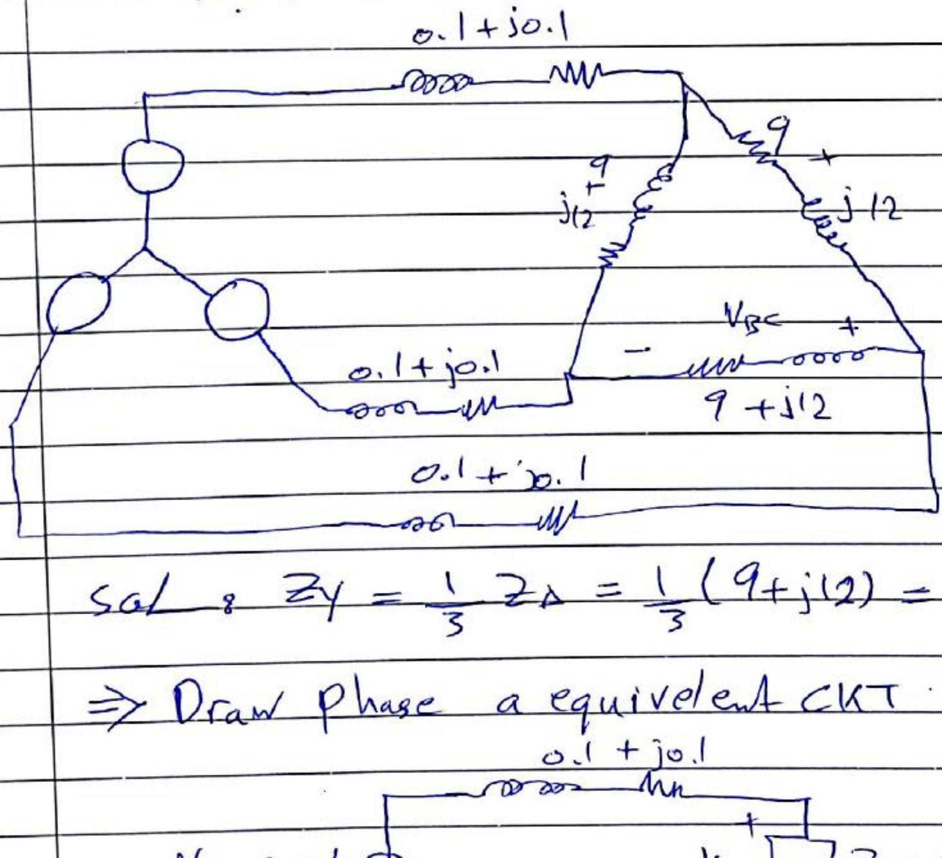
$$P_{1\phi} = \frac{P_T}{3} = \frac{P_1+P_2}{3} = \frac{3660}{3} = 1220\,W$$

$$Q_{1\phi} = Q_T/3 = \sqrt{3}(P_2-P_1)/3 = 311.77\ VAR$$

$$\theta = \tan^{-1}\left(\frac{Q_{1\phi}}{P_{1\phi}}\right) = 14.33^\circ$$

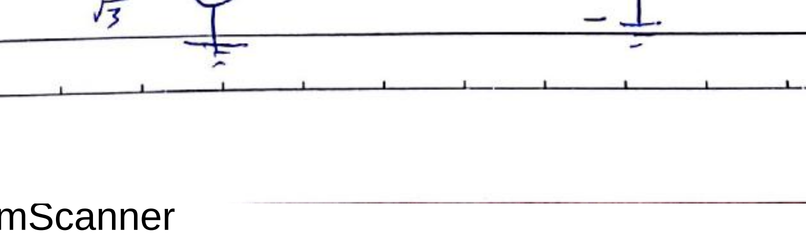
$$\cos(\theta) = 0.968 \text{ lagging}$$ #

⇒ Find V_{BC}? , $V_{ab} = 208$



Sol : $Z_Y = \frac{1}{3} Z_\Delta = \frac{1}{3}(9+j12) = 3+j4$

⇒ Draw phase a equivalent CKT , $|V_{ab}| = 208$



Scanned by CamScanner

No

taking V_{an} as the reference :-

$V_{AN} = \frac{3+j4}{3.1+j4.1} * \frac{208}{\sqrt{3}} \angle 0 = 117 \angle 0.22 \, V$

$V_{AB} = \sqrt{3} * 117 \angle 0.22+30^\circ = 203 \angle 30.22$

$V_{BC} = 203 \angle 30.22-120^\circ$

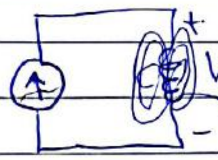
Scanned by CamScanner

※ Chapter 13

No

* Magnetically coupled ckts :-

→ Self inductance:-

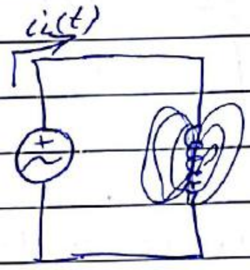


$V_L = L\frac{di(t)}{dt}$

→ $\phi = \frac{B}{A}$

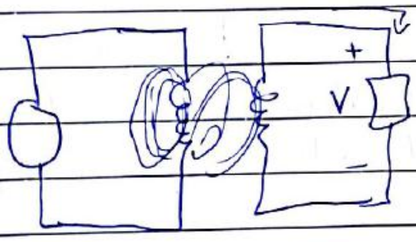
(mag. flux)

$V_L = j\omega L I$

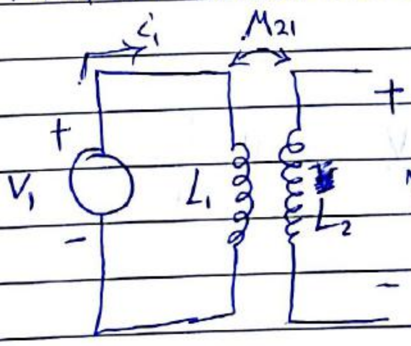


$V_L = L\frac{di(t)}{dt}$

$V_L = j\omega L I$



Mutual inductance:- الحث المتبادل

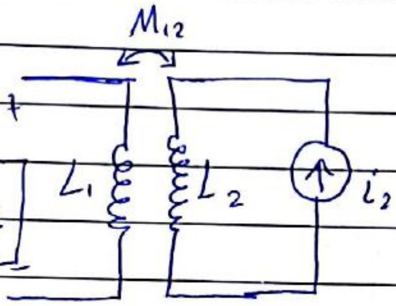


$V_2 = M_{21} * \frac{di_1}{dt}$

L_2 source 1

$V_1 = L_1\frac{di_1}{dt}$

No

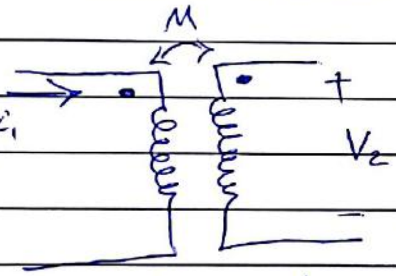


$$\boxed{V_1 = M_{12}\frac{di_2}{dt}}$$

⇒ what if we switch the terminals of L_2 OR change the direction of the current.

⇒ Dot convention :-

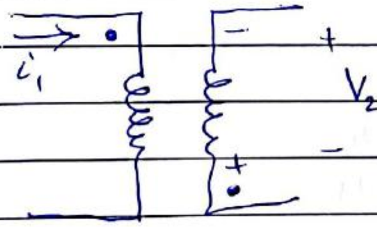
(1)



[if the current enters the dot in one coil, it makes the dotted terminal on the other coil positive

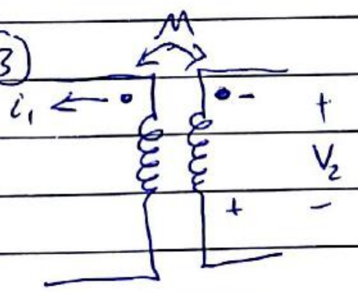
$$V_2 = M\frac{di_1}{dt}$$

(2)



$$V_2 = -M\frac{di_1}{dt}$$

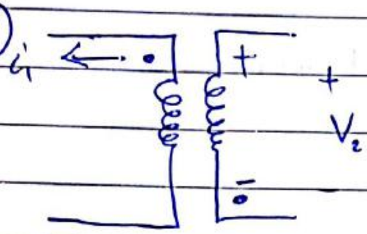
(3)



[if the current leaves the dot in one of the coils it makes the dotted terminal on the other coil negative

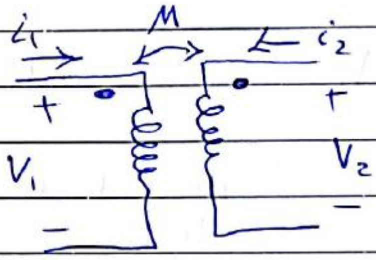
$$V_2 = -M\frac{di_1}{dt}$$

No

(4) 

$$V_2 = M\frac{di_1(t)}{dt}$$

(ex) $M = 2H$



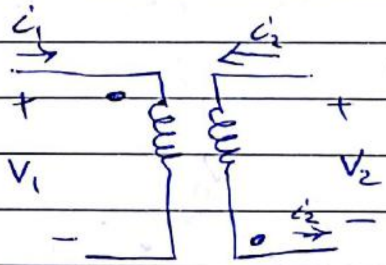
Determine V_2 when
$i_1 = 5\sin 10t$ & $i_2 = 0$

sol :

$$V_2(t) - M\frac{di_1(t)}{dt}$$

$$= 2 * 5 * 10\cos(10t = 100\cos 10t\ V$$

⇒ determine V_1 if :



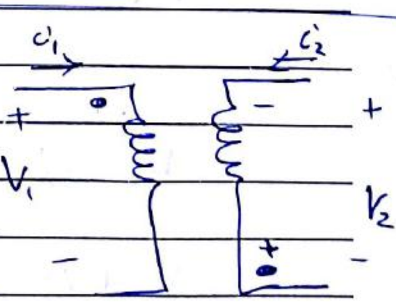
$i_2 = 5\sin 45t\ A$, $i_1 = 0$

$$V_1 = (-)M\frac{di_2}{dt}$$

$$= -2 * 5 * 45 * \cos(45t)$$

$$= -450\cos(45t)\ V$$

⇒ determine V_2 if $i_1 = -8e^{-t}$ & $i_2 = 0$



sol :

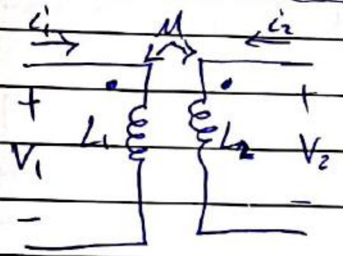
$$V_2(t) = (-)M\frac{di}{dt}$$

$$= -M\ di/dt$$

$$= -* 2 * (-8) * (-1)\ e^{-t}\ V$$

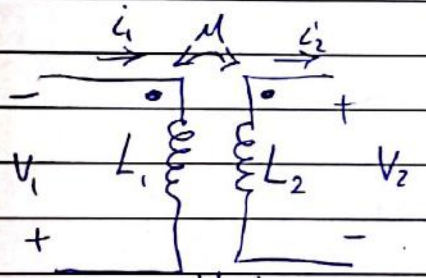
$$= -16e^{-t}\ V$$

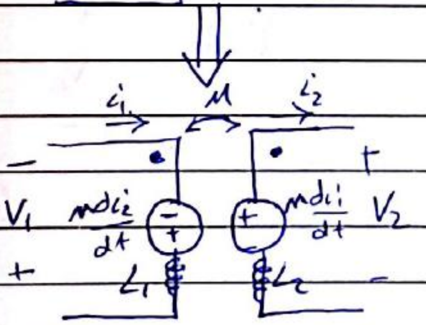
Combined mutual & self inductance :-



$$V_1 = L_1\frac{di_1}{dt} + M\frac{di_2}{dt}$$

$$V_2 = L_2\frac{di_1}{dt} + M\frac{di_1}{dt}$$





اذا فهمت المعادلة دي باقي الشابتر بسيط

$$+V_1 - M\frac{di_2}{dt} + L\frac{di_1}{dt} = 0$$

$$V_1 = -L_1\frac{di_1}{dt} + M\frac{di_2}{dt}$$

$$V_2 + L_2\frac{di_2}{dt} - M\frac{di_1}{dt} = 0$$

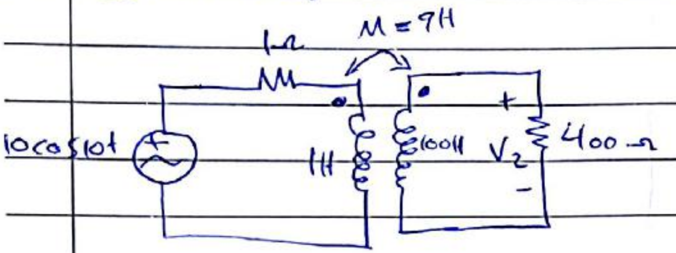
$$V_2 = -L_2\frac{di_2}{dt} + M\frac{di_1}{dt}$$

$$V_1 = -j\omega L_1 I_1 + j\omega M I_2$$

$$V_2 = -j\omega L_2 I_2 + j\omega M I_1$$

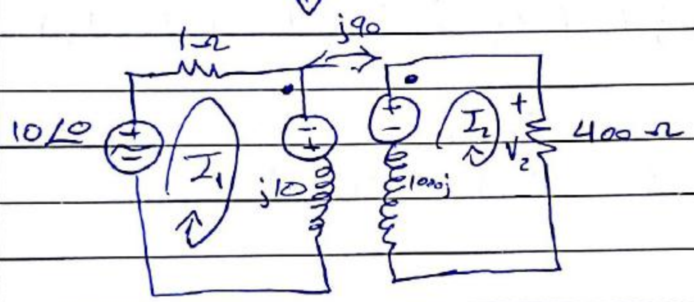
Scanned by CamScanner

ex Find V_2



$\omega = 10$ rad/sec

⇓



$-10\angle 0 + 1I_1 + j10\,I_1 - j90\,I_2 = 0$ —— (1)

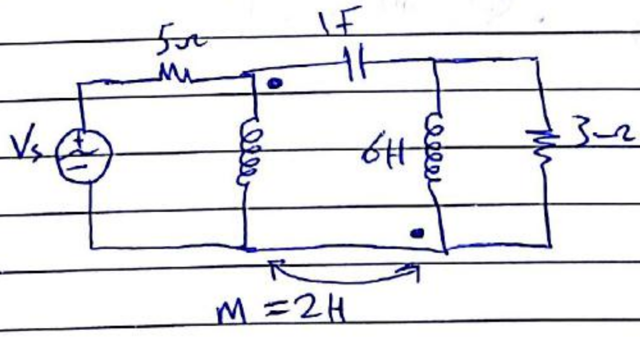
$400 I_2 + j1000\,I_2 - j90\,I_1 = 0$ —— (2)

$V_2 = 400 I_2$

$\Rightarrow I_2 = 0.172\angle -16.7^\circ A$

$V_2 = 68.8\angle -16.7\,V$

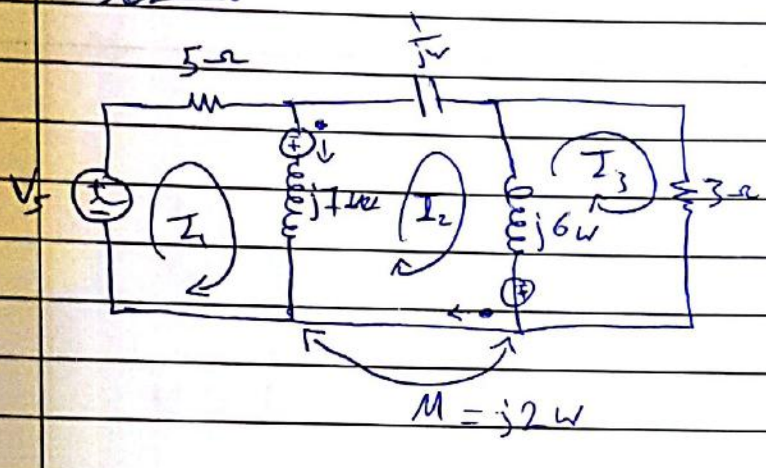
ex write the equation for meshes in the CKT :-



follow solution

No

Sol :



Mesh 1 : $-V_s + 5I_1 + j7w(I_1 - I_2) - j2w(I_2 - I_3) = 0$

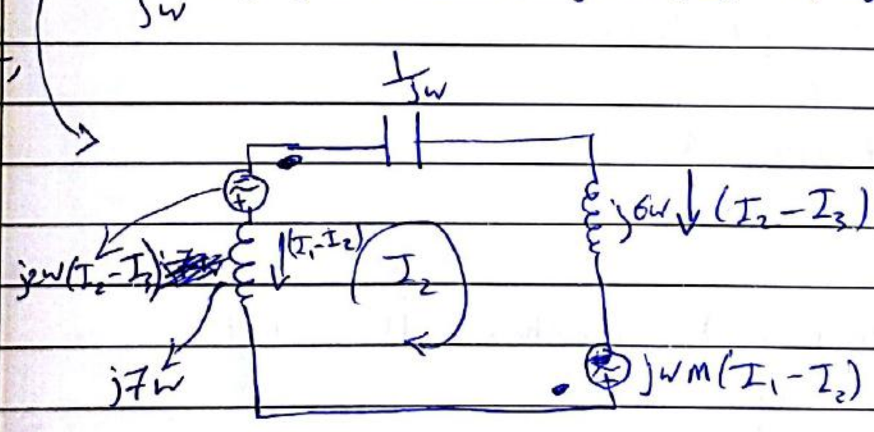
Mesh 3 : $3I_3 + j6w(I_3 - I_2) + j2w(I_1 - I_2) = 0$

or $\Rightarrow$ $3I_3 + j6w(I_3 - I_2) - j2w(I_2 - I_1) = 0$

Mesh 2 :-

$\frac{1}{jw} I_2 + j6w(I_2 - I_3) + j7w(I_2 - I_1) - j2w(I_1 - I_2) + j2w(I_2 - I_3) = 0$

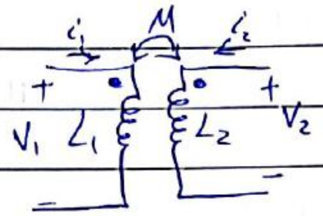
Mesh 2 =,



No

Energy stored in a circuit with mutual inductance :

[prove that $\underbrace{M_{12}}_{\text{coil} \; \text{source}} = \underbrace{M_{21}}_{\text{coil} \; \text{source}}$]



① set $I_2 = 0$

set $i_1 : 0 \to I_1$

$t : 0 \to t_1$

$$V_1 i_1 = L \frac{di_1}{dt} i_1$$

$$\Rightarrow \int_0^{t_1} V_1 i_1 \, dt = \int_0^{I_1} L i_1 \, di_1$$

energy $\Rightarrow W_1 = \int_0^{t_1} V_1 i_1 \, dt = \frac{1}{2} L_1 I_1^2$, energy stored from $t = 0$ to $t = t_1$

② set $i_1 = I_1$

$i_2 : 0 \to I_2$

$t : t_1 \to t_2$

$$V_2 i_2 = L_2 \frac{di_2}{dt} i_2$$

$$\int_{t_1}^{t_2} V_2 i_2 \, dt = \int_0^{I_2} L_2 i_2 \, di_2$$

energy : $W_2 = \frac{1}{2} L_2 I_2^2$

$\Rightarrow$ ~~Energy stored~~

Scanned by CamScanner

الخميس 23/3

No

$\Rightarrow$ energy stored due to the mutual inductance
I_1 & mutual Voltage

$$\int_{t_1}^{t_2} v_1 i_1 \, dt = \int_{t_1}^{t_1} M_{12} \frac{di_2}{dt} i_1 \, dt = M_{12} I_1 \int_0^{I_2} di_2$$

$$= M_{12} I_1 I_2$$

Total energy stored :

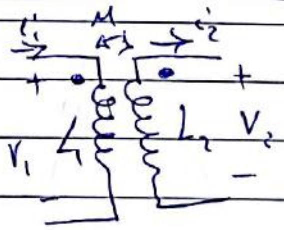
$$W = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 + M_{12} I_1 I_2 .$$

$\Rightarrow$ What if I interchange the assumption :-

$\Rightarrow$ $I_1 = 0$, $i_2(t) = I_2$, t $0 \rightarrow t_1$ $\Big\{$ set $i_2(t) = I_2$, $i_1(t) \Rightarrow 0 \rightarrow I_1$, $t \Rightarrow t_1 \rightarrow t_2$

$$W_{total} = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 + M_{21} I_1 I_2$$

$$\Rightarrow M_{12} = M_{21} = M$$



$$W_{total} = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 \, M I_1 I_2$$

$$W(t) = \frac{1}{2} L_1 i_1^2(t) + \frac{1}{2} L_2 i_2^2(t) \mp M i_1(t) i_2(t)$$

اذا كان التيارين داخلين بالدوت او طالعين بتكون M موجب
،، ،، واحد داخل والثاني طالع ،، ،، سالب

No

Set an upper limit for M :-

assume that i_1 & i_2 are positive.

$W > 0$

$$\frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 - M I_1 I_2 > 0$$

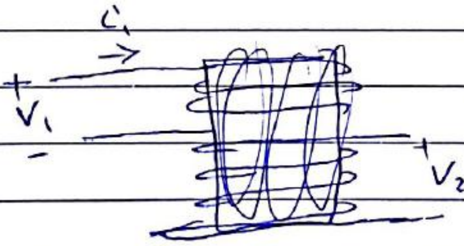
$$\frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 - M I_1 I_2 - I_1 I_2 \sqrt{L_1 L_2} + I_1 I_2 \sqrt{L_1 L_2} > 0$$

$$\underbrace{\frac{1}{2} (I_1 \sqrt{L_1} - I_2 \sqrt{L_2})^2}_{+ve} + \underbrace{I_1 I_2 (\sqrt{L_1 L_2} - M)}_{+ve} > 0$$

$$I_1 I_2 (\sqrt{L_1 L_2} - M) > 0 \Rightarrow \sqrt{L_1 L_2} - M > 0$$

$$M < \sqrt{L_1 L_2}$$

Coupling Coefficient :-

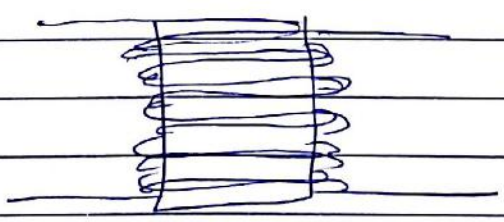


Magnetic core

$0 < K < 1$

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

→ coupling coefficient



ال Coupling coefficient

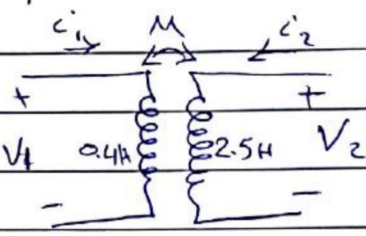
حون آكبراشي

No

(ex) Find $V_1(0)$, $W(0)$

$k = 0.6$

عرضنا انو M موجبة لانهم الثنين داخلين ال Dot



sol

$M = k\sqrt{L_1 L_2}$

$= 0.6\sqrt{0.4 * 2.5}$

$= 0.6$

$i_1 = 4i_2 = 20\cos(500t - 20^\circ)\,mA$

$V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$

$V_1(0) = L_1 \frac{di_1(0)}{dt} + M \frac{di_2(0)}{dt}$

$= 0.4 * [-10\sin(-20)] + 0.6\,[-2.5\sin(-20)]$

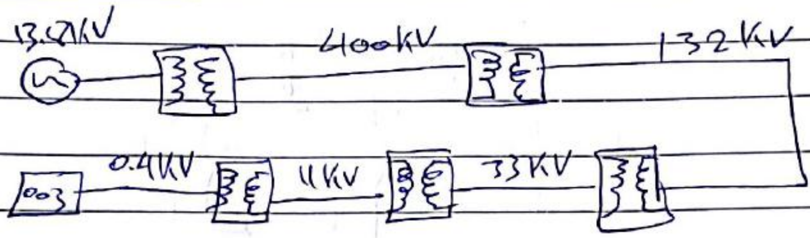
$= 1.881\ V$

$W(0) = \frac{1}{2} L_1 i_1^2(0) + \frac{1}{2} L_2 i_2^2(0) + M\, i_1(0)\, i_2(0)$

$w(0) = 151\ \mu J$

No

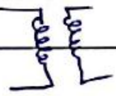
Transformers:-



transformers:-

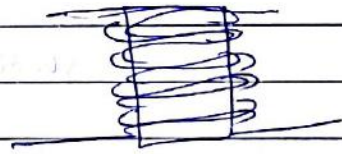
linear

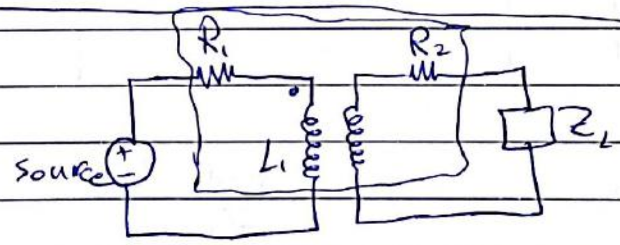
The coils are wound in Air



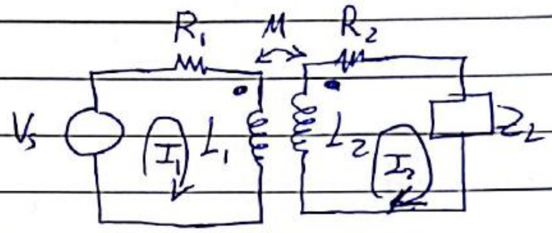
Ideal

The coils are wound around a magnetic core





* linear transformer :-

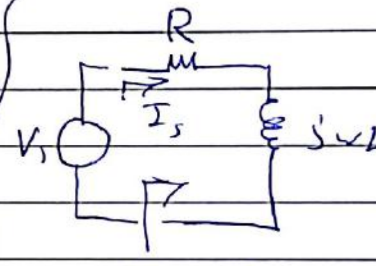


$$V_s = (R_1 + j\omega L_1) I_1 - j\omega M I_2$$
$$(R_2 + j\omega L_2 + Z_L) I_2 - j\omega M I_1 = 0$$

$$Z_{11} = R_1 + j\omega L_1$$
$$Z_{22} = R_2 + Z_L + j\omega L_2$$

$$\Rightarrow V_s = Z_{11} I_1 - j\omega M I_2 \quad \text{---} (1)$$

$$0 = -j\omega M I_1 + Z_{22} I_2 \quad \text{---} (2)$$



$Z_{in} = R + j\omega L$

$$\begin{bmatrix} V_s \\ 0 \end{bmatrix} = \begin{bmatrix} Z_{11} & -j\omega M \\ -j\omega M & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

from 2 :- $I_2 = \dfrac{j\omega M}{Z_{22}} I_1$

** substitude in 1 :-

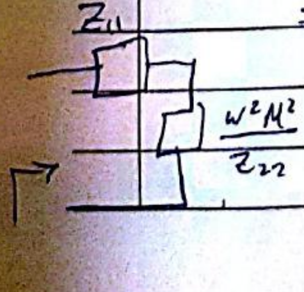
$$V_s = Z_{11} I_1 - j\omega M \left(\frac{j\omega M}{Z_{22}} \right) I_1$$

$Z_{22} = R_{22} + jX_{22}$

$$Z_{in} = \frac{V_s}{I_1} = Z_{11} + \frac{\omega^2 M^2}{Z_{22}} = Z_{11} + \frac{\omega^2 M^2}{R_{22} + jX_{22}}$$

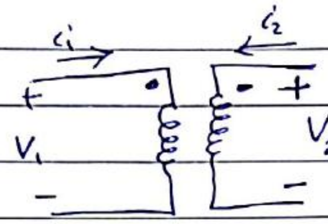
$$= Z_{11} + \underbrace{\frac{\omega^2 M^2 R_{22}}{R_{22}^2 + X_{22}^2}}_{\text{Real}} - \underbrace{\frac{j\omega^2 M^2 X_{22}}{R_{22}^2 + X_{22}^2}}_{\text{Imj}}$$

الحد الثاني هو Reflected Impedence.

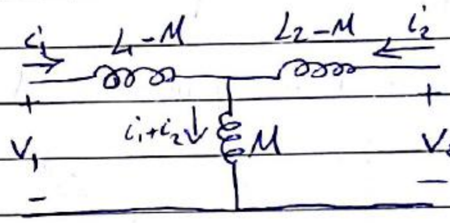


No

→ The presence of the secondary coil, increases the input impedance seen by the source.



→ The T-equivalent CKT.



$$V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

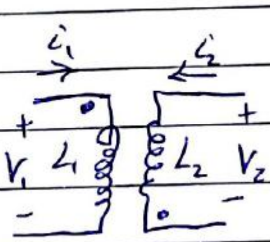
$$V_2 = L_2 \frac{di_2}{dt} + M \frac{di_1}{dt}$$

$$V_1 = (L_1 - M)\frac{di_1}{dt} + M \frac{d(i_1+i_2)}{dt}$$

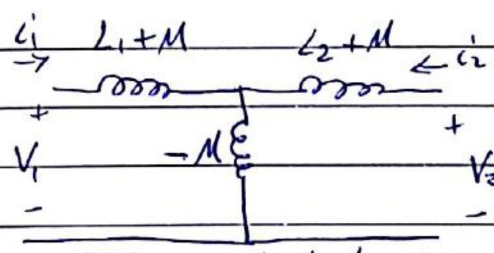
$$V_1 = L_1 \frac{di_1}{dt} - M \cancel{\frac{di_1}{dt}} + M \frac{di_2}{dt} + M \cancel{\frac{di_2}{dt}}$$

$$V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$V_2 = (L_2 - M)\frac{di_2}{dt} + M \frac{d(i_1+i_2)}{dt}$$



$\Longrightarrow$

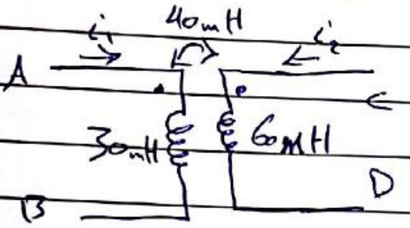


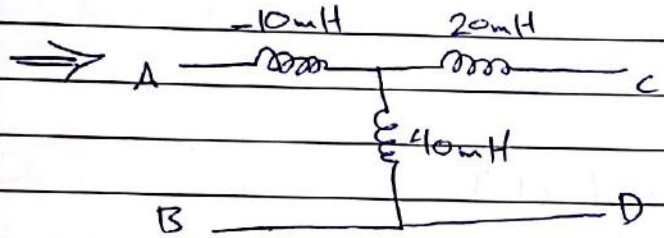
T-equivalent CKT

No

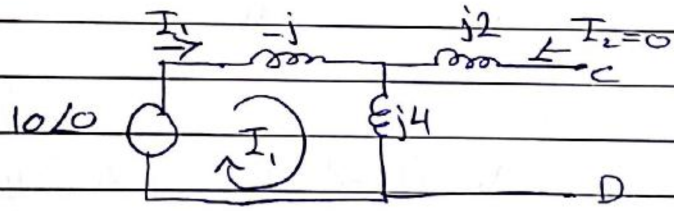
لو ما اعطى تيارات بنفرض الاتجاه من عنا

ex) Find the T-equivalent CKT





if $V_{AB} = 10\angle 0$ & $w = 100$, find I_1 & V_{CD}

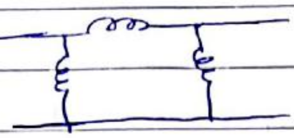


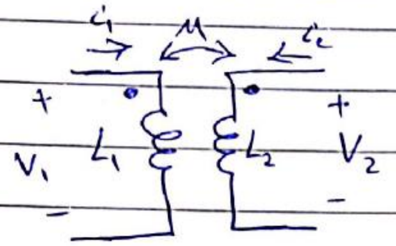
$$I_1 = \frac{10\angle 0}{-j+4j} = 3.33\angle{-90} = 3.33 \sin(100t) \text{ A}$$

$$V_{CD} = I_1 * j4 = 13.33\angle 0 = 13.33 \cos 100t$$

No

* The π equivalent ckt :-





$$V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$V_2 = L_2 \frac{di_2}{dt} + M \frac{di_1}{dt}$$

$$\rightarrow \frac{di_2}{dt} = \frac{1}{L_2} V_2 - \frac{M}{L_2} \frac{di_1}{dt}$$

$$\rightarrow V_1 = L_1 \frac{di_1}{dt} + M \left[\frac{1}{L_2} V_2 - \frac{M}{L_2} \frac{di_1}{dt} \right]$$

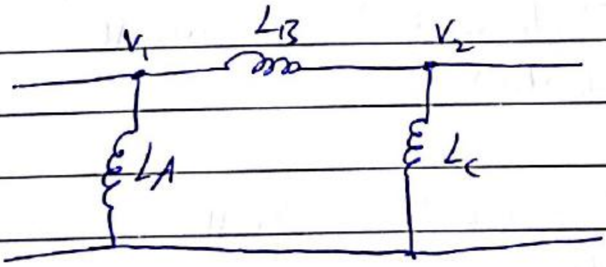
$$V_1 = L_1 \frac{di_1}{dt} + \frac{M}{L_2} V_2 - \frac{M^2}{L_2} \frac{di_1}{dt}$$

$$V_1 - \frac{M}{L_2} V_2 = \left(L_1 - \frac{M^2}{L_2} \right) \frac{di_1}{dt}$$

like nodal analysis

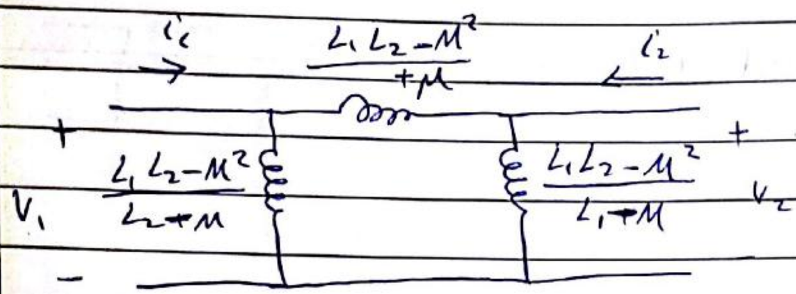
$$\frac{di_1}{dt} = \frac{L_2}{L_2 L_1 - M^2} V_1 - \frac{M}{L_2 L_1 - M^2} V_2$$

$$\frac{di_2}{dt} = \frac{-M}{L_2 L_1 - M} V_1 + \frac{L_1}{L_2 L_1 - M^2} V_2$$

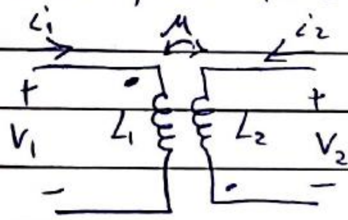


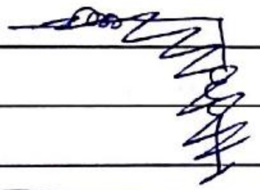
$$0 = \frac{V_1 - V_2}{(\ \ )} + \frac{V_1 - 0}{(\ \ )} + I_1$$

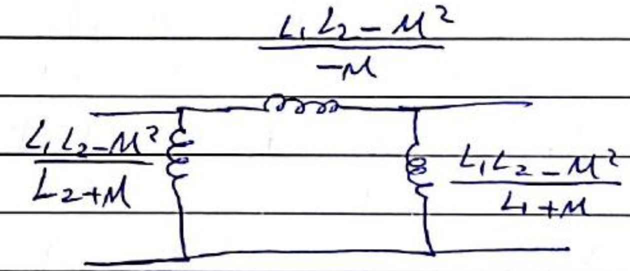
Scanned by CamScanner



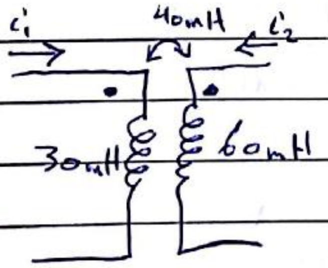
what happens if we change the dots



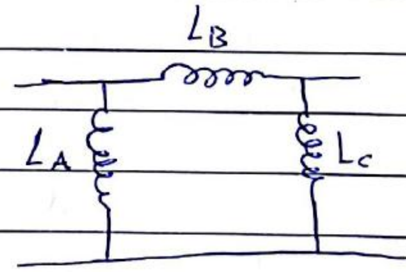




29/3 ⇒ ex Find the π equivalent CKT for the linear transformer shown :-



$\Rightarrow$



$$L_A = \frac{30*10^{-3} * 60*10^{-3} - 1600*10^{-6}}{60*10^{-3} - 40*10^{-3}} = 10\,mH$$

$$L_B = \frac{30*60*10^{-6} - 1600*10^{-6}}{40*10^{-3}} = 5\,mH$$

$$L_C = \frac{30*60*10^{-6} - 1600*10^{-6}}{30*10^{-3} - 40*10^{-3}} = -20\,mH$$

الثلاثاء 29/3

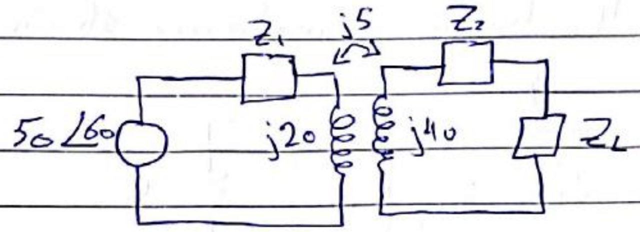
No

ex) Calculate the input impedance & current I_1

$Z_1 = 60 - j100$

$Z_2 = 30 + j40$

$Z_L = 80 + j60$



sol

هون ما بفرق اتجاه التيار لانو M^2

$Z_{in} = Z_{11} + \dfrac{w^2M^2}{Z_{22}} \Rightarrow$ reflected impedence

Z_1 Z_{11}

Z_{in}: impedence seen by the source (Z_{th})

$Z_{11} = R_1 + jwL_1$

$Z_{22} = \underset{Z_2}{\underset{||}{R_2}} + jwL_2 + L_2$

$Z_{11} = Z_1 + jwL_1$

$= 60 - j100 + j20$

$= 60 - j80\ \Omega$

$jwM = j5$

$wM = 5$

$Z_{22} = Z_2 + jwL_2 + Z_L$

$= 30 + j40 + j40 + 80 + j60$

$= 110 + j140\ \Omega$

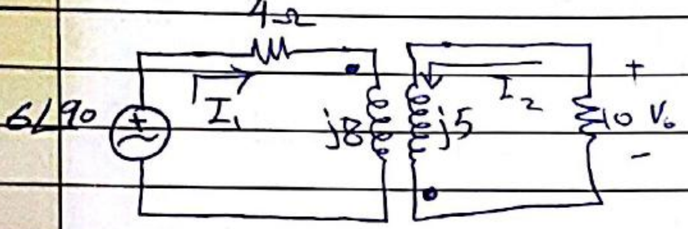
$Z_{in} = 60 - j80 + \dfrac{25}{110 + j140} = 100.14\angle{-53}\ \Omega$

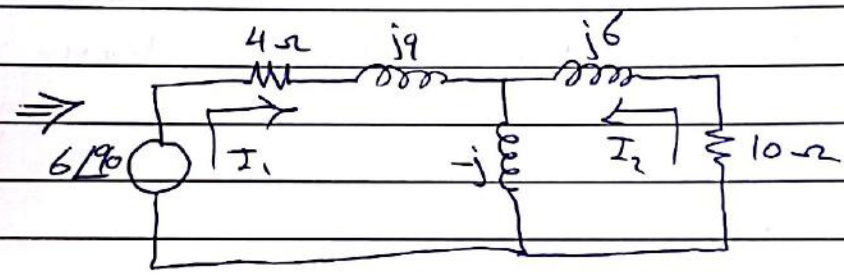
$Z_{in} = \dfrac{V_s}{I_1} \Rightarrow I_1 = \dfrac{V_{in}}{Z_{in}} = \dfrac{50\angle 60}{100.19\angle{-53}} = 0.5\angle 113.1$

Scanned by CamScanner

No

(ex) Solve for I_1, I_2, V_o using T-equivalent CKT for the linear transformer shown:-





$$-6\angle 90 + (4+j9)I_1 - j(I_1 + I_2) = 0$$

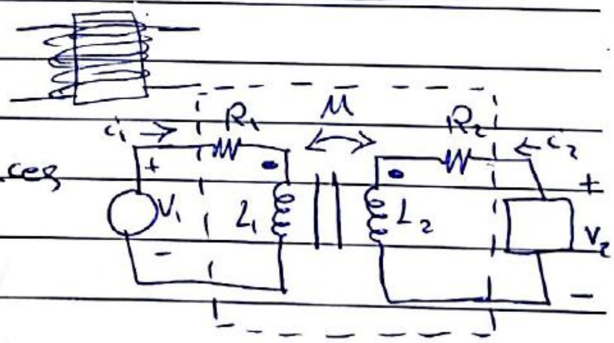
$$(10 + j6)I_2 - j(I_2 + I_1) = 0$$

$$I_2 = 0.06 \angle 90 \qquad I_1 = 0.6 + j0.3$$

$$V_o = -10 * I_2 = 0.6 \angle 90$$

---

* Ideal Transformer:-



→ the coils & mutual inductances large ($L_1 = \infty, L_2 = \infty, M = \infty$)

→ $K = 1$

→ $R_1 = 0 = R_2$

$$V_1 = j\omega L_1 I_1 + j\omega M I_2 \quad \text{———} \ (1)$$

$$V_2 = j\omega L_2 I_2 + j\omega M I_1 \quad \text{———} \ (2)$$

→ $I_1 = \dfrac{(V_1 - j\omega M I_2)}{j\omega L_1}$

No

subistitute in ② :-

$$V_2 = j\omega L_2 I_2 + j\omega M \left[\frac{V_1 - j\omega M I_2}{j\omega L_1} \right]$$

$$= j\omega L_2 I_2 + \frac{M}{L_1} V_1 - \frac{j\omega M^2 I_2}{L_1} \quad , M = \sqrt{L_1 L_2}$$

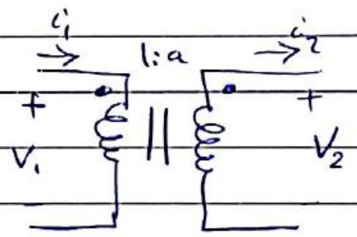
$$V_2 = \cancel{j\omega L_1 I_2} + \frac{\sqrt{L_1 L_2}}{L_1} V_1 - \cancel{\frac{j\omega L_1 L_2 I_2}{L_2}}$$

$$V_2 = \sqrt{\frac{L_2}{L_1}} V_1 = n V_1 = a V_1 = \frac{N_2}{N_1} V_1$$

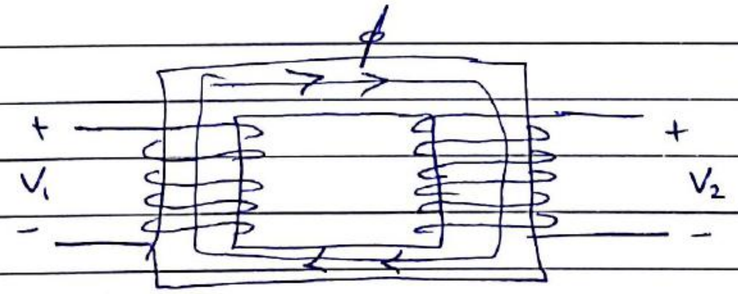
→ turns ratio

$$\boxed{L_1 = \frac{N_1^2}{\Re}}$$

$$\boxed{L_2 = \frac{N_2^2}{\Re}}$$



$$\sqrt{\frac{L_2}{L_1}} = \frac{N_2}{N_1}$$



$$V_1 = -N_1 \frac{d\phi}{dt} \quad , \quad V_2 = -N_2 \frac{d\phi}{dt}$$

$$\frac{d\phi}{dt} = \frac{V_1}{N_1} = \frac{V_2}{N_2} \Rightarrow \boxed{\frac{V_2}{V_1} = \frac{N_2}{N_1}}$$

Scanned by CamScanner

No

$\frac{V_2}{V_1} = \frac{N_2}{N_1} \Rightarrow N_2 > N_1 \rightarrow$ step up transformer

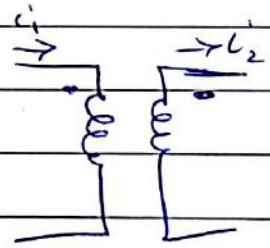
$N_2 < N_1 \rightarrow$ step down transformer

$\Rightarrow$ 2 rules to define the Voltage polerities & the current directions:

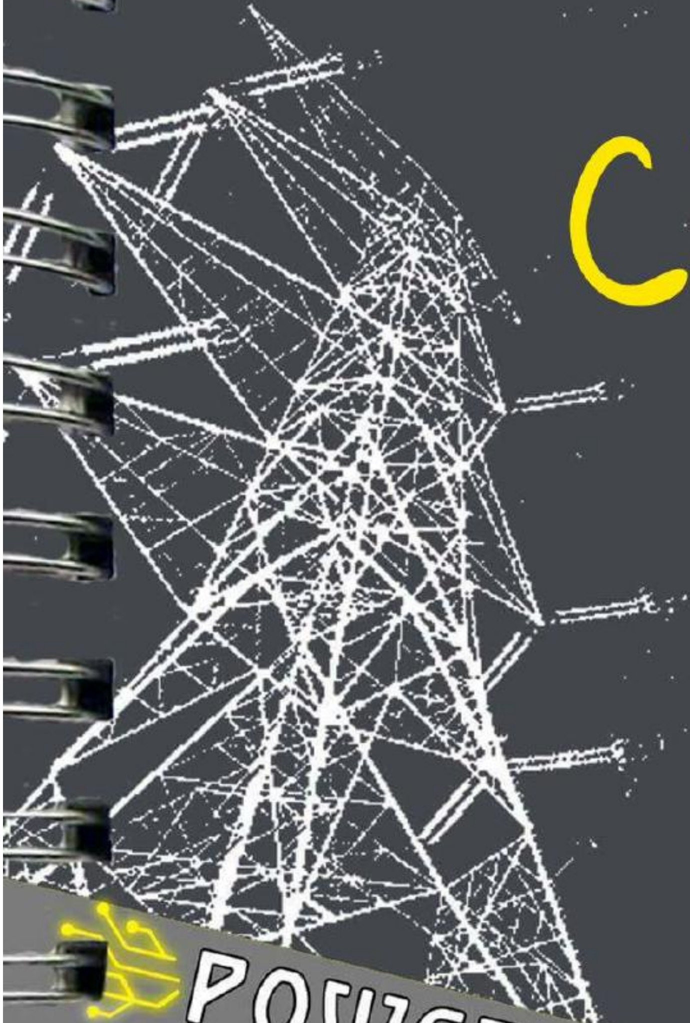
(1) if V_1 & V_2 are both positive or both negative at the dotted terminals use $+n$, or otherwise use $-n$

(2) if I_1 & I_2 both enter or both leaves the dotted terminals use $-n$ for $\frac{I_1}{I_2}$, otherwise use $+n$

$\frac{I_1}{I_2} = -n$



Circuits2



POWERUNIT

By: Maen Mahadeen

Dr. Mohd Al-haj

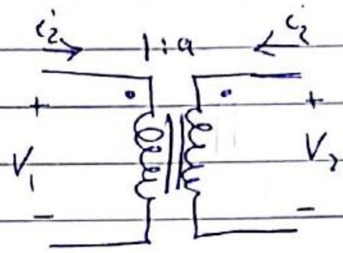
Spring 16

Scanned by CamScanner

الخميس 31/3

No

Ideal transformers :-



$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = a = n$$

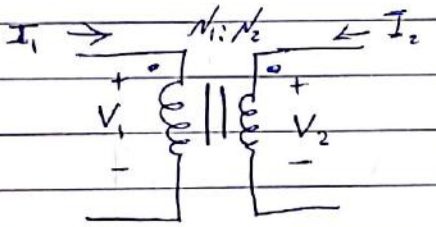
⇒ The ideal Tr. is lossless :-

$$V_1 I_1 = V_2 I_2$$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2} \Rightarrow \frac{I_1}{I_2} = \frac{N_2}{N_1}$$

⇒ 2 rules : ① --- ② ---

(1)

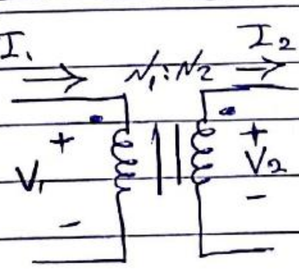


$$\frac{V_2}{V_1} = +\frac{N_2}{N_1} = +n$$

$V_1 = 10$, $N_2 = 5$, $N_1 = 1$
$\Rightarrow V_2 = +50$

$$\frac{I_1}{I_2} = -n$$

(2)

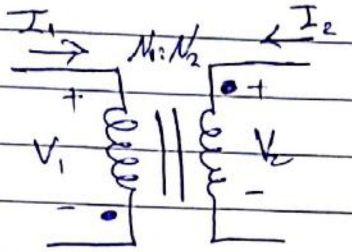


$$\frac{V_2}{V_1} = +n \quad , \quad \frac{I_1}{I_2} = +n$$

Scanned by CamScanner

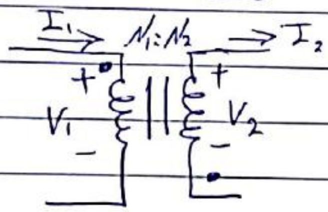
No

(3)



$$\frac{V_2}{V_1} = -\frac{N_2}{N_1} = -n \quad , \quad \frac{I_1}{I_2} = +\frac{N_2}{N_1} = +n$$

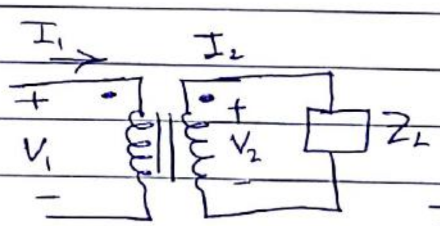
(4)



$$\frac{V_2}{V_1} = -\frac{N_2}{N_1} = -n \quad , \quad \frac{I_1}{I_2} = -\frac{N_2}{N_1} = -n$$

$$|S_1| = V_1 I_1 = \frac{V_2}{n}(n I_2) = V_2 I_2 = |S_2|$$

$$Z_{in} = \frac{V_1}{I_1}$$

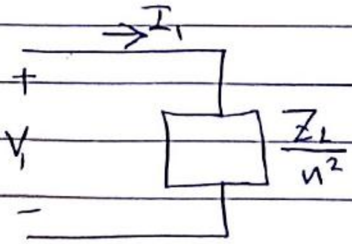


$$Z_L = \frac{V_2}{I_2}$$

$$= \frac{V_2/n}{n I_2}$$

$$= \frac{V_2}{I_2} * \frac{1}{n^2} = \frac{Z_L}{n^2}$$

Reflected Impedance



Scanned by CamScanner

No

(ex) An ideal TR. is rated $\underset{V_1}{2400}/\underset{V_2}{120}$ V , $\underset{S}{9.6}$ KVA and has 50 turns on the secondary side, Find:-

1) turns ratio: $n = a = \dfrac{N_2}{N_1} = \dfrac{V_2}{V_1} = \dfrac{120}{2400} = 0.05$ (unitless)

2) turns on primary side :-

$$n = \frac{N_2}{N_1} \Rightarrow 0.05 = \frac{50}{N_1} \Rightarrow N_1 = 1000 \text{ turns}$$

3) The currents ratings for the primary & the secondary cKT:

$$S = S_1 = S_2$$

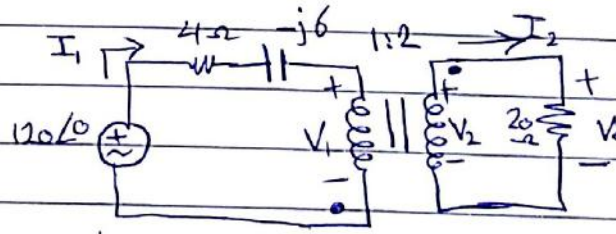
$$S_1 = V_1 I_1 \Rightarrow I_1 = \frac{S_1}{V_1} = \frac{9.6 * 10^3}{2400} = 4A$$

$$S_2 = V_2 I_2 \Rightarrow I_2 = \frac{S_2}{V_2} = \frac{9600}{120} = 80A$$

currents rating: maximum current flow through the load

(ex) For the ideal transformer shown: Find ⇒

1) the source current I_1 , 2) the output ~~volt~~ Voltage $[V_o]$
3) the complex Power supplied by the source .



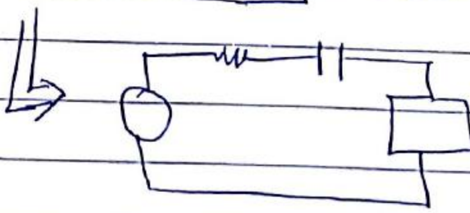
Sol :

$Z_{in} = V_s / I_1$

$$Z_{in} = 4 - j6 + \frac{Z_L}{n^2}$$

$$= 4 - j6 + 5$$

$$= 9 - j6 = 10.82 \angle{-33.7}$$

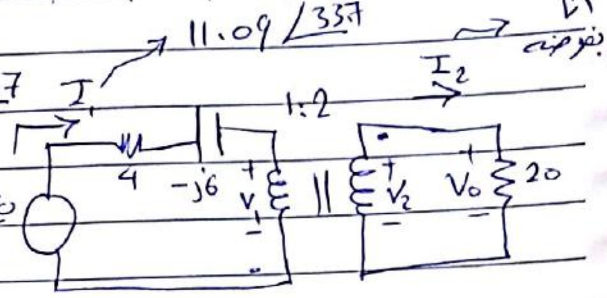


$\dfrac{Z_L}{n^2} = \dfrac{20}{4} = 5$

Scanned by CamScanner

No

$I_1 = \dfrac{120\angle 0}{10.82\angle -33.7} = 11.09\angle 33.7$



$V_o = R * I_2$

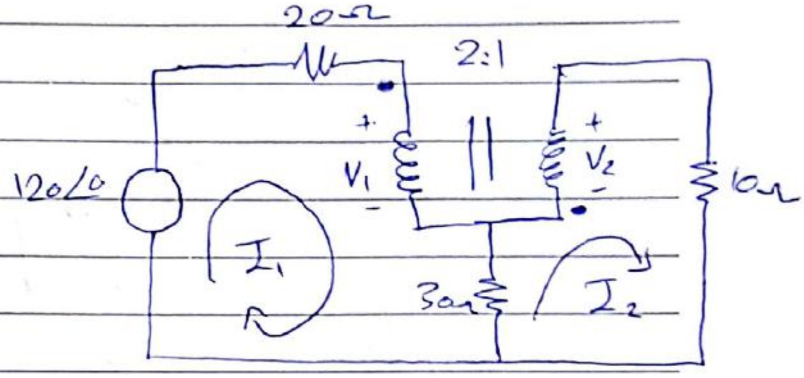
$\dfrac{I_1}{I_2} = (-)\,n$

$\Rightarrow I_2 = \dfrac{-1}{n} I_1 = \dfrac{-1}{2} * 11.09\angle 33.7 = -5.545\angle 33.69$
$= 5.545\angle 213.7$

$V_o = 20 I_2 = 110.9\angle 213.7$

No

(ex) calculate the Power supplied to the 10 Ω - resistor.



@ Mesh 1 : $-120 + 20I_1 + V_1 + 30(I_1 - I_2) = 0$

@ Mesh 2 : $10I_2 + 30(I_2 - I_1) - V_2 = 0$

$$\frac{V_2}{V_1} = \frac{-1}{2} \quad , \quad \frac{I_1}{I_2} = \frac{-1}{2}$$

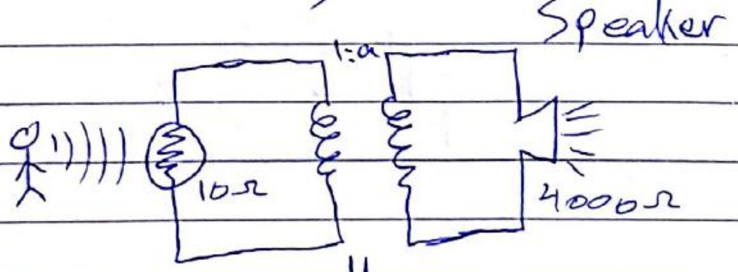
$\Rightarrow I_2 = -0.7272\ A$

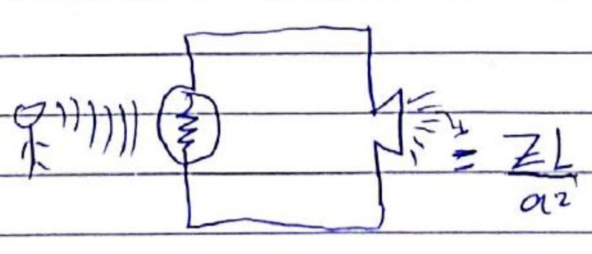
$\Rightarrow P = (-0.7272)^2 * 10$

$= 5.3\ W$

$\Rightarrow$ All equation are valid for both time & frequency domains

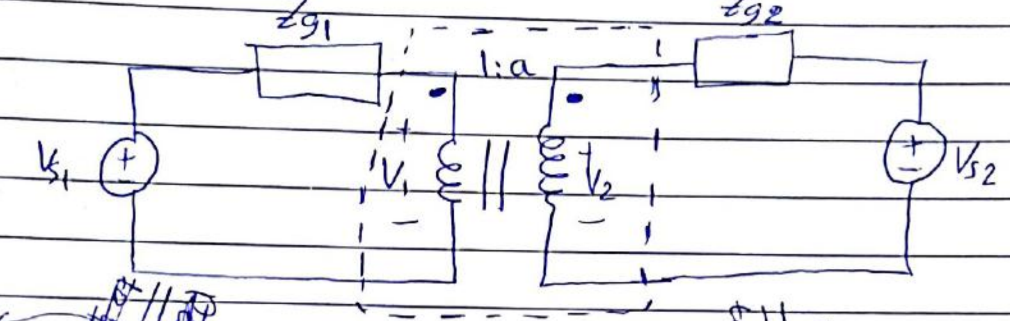
$\Rightarrow$ Impedance matching





$= \frac{Z_L}{a^2}$

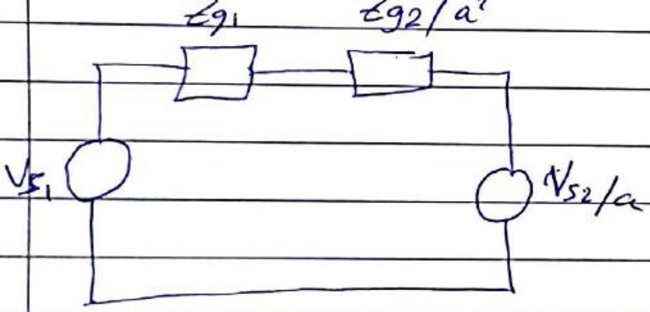
Equivalent CKT :-

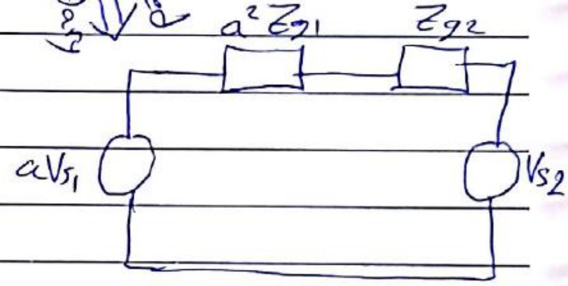


$$\frac{V_2}{V_1} = a$$

Re ffered to Primary

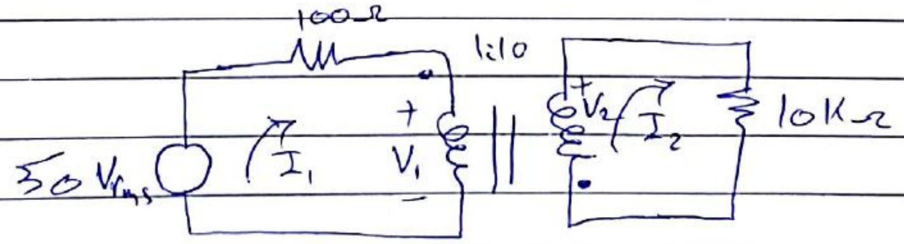
Reffered to secondary

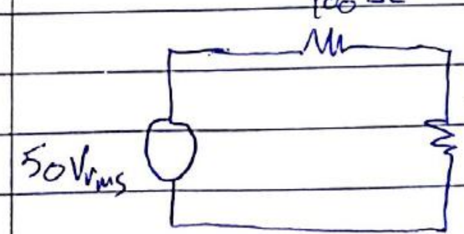




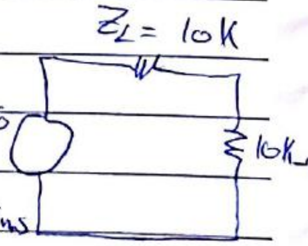
---

ex) Draw the equivalent impedence reffered to Primary & seondary.





$$Z_L = \frac{10 * 10^3}{100} = 100\,\Omega$$



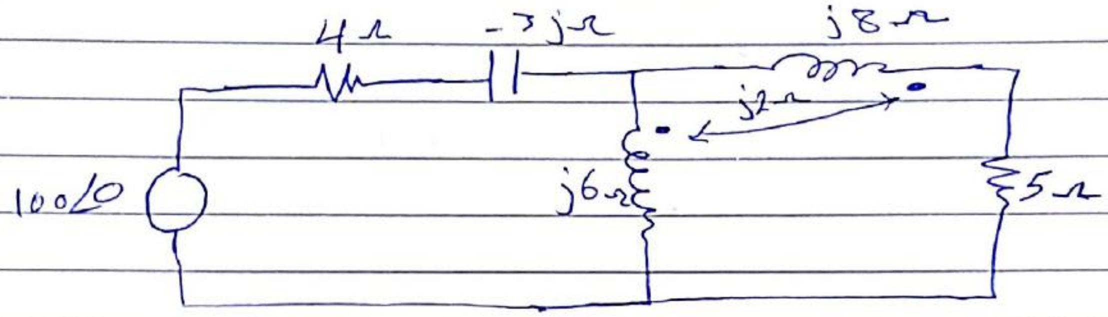
$V = -a * 50$

$= -500\ V_{rms}$

No

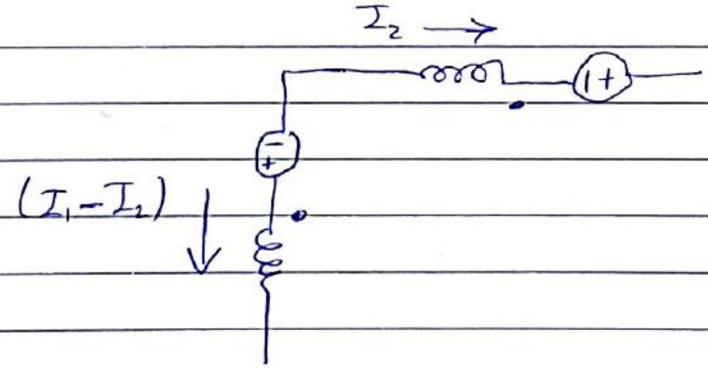
Review to second exam

(ex) Calculate the mesh currents in the CKT:-



sol:

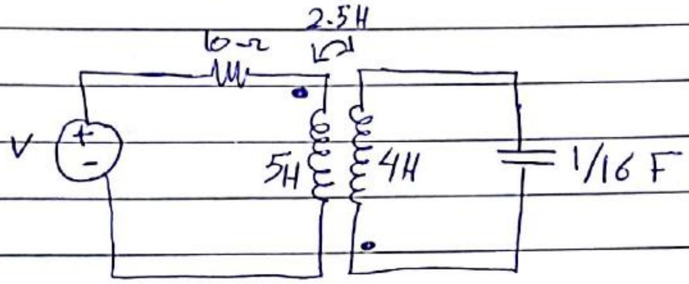
@ Mesh 1 : $-100\angle 0 + (4-j3)I_1 + j6(I_1 - I_2) - j2I_2 = 0$



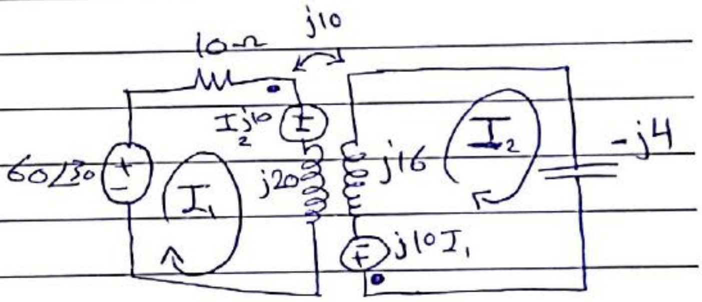
@ Mesh 2 :

$(5+j8)I_2 + j6(I_2 - I_1) + j2I_2 - j2(I_1 - I_2) = 0$

ex) For the ckT shown, Find the coupling coefficient & the total energy stored at $t = 1\,sec$ if $V = 60\cos(4t+30)\,V$



$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{2.5}{\sqrt{5 * 4}} = 0.56$$



Mesh 1: $-60\angle 30 + 10 I_1 + j20 I_1 + j10 I_2 = 0$

Mesh 2: $(j16 - j4)\, I_2 + j10\, I_1 = 0$

$$I_1 = 3.905 \angle -19.4^\circ$$
$$I_2 = 3.25 \angle 160.6^\circ$$

$i_1(t) = 3.905 \cos(4 * 180/\pi - 19.4^\circ)$

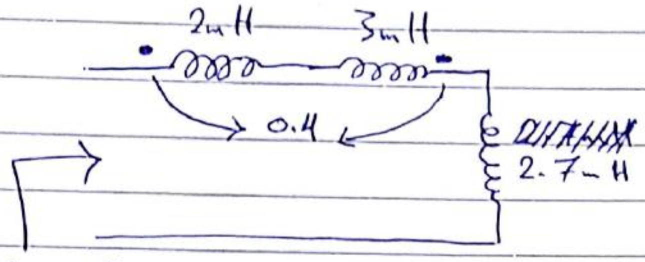
$i_2(t) = 2.25 \cos(4t + 160.6)$

$w(1) = \frac{1}{2} L_1 i_1^2(1) + \frac{1}{2} L_2 i_2^2(1) + M\, i_1(1) i_2(1) = 20.73\,J$

Scanned by CamScanner

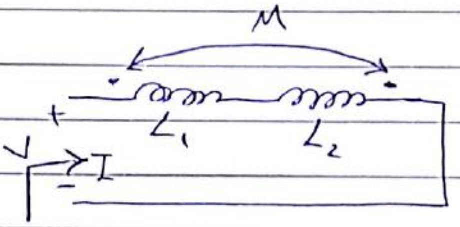
No

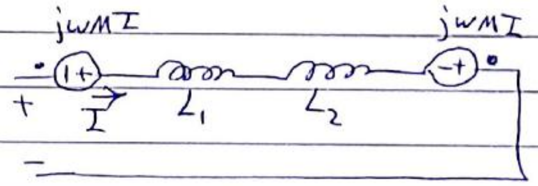
ex) Find the total inductance at the CKT :-



$L_{eq} = ?$

$$Z_{in} = \frac{V}{I}$$





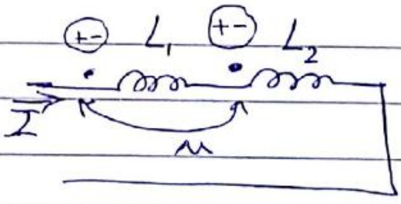
$$-V - j\omega MI + j\omega L_1 I + j\omega L_2 I - j\omega MI = 0$$

$$\frac{V}{I} = j\omega L_1 + j\omega L_2 - 2j\omega M$$

$$L_{eq} = L_1 + L_2 - 2M$$

اذا واحد داخل وواحد خارج سالب

if



$$L_{eq} = L_1 + L_2 + 2M$$

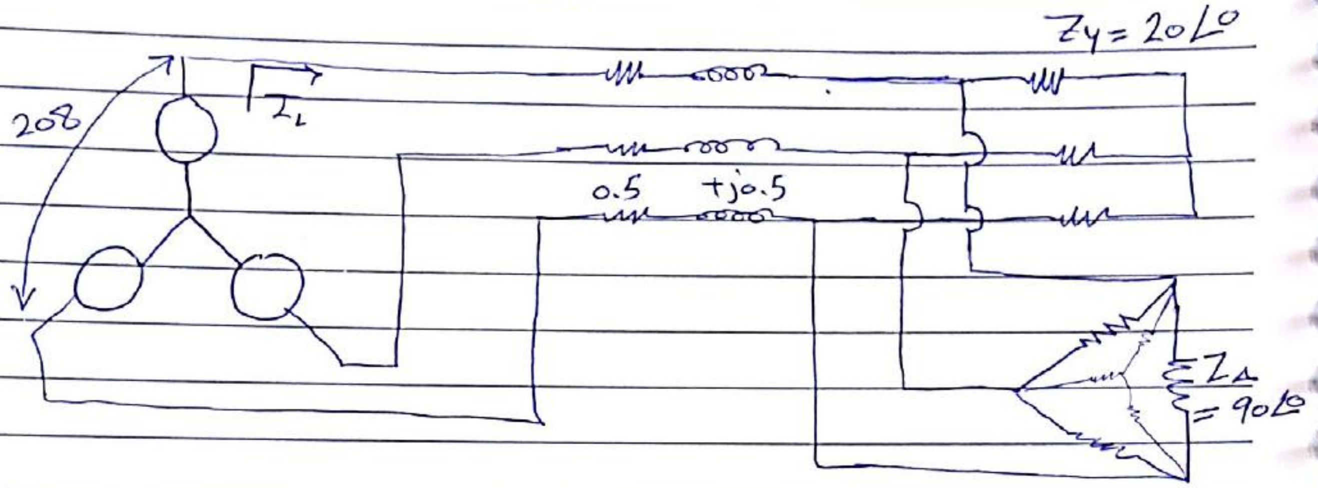
اذا التنين داخل او التنين خارج موجب

$\Rightarrow$ in the ex. apove :-

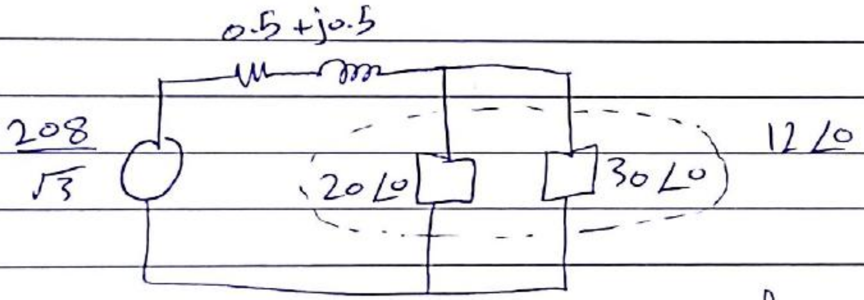
$$L_{eq} = 2m + 3m - 2 \times 0.4m + 2.7m$$

No

Voltage of generator = 208 V

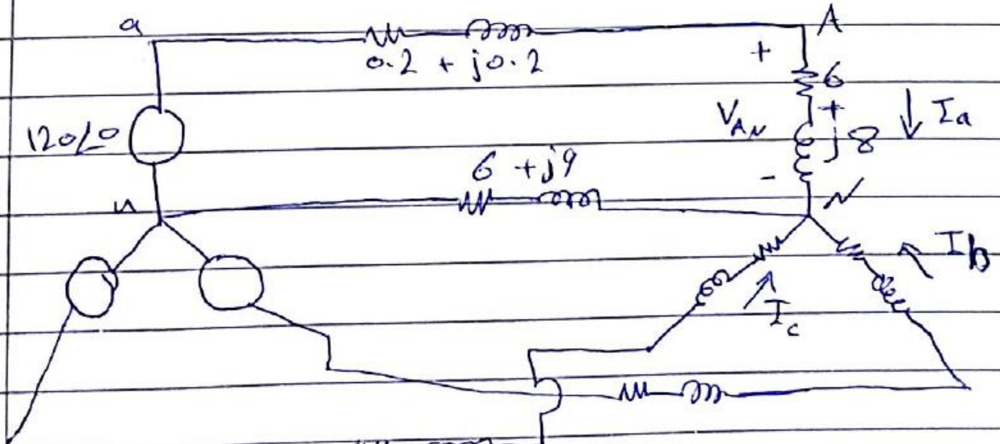


Sol :



$$I = \frac{208/\sqrt{3}\ \angle 0}{12\angle 0 + 0.5 + j0.5}$$ → reference

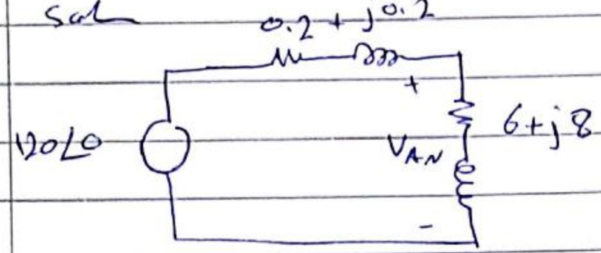
Solve for line currents, phase voltages at load & line voltages.



⟹ follow

No

sol



$$I_{aA} = \frac{120\angle 0}{6.2 + j8.2} = 11.7\angle -52.9$$

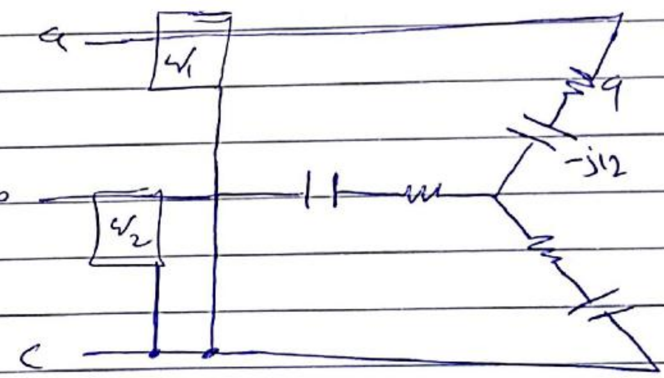
$$V_{AN} = I_{aA} * (6+j8) = 117\angle 0.23$$

$$V_{AB} = \sqrt{3} * 117\angle 0.23+30 \quad , \quad V_{BC} = \sqrt{3} * 117\angle 0.23+30+(-120)$$

$$PF = \cos(0+52.9)$$

$W_1 : V_{AB}, I_a$

$W_2 : V_{CB}, I_c$



$$V_{AB} = \sqrt{3} * 120\angle 30$$

$$V_{BC} = \sqrt{3} * 120\angle -90 = 208\angle -90$$

$$V_{CB} = 208\angle +90$$

$$I_a = \frac{V_{AN}}{9-j12} = 8\angle 53.13 \quad , \quad I_c = 8\angle 53.13.120$$

$$P_1 = 208 * 8 * \cos(30-53.13) = 1530\ w$$

$$P_2 = 208 * 8 * \cos(90-173.13) = 199\ w$$

follow $\Rightarrow$
solution

Scanned by CamScanner

No

$V_{AB} = \sqrt{3} * 117 \angle 0.23+30$

$V_{BC} = \sqrt{3} * 117 \angle 0.23+30-120$

$\cancel{F.F}$ $PF = \cos(0+52.9)$

$P_T = P_1 + P_2 = 1729$, $P_{1\phi} = \frac{1729}{3}$

$Q_T = \sqrt{3}(P_2 - P_1) = -2305.36$ VAR

Scanned by CamScanner

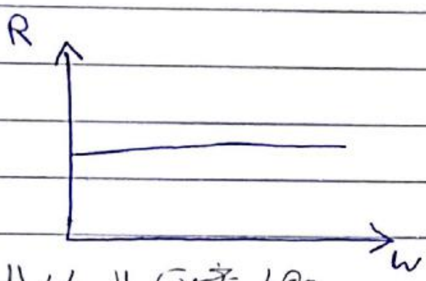
الأحد 4/6

#CH14

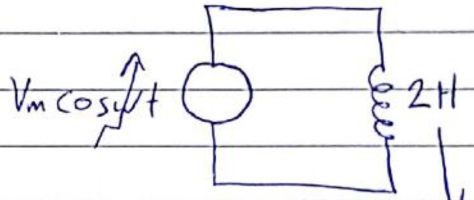
No

Frequency Response :-

→ what is the behaviour of the ckt if the frequency is changed.

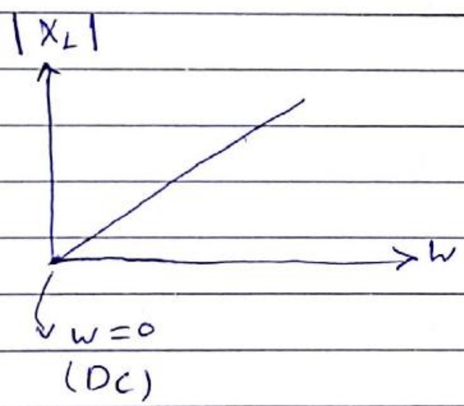


لما تتغير ال w ال R ثابتة



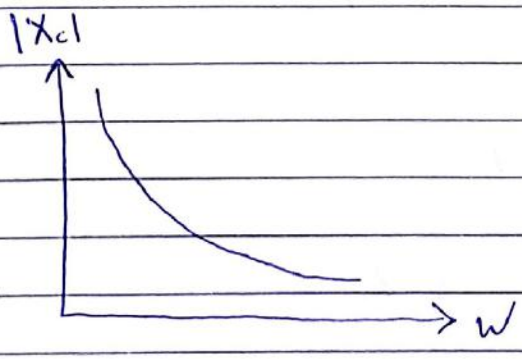
$X_L = j\omega L$

$I = \dfrac{V_m \angle 0}{j\omega L}$



$|X_L| = |2\pi f L|$

$= |\omega L|$



$|X_c| = \dfrac{1}{|\omega C|}$

$\underset{\text{rad}}{\omega} = 2\pi \underset{\text{Hz}}{f}$

No

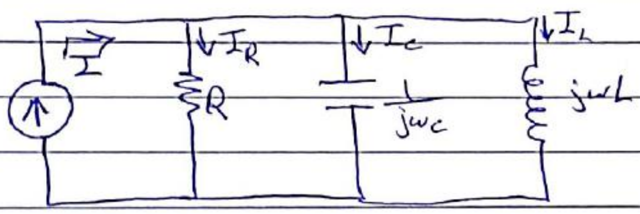
* Resonance circuits :-

$$\overbrace{\text{Parallel} \qquad\qquad \text{Series}}$$

⇒ it is ~~contains~~ a circuit that contains an inductor & capacitor in a parallel or in series.

let us study this ckt :-

$$I = I_R + I_c + I_L$$



$$Z_{total} = R \parallel \frac{1}{j\omega c} \parallel j\omega L$$

$$Y_{total} = \frac{1}{R} + j\omega C + \frac{1}{j\omega L} = \frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)$$

$$|Y_{total}| = \sqrt{(1/R)^2 + (\omega C - 1/\omega L)^2}$$

$$V = I\, Z_{total} = I * \frac{1}{Y_{total}}$$

⇒ $|Y_{total}|$ is minimum & V is maximum when

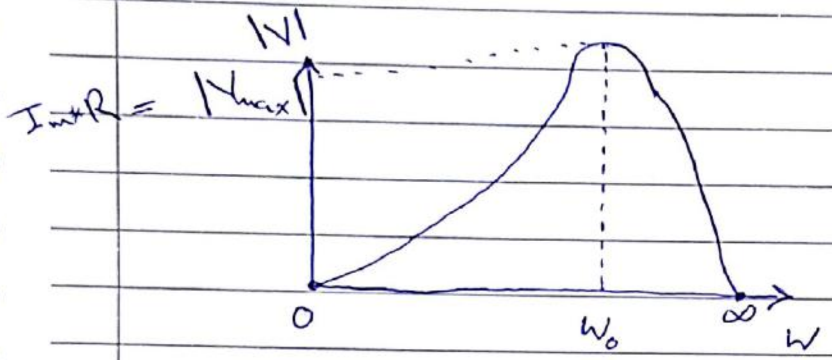
imaginary part = zero ⇐ $\omega C - \dfrac{1}{\omega L} = 0$

we call it resonance frequency ⇒ $\boxed{\omega_0 = \dfrac{1}{\sqrt{LC}}}$

Scanned by CamScanner

No

$$W_0 = \frac{1}{\sqrt{LC}} \quad , \quad f_0 = \frac{1}{2\pi\sqrt{LC}}$$

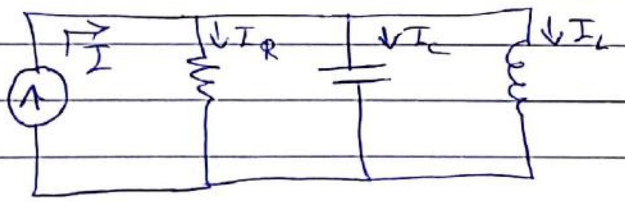


→ at resonance

→ V is maximum $= I_m * R$

→ $|Y_{total}|$ is minimum $\Rightarrow$ Z is maximum

→ I & V are inphase.



$$I = I_R + I_C + I_L$$

at resonance $I_m = I_R$ & $V = I_m * R$

$$I_C = \frac{V}{X_C} \quad , \quad I_L = \frac{V}{X_L}$$

→ at resonance I_L & I_C does not equal Zero

But $I_C = -I_L$ $\Rightarrow$ $I_C + I_L = 0$

Scanned by CamScanner

No

I_L at resonance

$$I_{L,0} = \frac{V_{L,0}}{j\omega_0 L}$$ voltage at resonance

$$= \frac{I_m R}{j\omega_0 L}$$

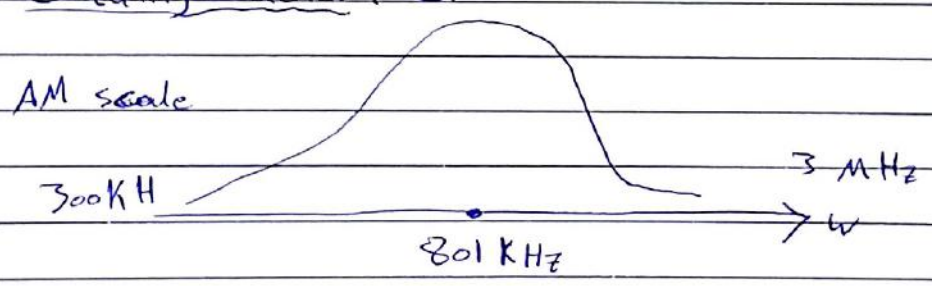
$$|I_{L,0}| = \frac{|V_{L,0}|}{|\omega_0 L|}$$

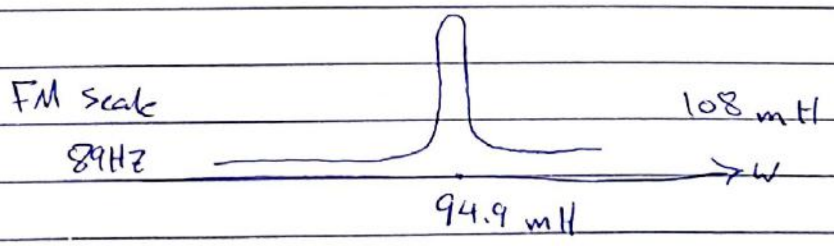
capacitor current at resonance

$$I_{C,0} = \frac{V_{C,0}}{1/j\omega_0 C}$$ capacitor voltage at resonance.

$$= j\omega_0 C\, V_{C,0} \quad \Big| \quad |I_{C,0}| = \omega_0 C\, |V_{C,0}|$$

Quality Factor: Q





Quality factor : Q

$$Q = 2\pi \frac{\text{maximum energy stored}}{\text{total energy lost per period}}$$

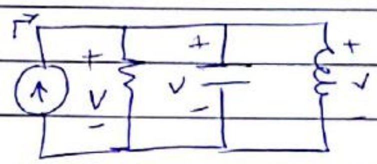
$$= 2\pi \frac{[\overset{\text{energy}}{W_L(t)} + W_C(t)]_{max}}{P_R T}$$

$$P = \frac{1}{T}\int v(t) i(t)$$

$$P_T = \int v(t) i(t)$$

$$i(t) = I_m \cos W_0 t$$

$$v(t) = R I_m \cos W_0 t$$



$$W_C(t) = \frac{1}{2} C V^2(t) = \frac{C * R^2 I_m^2 \cos^2 W_0 t}{2}$$

$$W_L(t) = \frac{1}{2} L i^2(t) = \frac{1}{2} L \left[\frac{1}{L^2} \frac{R^2 I_m^2 \sin^2 W_0 t}{\underbrace{W_0^2}_{\frac{1}{LC}}}\right] = \frac{C R^2 I_m^2 \sin^2 W_0 t}{2}$$

$$W_L(t) + W_C(t) = \frac{C R^2 I_m^2}{2} \left[\cos^2(W_0 t) + \sin^2(W_0 t)\right]$$

$$W_L(t) + W_C(t) = \frac{C R^2 I_m^2}{2}$$

$$P_R T = \frac{1}{2} I_m^2 R \frac{1}{f_0}$$

$$Q = 2\pi \frac{C R^2 I_m^2 / 2}{I_m^2 R / 2 f_0} \Rightarrow Q = W_0 R C \quad , W_0 = \frac{1}{\sqrt{LC}}$$

$$Q = \frac{1}{\sqrt{LC}} R C = R\sqrt{\frac{C}{L}} = \frac{R}{|X_{C,0}|} = \frac{R}{|X_{L,0}|}$$

No

at resonance

$I_{c,o} = -I_{c_{lo}} = j W_o C R I = j Q_o I$

$|I| = 2mA \qquad Q = 50$

$|I_{c,o}| = 100mA$

---

ex Parallel RLC ckt $L = 2mH$, $Q_o = 5$, $C = 10nF$

Find R & admittance at $0.9W_o$, W_o, $1.1W_o$

sol:

$$R = Q_o \sqrt{\frac{L}{C}} = 5\sqrt{\frac{2 * 10^{-3}}{10 * 10^{-9}}} = 2.23\ K\Omega$$

$$W_o = \frac{1}{\sqrt{LC}} = 223.6\ K\ rad/S^{1}$$

$$f_o = \frac{W_o}{2\pi}$$

$$Y = \frac{1}{R} + jWC + \frac{1}{jWL}$$

ضربنا ب 0.9 مكان $0.9W_o$

$$*0.9$$

$$Y(W_o) = \frac{1}{223.6 * 10^3} + j(223.6 * 10^3)\,10^{-9} * \frac{1}{j * 223.6 * 10^3 * 2 * 10^{-3}}$$

$$*0.9$$

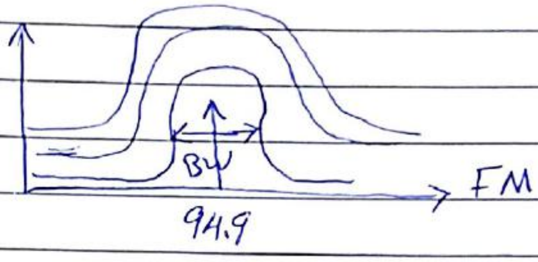
$|Y(W_o)| = 4.472 * 10^{-4}$ ℧ or S^{1} ~ Semenz

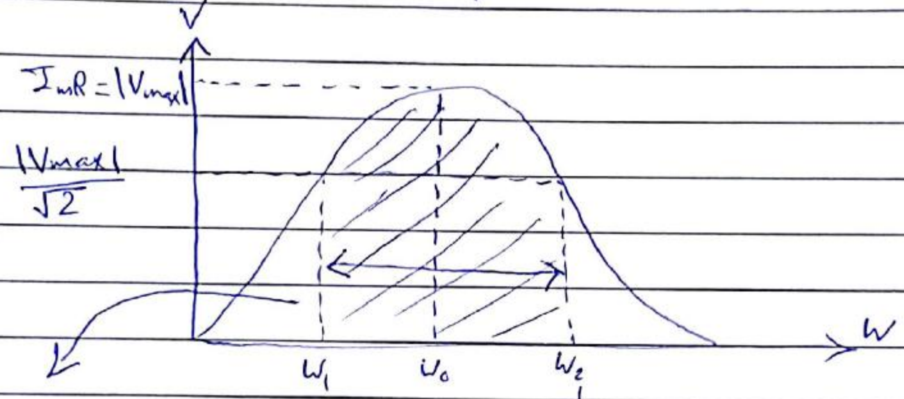
$|Y(0.9W_o)| = 6.504 * 10^{-4}\ S^{1}$

$|Y(1.1W_o)| = 6.182 * 10^{-4}\ S^{1}$

Scanned by CamScanner

Band width :-





Half-Power Band width

↳ lower half-Power frequency

↳ upper half-power frequency

W_1 & W_2 are called two half power frequancies.

$$V(W_0) = \sqrt{2}\, V(W_1) = \sqrt{2}\, V(W_2)$$
$$Y(W_0) = \frac{1}{\sqrt{2}} Y(W_1) = \frac{1}{\sqrt{2}} Y(W_2)$$

$B = W_2 - W_1$ ↗ Band width

↳ half - Power BW

How to define BW :-

$$Y = \frac{1}{R} + j\left(WC - \frac{1}{WL}\right)$$

use $Q_0 = w_0 RC$

⟹ follow

No

$$Y = \frac{1}{R} + j\frac{1}{R}\left(\frac{\omega\,\omega_0 RC}{\omega_0} - \frac{\omega_0 R}{\omega\,\omega_0 L}\right)$$

$$Y = \frac{1}{R}\left[1 + jQ_0\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)\right]$$

if we need $Y(\omega_1) = \sqrt{2}\,Y(\omega_0)$ & $Y(\omega_2) = \sqrt{2}\,Y(\omega_0)$

$$Q_0\left(\frac{\omega_2}{\omega_0} - \frac{\omega_0}{\omega_2}\right) = 1 \quad \text{— (1)}$$

&

$$Q_0\left(\frac{\omega_1}{\omega_0} - \frac{\omega_0}{\omega_1}\right) = -1 \quad \text{— (2)}$$

$$\boxed{\begin{aligned} Y(\omega_0) &= \frac{1}{R}\sqrt{(1)^2+(0)^2} = 1/R \\ Y(\omega_1) &= \frac{1}{R}\sqrt{(1)^2+(1)^2} = \frac{\sqrt{2}}{R} \end{aligned}}$$

$$\omega_1 = \omega_0\left[\sqrt{1+\left(\frac{1}{2Q_0}\right)^2} - \frac{1}{2Q_0}\right]$$

$$\omega_2 = \omega_0\left[\sqrt{1+\left(\frac{1}{2Q_0}\right)^2} + \frac{1}{2Q_0}\right]$$

$$B = \omega_2 - \omega_1 = \frac{\omega_0}{Q_0}$$

Scanned by CamScanner

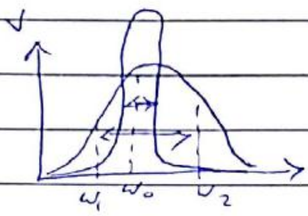
$$W_1 = W_o\left[\sqrt{1+\left(\frac{1}{2Q_o}\right)^2} - \frac{1}{2Q_o}\right]$$

$$W_2 = W_o\left[\sqrt{1+\left(\frac{1}{2Q_o}\right)^2} + \frac{1}{2Q_o}\right]$$

half Power BW

$$\beta = W_2 - W_2$$

$$\boxed{\beta = \frac{W_o}{Q_o}}$$



$$\boxed{W_o^2 = W_1 W_2} \Rightarrow W_o = \sqrt{W_1 W_2}$$

* Approximations for High Quality factor $Q_o > 5$

$$W_1 \simeq W_o\left[1 - \frac{1}{2Q_o}\right], \quad W_2 \simeq W_o\left[1 + \frac{1}{2Q_o}\right]$$

$$W_{1,2} \simeq W_o \mp \frac{1}{2}\beta \qquad \frac{1}{2}\beta = \frac{W_o}{2Q_o}$$

ex) Parallel RLC ckt with

$R = 40k\Omega$, $L = 1H$, $C = \frac{1}{64}\mu F$

Find the locations for the two half power BW & the approximate value for admittance at 8200 rad/s

SoL :

$$Q_o = W_o RC, \quad W_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1 * \frac{1}{64} * 10^{-6}}} = 8K \text{ rad/s}$$

$$Q_o = 8*10^3 * 40 * 10^3 * \frac{1}{64} * 10^{-6} = 5$$

Follow

No

$\Rightarrow \omega_1 = \omega_0 \left[1 - \frac{1}{10}\right] = 7200 \text{ rad/sec}$

$\omega_2 = \omega_0 \left[1 + \frac{1}{10}\right] = 8800 \text{ rad/s}$

$Y = \frac{1}{R} + j\omega C + 1/j\omega L$

$= \frac{1}{40 \times 10^3} + j(8200)\frac{1}{64} \times 10^{-6} + \frac{1}{j8200}$

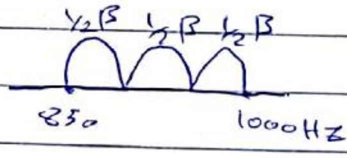
$Y = \frac{1}{R}\left[1 + jN\right]$ approximate

$|Y| = \frac{1}{R}\sqrt{1+N^2}$, $\angle Y = \tan^{-1}(N)$

$N = \frac{\omega - \omega_0}{\frac{1}{2}\beta}$ → number of half BW OFF resonance

ex) find N at 850 HZ

$N = \frac{850 - 1000}{50} = -3$



@ 8200 :-

$N = \frac{8200 - 8000}{800} = 0.25$

$Y = \frac{1}{40 \times 10^3}\left[1 + j0.25\right]$

$|Y| = \frac{1}{40 \times 10^3}\sqrt{1 + (0.25)^2}$, $\angle Y = \tan^{-1}(0.25) = 14.04°$

→ 25.77 MS

Scanned by CamScanner

No

* Series Resonance :

$$Z = R + jwL + \frac{1}{jwC} = R + j\left[wL + \frac{1}{wC}\right]$$

$$|Z| = \sqrt{R^2 + \left(wL - \frac{1}{wC}\right)^2}$$

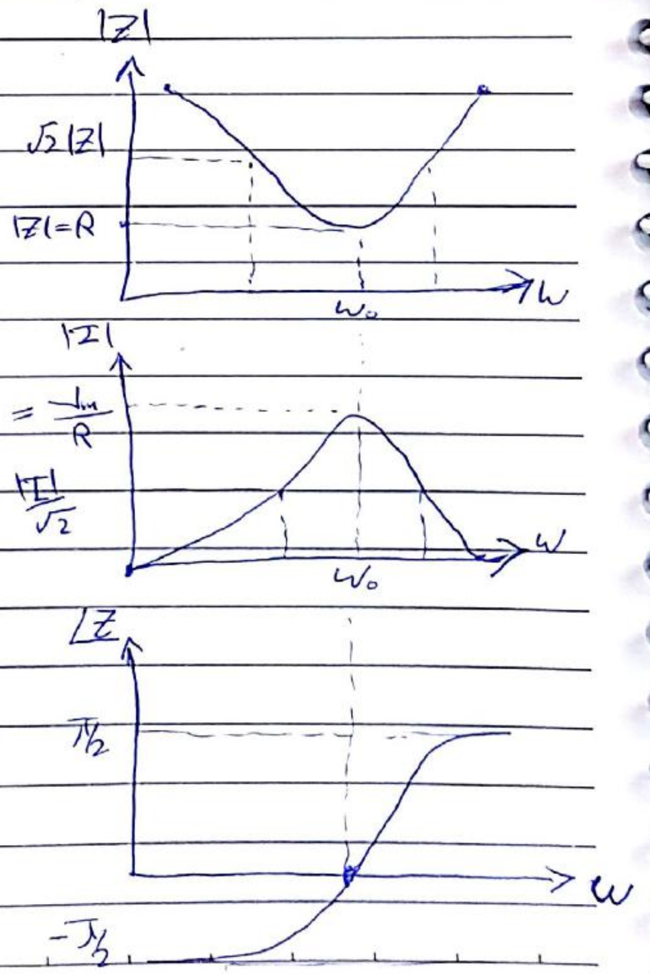
when $= 0$

$$wL = \frac{1}{wC} \Rightarrow w_o = \frac{1}{\sqrt{LC}}$$

Resonance frequency

* For series resonance :

@ Resonance frequency :-



(1) $|Z|$ is minimum

(2) $|I|$ is maximum

(3) V & I are inphase

Pure resistive load.

(4) $V_{L,o}$, $V_{c,o} \neq 0$

$$V_{c,o} = -V_{c,o}$$

$$|V_{c,o}| = |I| \frac{1}{|wC|} = \frac{V_m}{RWC}$$

Scanned by CamScanner

No

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad , \quad f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$Q_0 = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 R C} = \frac{\omega_0}{\beta}$$

$$\Rightarrow \boxed{\beta = \frac{\omega_0}{Q_0}}$$

$$Q_0 = 2\pi \cdot \frac{\text{maximum stored energy}}{\text{Total energy lost Per Period}}$$

$$\beta = \omega_2 - \omega_1 = \frac{\omega_0}{Q_0}$$

$$\omega_1 = \omega_0\left[\sqrt{1+\left(\frac{1}{2Q_0}\right)^2} - \frac{1}{2Q_0}\right]$$

$$\omega_2 = \omega_0\left[\sqrt{1+\left(\frac{1}{2Q_0}\right)^2} + \frac{1}{2Q_0}\right]$$

For CKts with high Q_0 :-

$$\omega_{1,2} = \omega_0\left[1 \mp \frac{1}{2Q_0}\right]$$

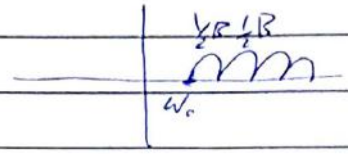
Scanned by CamScanner

الأحد 4/17

No

$Z_{eq} = R(1 + jN)$, $|Z| = R\sqrt{1+N^2}$, $\angle Z = \tan^{-1}(N)$

$N = \dfrac{W - W_o}{\frac{1}{2}\beta}$



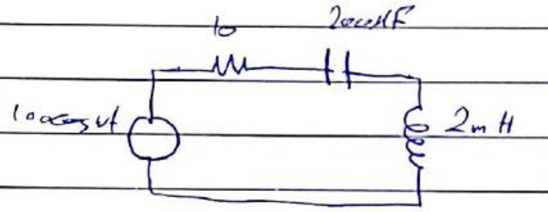
$N \equiv$ # of BW off resonance

ex) $V_s = 100 \cos Wt$ mV for a series RLC ckt with $R = 10\,\Omega$, $C = 200\,nF$, $L = 2\,mH$, calculate $|I|$ if $W = 48$ K rad/s

sol:

لما بدنا اياه Exact solution:

$Z = R + jWL + \dfrac{1}{jWC}$ $[W = 48k]$



الي بدنا اياه sol:

$W_o = \dfrac{1}{\sqrt{LC}} = \dfrac{1}{\sqrt{2 * 10^{-3} * 200 * 10^{-9}}} = 50$ k rad/sec

$Q_o = \dfrac{1}{W_o RC} = \dfrac{W_o L}{R} = \dfrac{50 * 10^3 * 2 * 10^{-3}}{10}$

$= 10 > 5$

$N = \dfrac{W - W_o}{\frac{1}{2}\beta}$, $\beta = \dfrac{W_o}{Q_o} = \dfrac{50}{10} = 5$ K rad/s

$N = \dfrac{48K - 50K}{2.5\,K} = -0.8$

$Z_{eq} = \left[R\sqrt{1+N^2}\right] \angle \tan^{-1} N = 12.81 \angle -38.66\ \Omega$

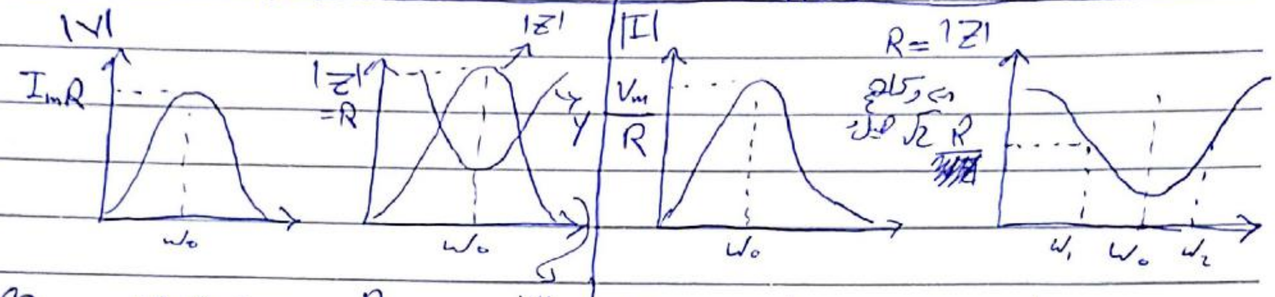
$|I| = \dfrac{100\,mV}{12.81} = 7.806$ mA

Scanned by CamScanner

No

ملخص القوانين

Parallel	Series



Parallel:

$$Q_o = w_o R C = \frac{R}{w_o L}$$

$|Y|_1 = \frac{1}{R}$

Series:

$$Q_o = \frac{1}{w_o R C} = \frac{w_o L}{R}$$

$$|I_L(jw_o)| = |I_C(jw_o)| = Q_o\,|I(jw_o)|$$

$$|V_L(jw_o)| = |V_C(jw_o)| = Q_o\,|V(jw_o)|$$

Exact : [Parallel & series]

$$w_o = \frac{1}{\sqrt{LC}} = \sqrt{w_1 w_2}$$

$$w_{1,2} = w_o\left[\sqrt{1+\left(\frac{1}{2Q_o}\right)^2} \mp \frac{1}{2Q_o}\right]$$

Approximate :- $[Q_o \geq 5]$

$$w_{1,2} = w_o\left[1 \mp \frac{1}{2Q_o}\right]$$

$$w_o = \frac{1}{2}(w_1 + w_2)$$

$$w_{1,2} = w_o \mp \frac{1}{2}\beta$$

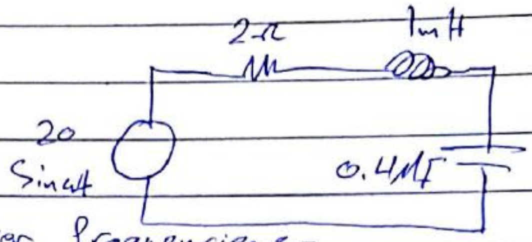
$Z_s = R[1 + jN]$, $Y_p = \frac{1}{R}[1 + jN]$

Z_s → Series, Y_p → Parallel

$$N = \frac{w - w_o}{\frac{1}{2}\beta}$$

No

ex) For the series resonant ckT shown, Find :-



(1) Resonance frequency, half power frequencies :-

$$W_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-3} * 0.4 * 10^{-6}}} = 50 \text{ k rad/sec}$$

$$Q_o = \frac{W_o L}{R} = \frac{50 * 10^3 * 10^{-3}}{2} = 25$$

$$\beta = \frac{W_o}{Q_o} = \frac{50 \text{ krad/sec}}{25} = 2 \text{ krad/sec}$$

$$W_1 = W_o - \tfrac{1}{2}\beta = 49 \text{ k rad/sec}$$

$$W_2 = W_o + \tfrac{1}{2}\beta = 51 \text{ k rad/sec}$$

(2) Find the amplitude of the current at W_o, W_1, W_2.

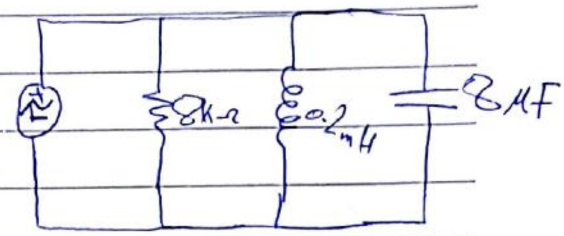
at W_o $|I| = \frac{V_m}{R} = \frac{20}{2} = 10A$

@ $W_1, W_2 \Rightarrow |I| = \frac{|I_{max}|}{\sqrt{2}} = \frac{10}{\sqrt{2}}$

لو ما بعرف $\Rightarrow N = \frac{W - W_o}{\frac{1}{2}\beta} = \frac{W_1 - W_o}{\frac{1}{2}\beta} = \frac{49 - 50}{\frac{1}{2} * 2} = 1$

Scanned by CamScanner

(ex) For the Parallel RLC CKT shown
Find (1) $\omega_0, Q_0, \beta, \omega_1, \omega_2$
(2) the Power dessipated @ $\omega_0, \omega_1, \omega_2$



$$\omega_0 = \frac{1}{\sqrt{LC}} = 25K \text{ rad/sec}$$

$$Q_0 = \omega_0 RC = 1600 \text{ [high selective ckt]}$$

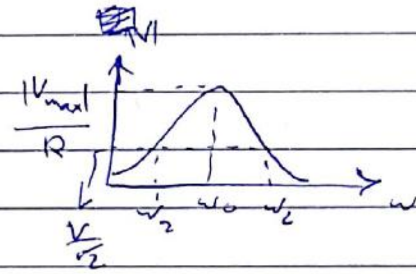
impulse

$$\beta = \frac{\omega_0}{Q_0} = 15.625 \text{ rad/sec}$$

$$\omega_1 = \omega_0 - \frac{1}{2}\beta = 24{,}992 \text{ rad/sec}.$$

$$\omega_2 = \omega_0 + \frac{1}{2}\beta = 25{,}008 \text{ rad/sec}.$$

(2) Power at ω_0



$$P = \frac{1}{2}|I|^2 R$$

Peak ليه

$$|I| = \frac{10\angle{-90}}{8*10^3} = \underbrace{1.25\angle{-90}\ mA}_{\text{Peak}}$$

$$P = \frac{1}{2} * (1.25*10^{-3})^2 * 8*10^3 = 6.25\ mW$$

Power at ω_1, ω_2 equal $\frac{1}{2}$ Power at ω_0 (half power band width) X

الطريقة الأولى => $\cancel{P_1 = \frac{1}{2}\left(\frac{1.25}{\sqrt{2}}*10^{-3}\right)^2 * 8*10^3 = 3.125}$

$$P_1 = \frac{(V_m/\sqrt{2})^2}{2R} = 3.125\ mW$$

$P@\omega_0 = P@\omega_1 = P@\omega_2 = 6.25\ mW$ ← الحل الصحيح ، الحل غلط

لأنه موجود في Voltage source

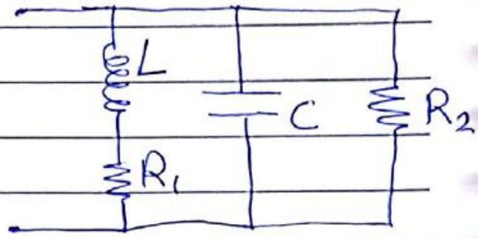
19/4

No

* Other Resonance Forms:-

→ Not Parallel, Not series.

Key : $\boxed{\begin{matrix} I_m[Z] = 0 \\ I_m[Y] = 0 \end{matrix}}$



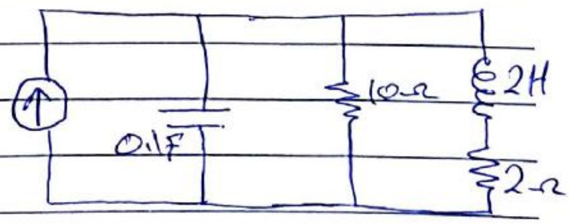
$$Y(W) = jWC + \frac{1}{R_2} + \frac{1}{jwL + R_1} \frac{*(-jwL + R_1)}{*(-jwL + R_1)}$$

$$Y(W) = \frac{1}{R_2} + jWC + \frac{R_1 - jwL}{R_1^2 + (WL)^2}$$

$$I_m[Y] = WC - \frac{WL}{R_1^2 + (WL)^2} = 0$$

$$\boxed{W_o = \sqrt{\frac{1}{LC} - \left(\frac{R_1}{L}\right)^2}} \Rightarrow \text{Resonance Frequency for this form}$$

(ex) Determine the resonance Frequency For the ckt shown



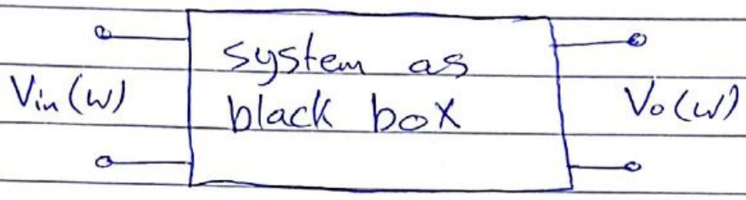
$$Y = jW\,0.1 + \frac{1}{10} + \frac{1*(2-jw2)}{(2+jw2)*(2-jw2)}$$

$$Y = jW0.1 + 0.1 + \frac{2 - jw2}{4 + 4w^2}$$

$$I_m[Y] = 0.1W - \frac{2W}{4+4W^2} = 0, \quad \boxed{W_o = 2 \text{ rad/s}}$$

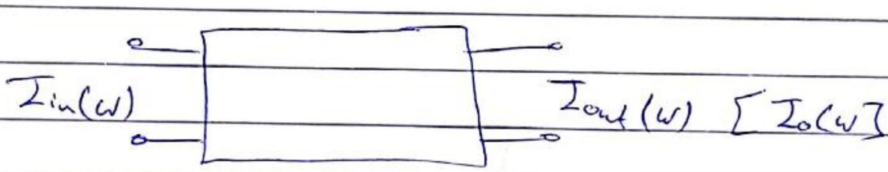
Transfer Function :-

↳ How to relable the input to the output irrespective of the system



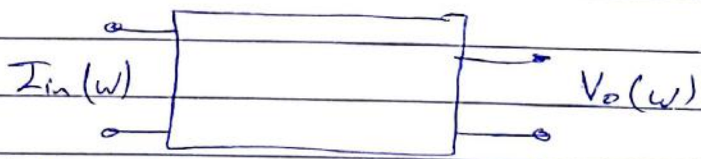
$H_v(w) \triangleq$ Voltage gain

$$H_v(w) = \frac{V_o(w)}{V_{in}(w)} \equiv \text{Voltage gain}$$



$H_I(w)$ = current gain

$$H_I(w) = \frac{I_o(w)}{I_{in}(w)}$$

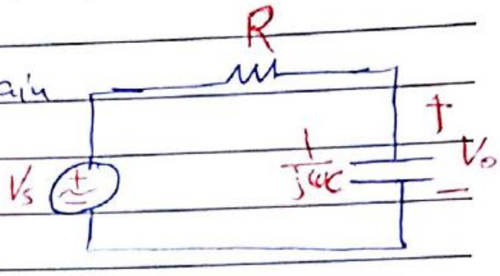


$$H_Z(w) = \frac{V_o(w)}{I_{in}(w)} \triangleq \text{Transfer Impedence}$$

Scanned by CamScanner

No

ex For the circuit shown obtain the transfer function $\frac{V_o}{V_s}$, where $V_s = V_m \cos wt$



sol:

$$H_v(w) = \frac{V_o}{V_{in}} = \frac{V_o}{V_s} = \frac{\cancel{I} * \frac{1}{jwc}}{\cancel{I} * (R + \frac{1}{jwc})}$$

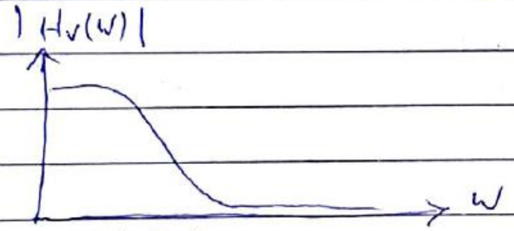
$$H_v(w) = \frac{\frac{1}{jwc} * jwL}{(1/jwc + R) * jwL} = \frac{1}{1 + jwCR}$$

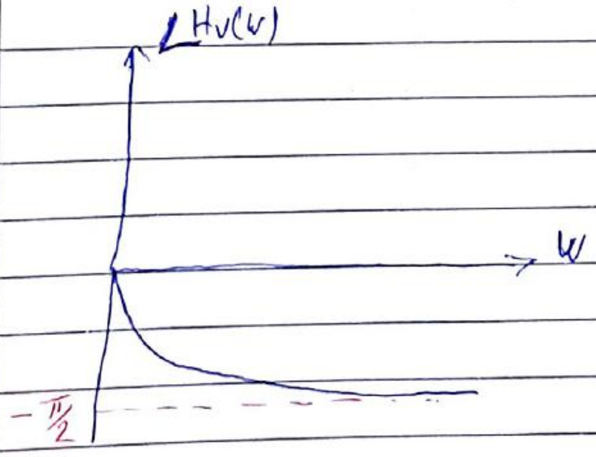
$$|H_v(w)| = \frac{1}{\sqrt{1 + (wRC)^2}}$$

$$\angle (H_v(w)) = \angle \left(\frac{1}{1 + jwRc} * \frac{(1 - jwRC)}{(1 - jwRC)} \right) \Rightarrow$$

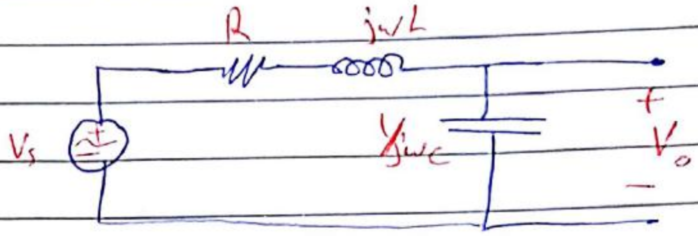
$\rightarrow \tan^{-1}(-wRC)$

Real Part is 1





ex Find the Voltage transfer Function for these ckt.



$$H_v(w) = \frac{V_o(w)}{V_s(w)}$$

$$= \frac{\cancel{I} * 1/jwC}{\cancel{I} * (R + jwL + 1/jwC)}$$

$$= \frac{(1/jwC) * (jwC)}{(R + jwL + 1/jwC) * (jwC)}$$

$j * j = -1$

$$H_v(w) = \frac{1 * ((1 - CLw^2) - jwRC)}{(jwRC - w^2LC + 1) * (\quad // \quad)}$$

$$|H_v(w)| = \frac{1}{\sqrt{(1 - CLw^2)^2 + (wCR)^2}}$$

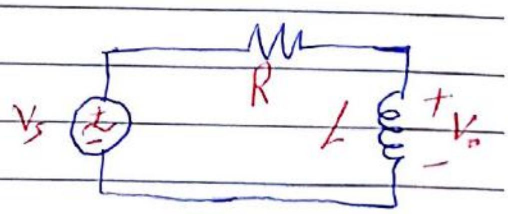
$$\angle H_v(w) = \tan^{-1}\left(\frac{-wCR}{1 - w^2LC}\right)$$

$$H(w) = \frac{\alpha - j\beta}{\alpha^2 + \beta^2}$$

$$\angle H(w) = \tan^{-1}(-\beta/\alpha)$$

ex obtain the transfer function $\frac{V_o}{V_s}$ of the RL ckt

$$H_v(w) = \frac{V_o(w)}{V_s(w)} = \frac{I * jwL}{I * (R + jwL)}$$



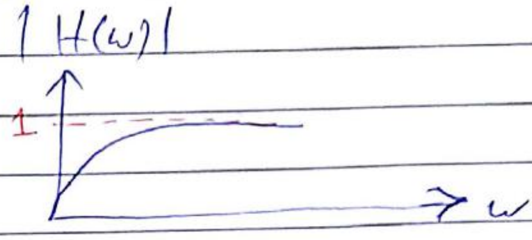
$$= \frac{(jwL) * (R - jwL)}{(R + jwL) * (R - jwL)}$$

Follow

Scanned by CamScanner

No

$$H_v(\omega) = \frac{\omega^2 L^2 + j\omega RL}{R^2 + \omega^2 L^2}$$



$$|H_v(\omega)| = \frac{\omega L}{\sqrt{R^2 + (\omega L)^2}}$$

$$\angle H(\omega) = \tan^{-1}\left[\frac{\omega RL}{\omega^2 L^2}\right] = \tan^{-1}\left[\frac{R}{\omega C}\right]$$

$\hookrightarrow$ From $H_v(\omega) = \dfrac{\omega^2 L^2 + j\omega RL}{R^2 + \omega^2 L^2}$

Scanned by CamScanner

21/4 الخميس

No

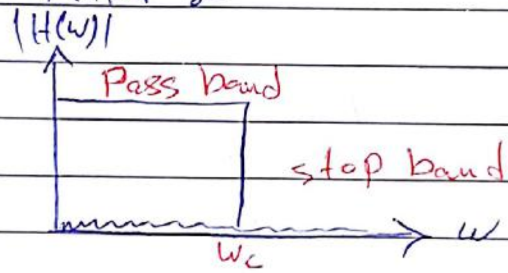
Filters:

→ a filter is a ckt that is defined to pass signals with disired frequancies & reject others.

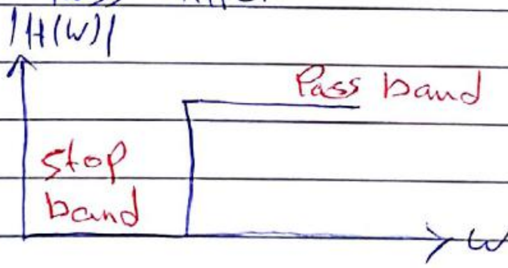
⇒ A filter is a frequancy selective device.

Types :-

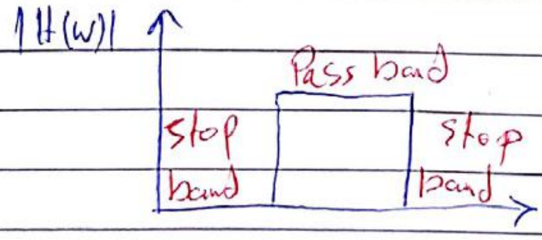
(1) Low Pass filter :-



(2) High Pass filter

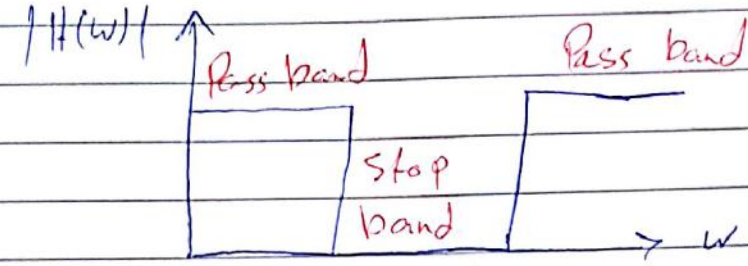


(3) band Pass filter :



Scanned by CamScanner

(4) band stop filter:-



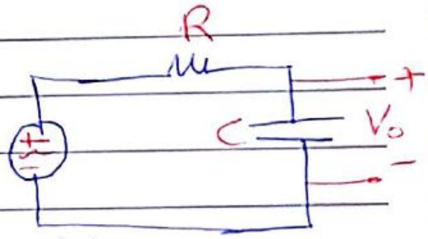
[1] Low Pass filter :-

ال w_c هون مطلوب

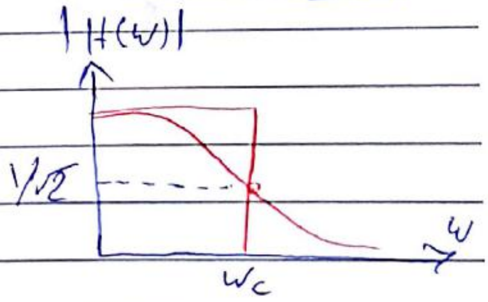
$\Rightarrow$ RC ckt with output taken of C

$$H(w) = \frac{V_o(w)}{V_{in}(w)} = \frac{1/jwC}{1/jwC + R}$$

$$= \frac{1}{1 + jwRC}$$



$$|H(w)| = \frac{1}{\sqrt{1 + w^2R^2C^2}}$$



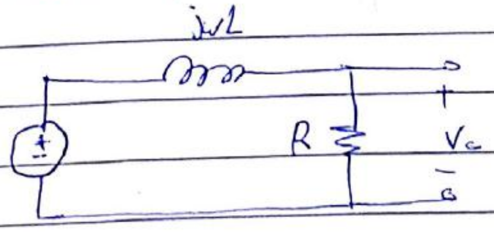
$$\frac{1}{\sqrt{1 + w^2R^2C^2}} = \frac{1}{\sqrt{2}} = |H(w_o)|$$

$$\Rightarrow w_c = \frac{1}{RC}$$

$H(0) = 1$ cut off

$H(\infty) = 0$ frequency

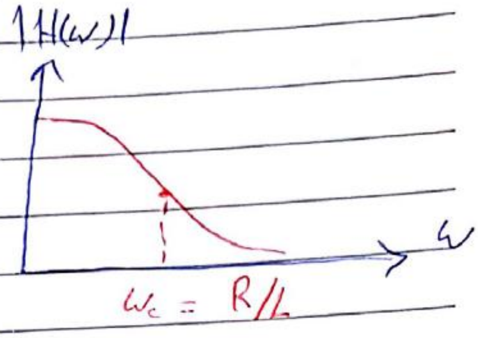
Another approach :-



No

$$H(\omega) = \frac{R}{j\omega L + R}$$

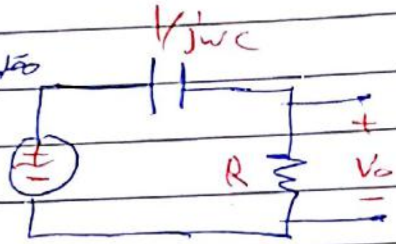
$$|H(\omega)| = \frac{R}{\sqrt{R^2 + (\omega L)^2}}$$



عكس ال Low Pass

*** High Pass filter :-**

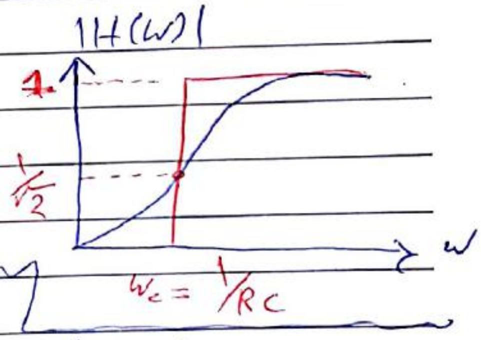
ال W_c صورة
مقلوب ال ↑



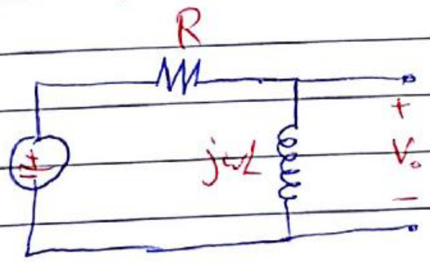
$$H(\omega) = \frac{V_o(\omega)}{V_{in}(\omega)}$$

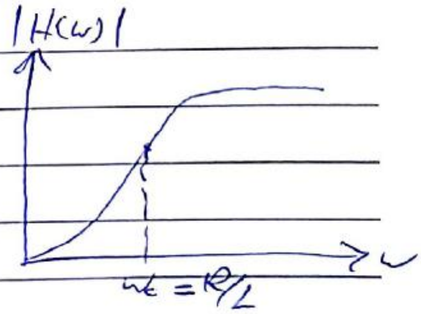
$$= \frac{R}{R + 1/j\omega C} = \frac{j\omega RC}{1 + j\omega RC}$$

$$|H(\omega)| = \frac{\omega RC}{\sqrt{1^2 + (\omega RC)^2}}$$



another approach :-





$$H(\omega) = \frac{j\omega L}{R + j\omega L}$$

$$|H(\omega)| = \frac{\omega L}{\sqrt{R^2 + (\omega L)^2}}$$

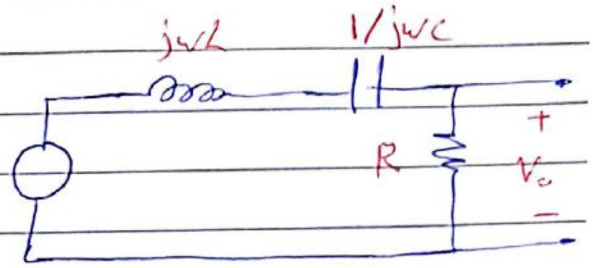
$H(0) = 0$

$H(\infty) = 1$

No

* Band Pass filters:-

→ Series RLC Ckt without output taken at R

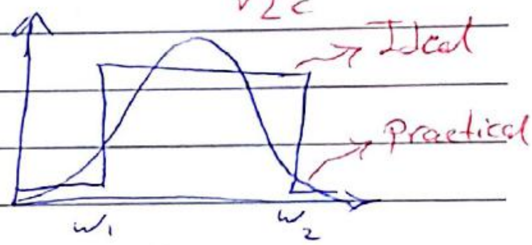


$$H(\omega) = \frac{R}{j\omega L + 1/j\omega C + R}$$

$$= \frac{j\omega RC}{(1-\omega^2 LC) + j\omega RC}$$

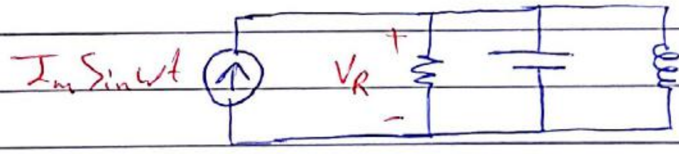
$$\omega_o = \frac{1}{\sqrt{LC}}$$

$$|H(\omega)| = \frac{\omega RC}{\sqrt{(1-\omega^2 LC)^2 + (\omega RC)^2}}$$



$H(0) = 0, \quad H(\infty) = 0$

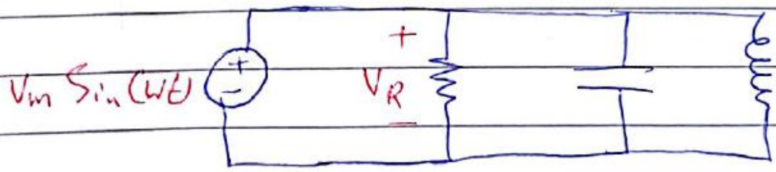
أهم الحالات الخاصة



$$P(\omega_o) = \frac{V_m^2}{2R}, \quad V_m = I_m R$$

$$P(\omega_1) = P(\omega_2) = \frac{1}{2} P(\omega_o) = \frac{V_m^2}{4R}$$

14.8



$V_R = V_m$

$$P = \frac{V_m^2}{2R} \quad [\omega_o, \omega_1, \omega_2]$$

*

24/4 الأحد

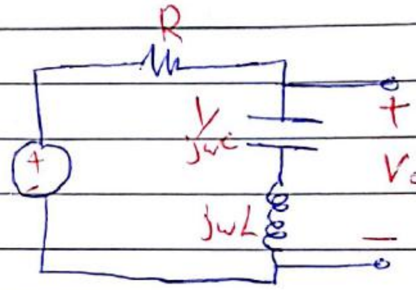
No

4| Band stop filter :-

↳ a filter that prevents a band of frequency and allow other frequency :-

⇒ RLC series ckt with output taken on LC

$$H(w) = \frac{V_o}{V_{in}} = \frac{j(wL - 1/wC)}{R + j(wL - 1/wC)}$$

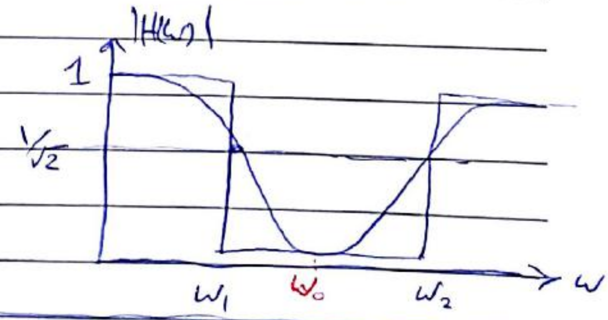


$$= \frac{j(1 - w^2LC)}{-wCR + j(1 - w^2LC)}$$

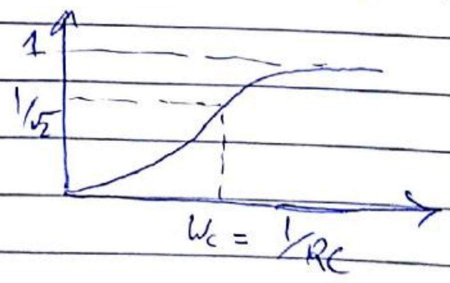
$$|H(w)| = \frac{(1 - w^2LC)}{\sqrt{(wRC)^2 + (1 - w^2LC)^2}}$$

$H(0) = 1$ $\qquad w_o = \frac{1}{\sqrt{LC}}$

$H(\infty) = 1$



ex) Design a high-pass filter with a corner frequency of 3 KHz



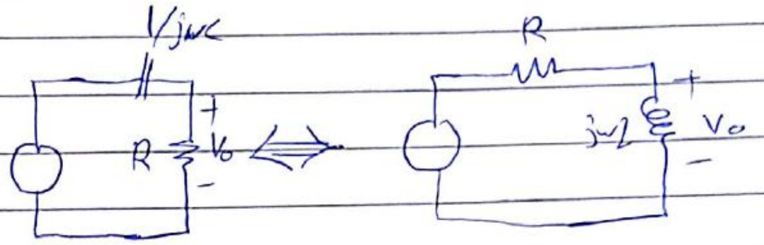
follow ⟹

No

sol :

choose an RC CKT with output on R

$W_c = 2\pi(3000) = \dfrac{1}{RC}$



$R = 4.7\ K\Omega$

$C = 11.29\ nF$

* فرضنا R ودورنا حسبنا C
حسب ايش متوفر بالاب

---

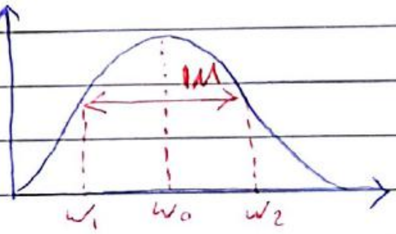
ex) Design a band pass filter characterized by BW = 1 MHz & high cutoff frequency of 1.1 MHz

← X لاتنساها

$W_2 = 1.1 * 2\pi = 6.912\ M\,rad/s$

$W_1 = W_2 - \beta$

$= (1.1M - 1M) * 2\pi = 628.3\ K\,rad/s$



$\beta = \dfrac{W_0}{Q_0} = \dfrac{1}{RC} = 6.283\ M\,rad/s$ —— (1)

$W_0 = \sqrt{W_1 W_2} = \sqrt{(6.912) * 628.3 * 10^9}$

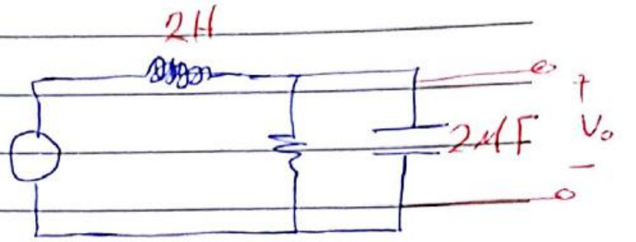
$W_0 = \dfrac{1}{\sqrt{LC}} = 2.084 * 10^6$ —— (2)

$\Rightarrow\ R = 3.4\ K\Omega\ ,\ L = 50\,mH\ ,\ C = 46\ pF$

Scanned by CamScanner

ex) Determine what type of filter is shown in the figure, what is the corner frequency, cutoff frequency

$$H(s) = \frac{R \parallel \frac{1}{sC}}{sL + R \parallel \frac{1}{sC}}$$



$\hookrightarrow s = \sigma + j\omega$

* مش مطلوب هالاشي ولكن من باب المعرفة

$$H(\omega) = \frac{R \parallel \frac{1}{j\omega C}}{j\omega L + R \parallel \frac{1}{j\omega C}}$$

$$H(s) = \frac{\cancel{R}}{\cancel{R - \omega^2 LCR}} = \frac{R}{s^2 RLC + sL + R}$$

$$H(\omega) = \frac{R}{R - \omega^2 LCR + j\omega L}, \quad |H(\omega)| = \frac{R}{\sqrt{(R - \omega^2 LCR)^2 + (\omega L)^2}}$$

$$H(\omega_c) = \frac{1}{\sqrt{2}}$$

* بنعوض عند 0 وعند ∞ بطلع نوعه

$H(\infty) = 0, \quad H(0) = 1$

$$\frac{1}{\sqrt{2}} = \frac{R}{\sqrt{(R - \omega^2 LCR)^2 + (\omega L)^2}}$$

$$\frac{1}{2} = \frac{R^2}{(R - \omega^2 LCR)^2 + (\omega L)^2}$$

$$2R^2 = (R - \omega^2 LCR)^2 + (\omega L)^2$$

$$2R^2 = R^2 - 2\omega^2 LCR + \omega^4 (LCR)^2 + \omega^2 L^2$$

$$\omega^4 (LCR)^2 + (L^2 - 2R^2 LC)\omega^2 - R^2 = 0$$

$$\omega^2 = \frac{-(L^2 - 2R^2 LC) \mp \sqrt{(L^2 - 2R^2 LC)^2 - 4(LCR)^2 R^2}}{2(LCR)^2}$$

$\omega_c^2 = 0.5509 \text{ M rad/s}$

OR $\omega_c^2 = 0.1154$ X

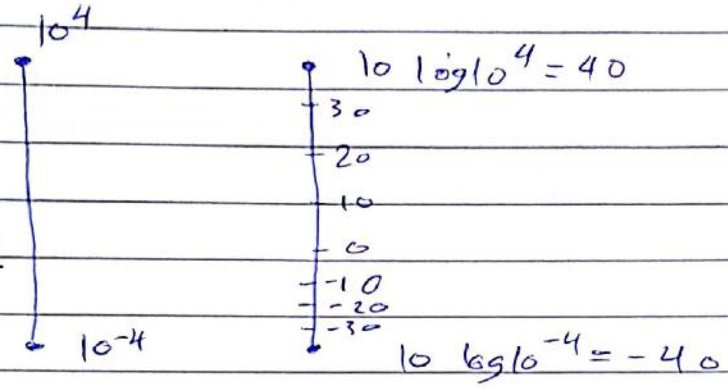
$\omega_c = 0.742 \text{ krad/s}$

4/26 الأحد

No

The Decible scale :-

$Gain = \frac{P_{out}}{P_{in}}$



$$Gain_{dB} = 10 \log \frac{P_{out}}{P_{in}}$$

$$Gain_{dB} = 10 \log \frac{V_{out}^2 / R_{out}}{V_{in}^2 / R_{in}}$$

if $R_{in} = R_{out}$

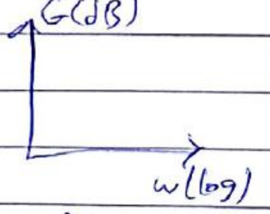
$$\Rightarrow Gain_{dB} = 10 \log \frac{V_{out}^2}{V_{in}^2} = 10 \log \left(\frac{V_{out}}{V_{in}}\right)^2 = 20 \log \left(\frac{V_{out}}{V_{in}}\right)$$

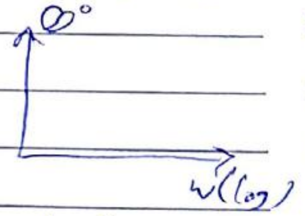
$$Gain_{dB} = 20 \log \frac{I_{out}}{I_{in}}$$

Bode Plots :- plots of the magnitude in decibels OR the phase shift in degrees Versus frequency in logarithmic scale

→ easy to construct

→ Approximate Plots





⇒ write transfer function (T.F) in standard form :-

$$H(w) = \frac{N(w)}{D(w)} = \frac{K\,(jw)^{\mp N}\left[1 + \frac{jw}{z_1}\right]}{\left[1 + \frac{jw}{P_1}\right]}$$

No

K = constant gain $\qquad$ Zero ≡ اصفار البسط

$j\omega$: Zero or Pole at Zero $\qquad$ Pole ≡ اصفار المقام

$\left[1 + \frac{j\omega}{Z_1}\right]$: Zero at Z_1

$\left[1 + \frac{j\omega}{P_1}\right]$: Pole at P_1

$$H(\omega) = \frac{200\, j\omega}{(j\omega + 2)(j\omega + 10)}$$

$$H(\omega) = \frac{200 * (j\omega)}{2\left(1 + \frac{j\omega}{2}\right) * 10\left(1 + j\omega/10\right)}$$

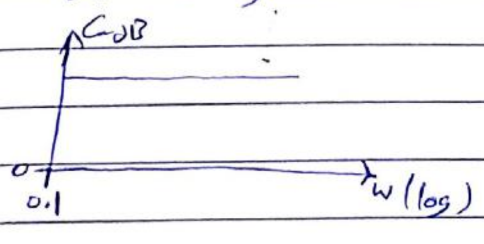
$$= \frac{10\,(j\omega)}{\left(1 + \frac{j\omega}{2}\right)\left(1 + \frac{j\omega}{10}\right)}$$

$$20 \log_{10} H(\omega) = 20 \log_{10}\left[\frac{10\,(j\omega)}{(1 + j\omega/2)(1 + j\omega/10)}\right]$$

$$20 \log_{10} H(\omega) = H(\omega)_{dB} = 20 \log 10 + 20 \log|j\omega| - 20 \log\left|1 + \frac{j\omega}{2}\right| - 20 \log\left|1 + \frac{j\omega}{10}\right|$$

plot of a constant K :-

$G_{dB} = 20 \log K$



Scanned by CamScanner

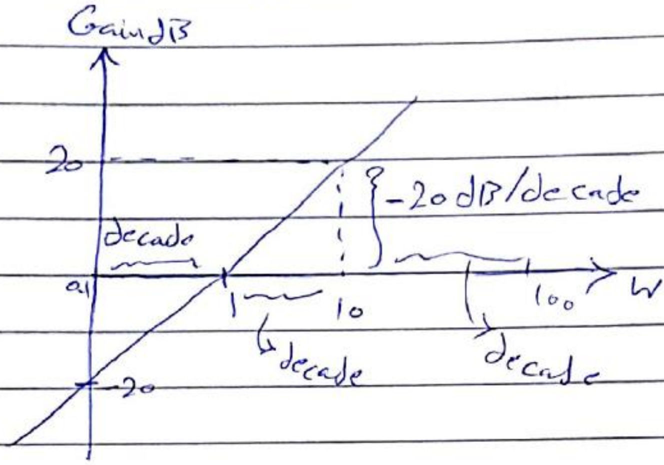
Plot of a Zero or Pole at origin :-

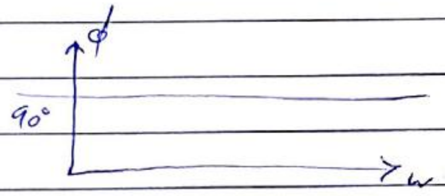
$H(w) = jw$

$H(1) = 20\log(1) = 0$

$H(10) = 20$

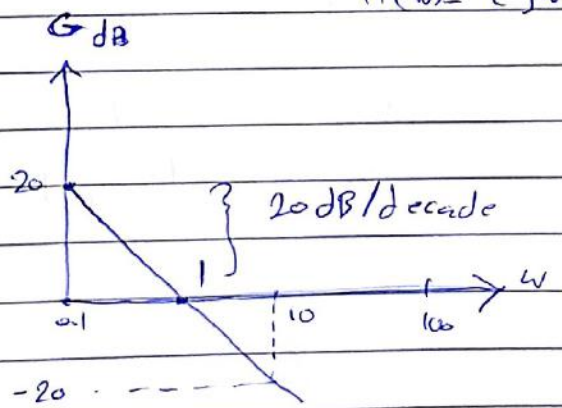
$H(0.1) = -20$

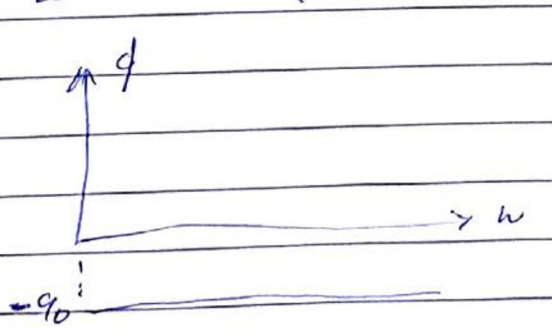




Plot of a Pole at origin

$H(w) = (jw)^{-1} = \frac{1}{jw}$





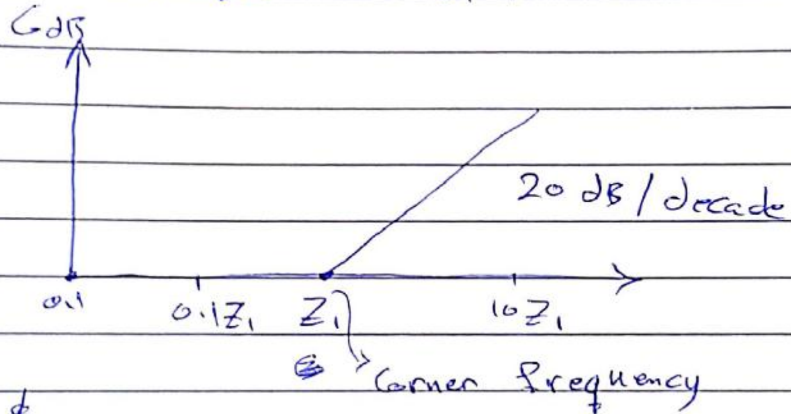
Scanned by CamScanner

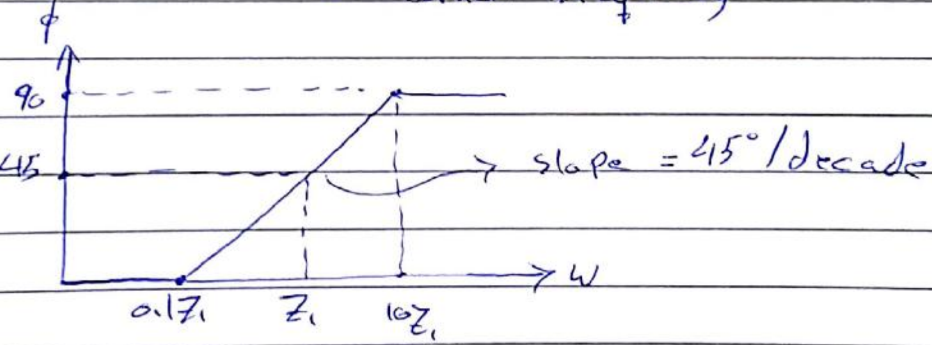
No

Simple Zero = $\left[1 + \frac{jw}{Z_1}\right]$

$$G_{dB} = 20 \log \left[1 + \frac{jw}{Z_1}\right]$$

$$= \begin{cases} 0\ dB & , w \simeq 0 \\ 20 \log \frac{w}{Z_1} & , w \simeq \infty \end{cases}$$





$$H(w) = 1 + \frac{jw}{100}$$

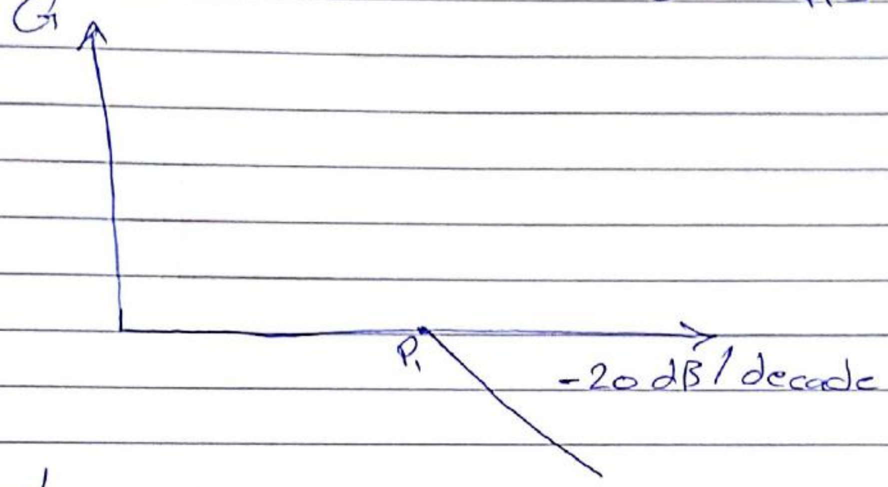
$$\angle H(10) = 1 + \frac{j10}{100} = 1 + j0.1 \simeq 0.1$$

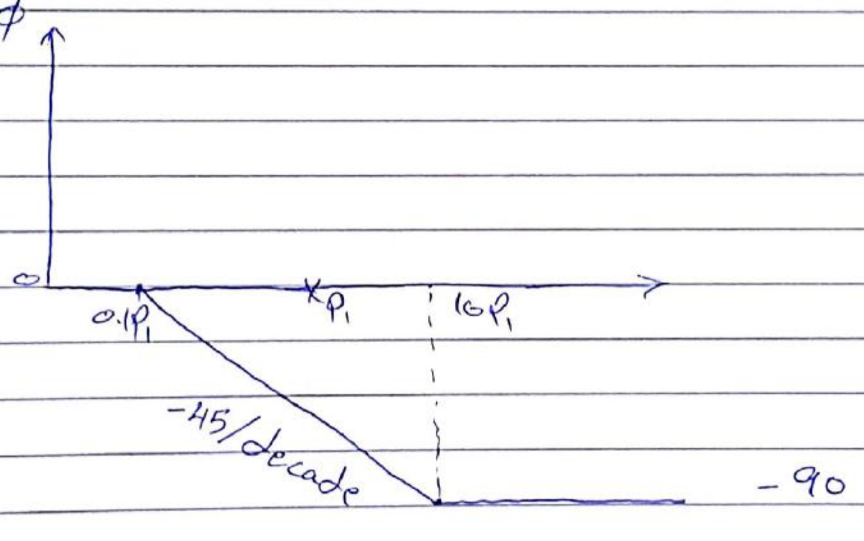
$$\angle H(1000) = 1 + j10$$

$$\angle H(100) = 45° = 90$$

No

Simple ~~plot~~ Pole : $20 \log \frac{1}{[1 + \frac{\omega}{P_1}]} = -20 \log [1 + \frac{\omega}{P_1}]$





4/27 الأحد

No

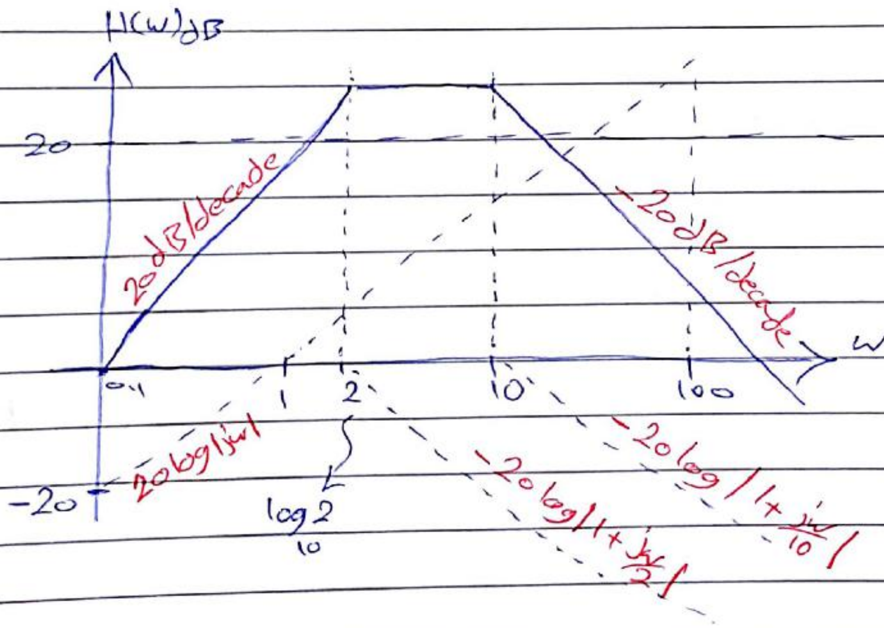
Ex construct the bode plots for:-

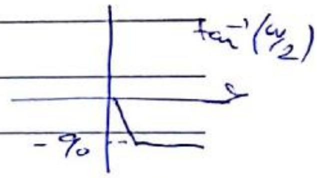
$$H(\omega) = \frac{200\, j\omega}{(j\omega + 2)(j\omega + 10)}$$

in standard form ⇒ $H(\omega) = \frac{200(j\omega)}{2(j\omega/2 + 1) * 10(j\omega/10 + 1)}$

$$H(\omega) = \frac{10(j\omega)}{(j\omega/2 + 1) * (j\omega/10 + 1)}$$

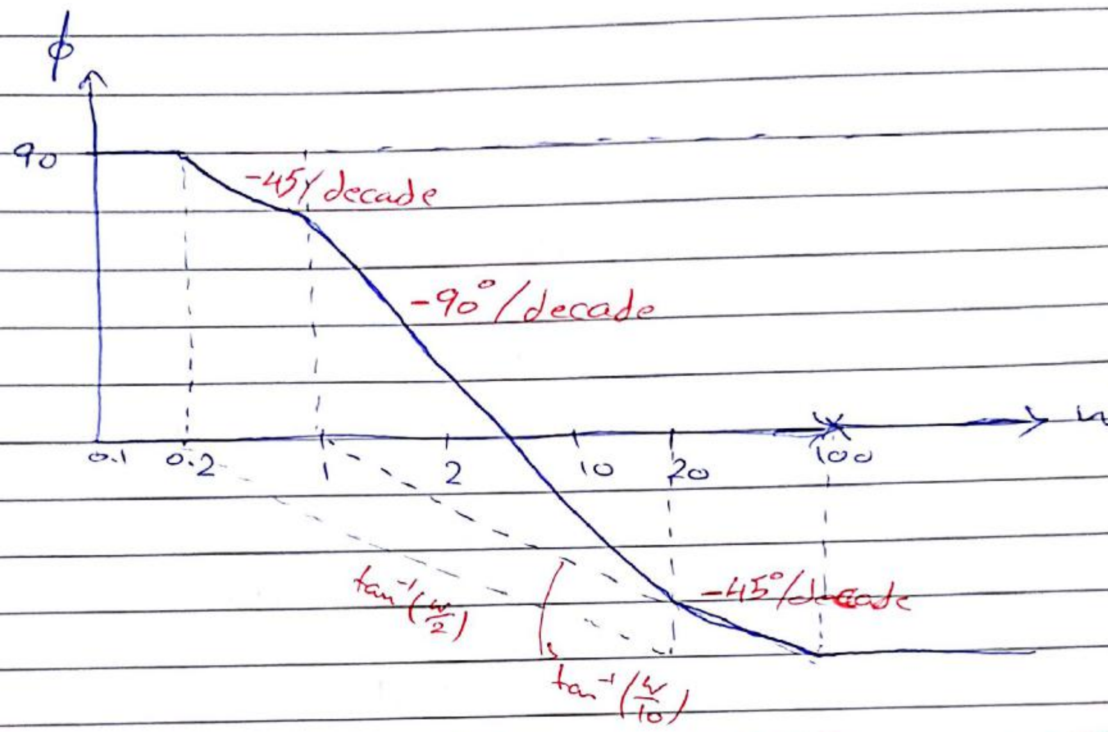
$$H(\omega)_{dB} = 20\log 10 + 20\log|j\omega| - 20\log|1 + j\omega/2| - 20\log|1 + \frac{j\omega}{10}|$$





Scanned by CamScanner

No



$$H(\omega) = \frac{5(j\omega+2)}{j\omega(j\omega+10)} = \frac{5 * 2(j\omega/2+1)}{j\omega * 10(j\omega/10+1)}$$

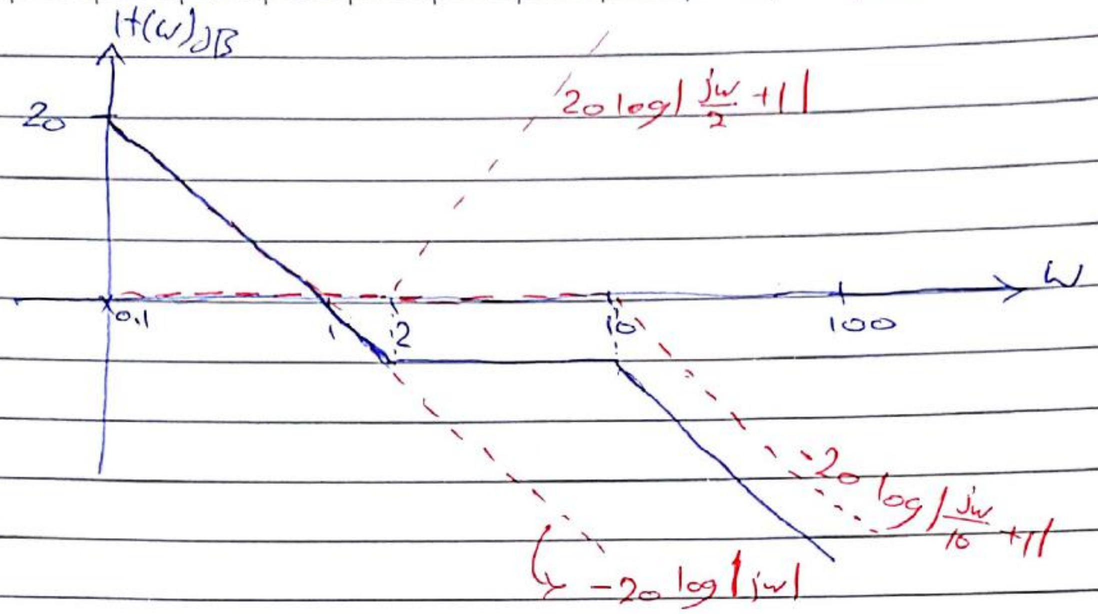
$$= \frac{(j\omega/2+1)}{j\omega * (j\omega/10+1)}$$

$$H(\omega)_{dB} = 20\log|j\omega/2+1| - 20\log|j\omega| - 20\log|j\omega/10+1|$$

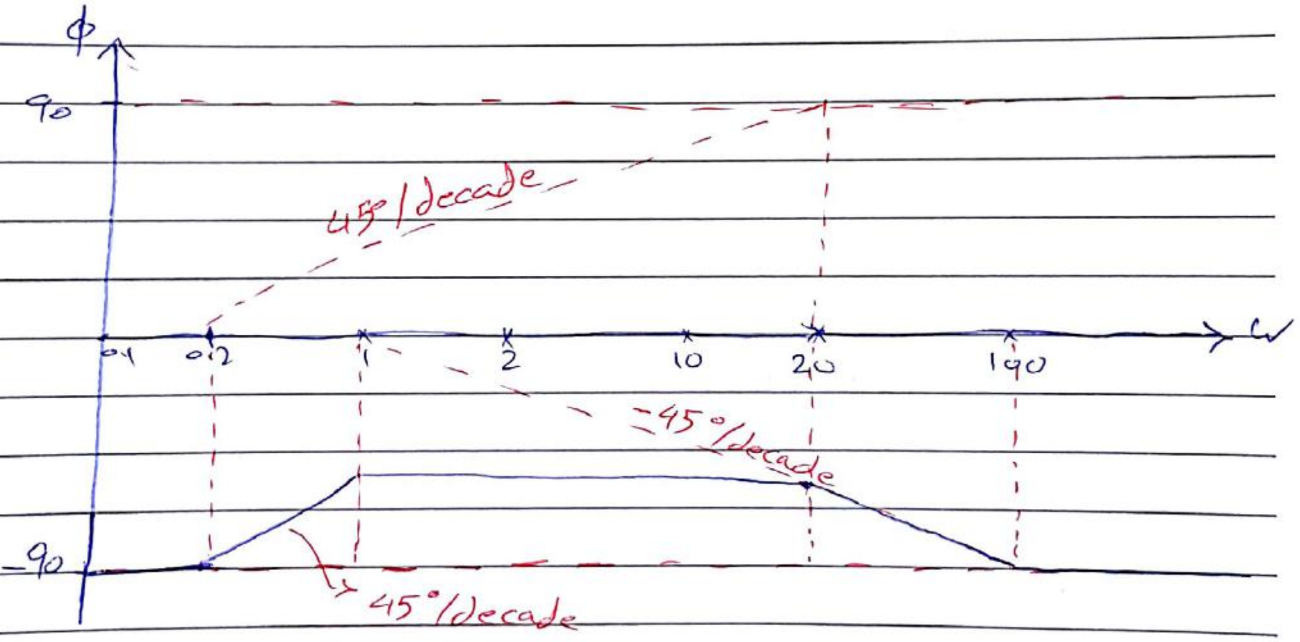
$$\angle H(\omega) = \tan^{-1}\omega/2 - 90 - \tan^{-1}\omega/10$$

Scanned by CamScanner

No



|H(w)|dB
20
$20\log|\frac{jw}{2}+1|$
w
0.1
1
2
10
100
$-20\log|\frac{jw}{10}+1|$
$-20\log|jw|$



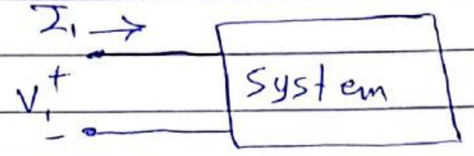
φ
90
45°/decade
w
0.1
0.2
1
2
10
20
100
−45°/decade
−90
45°/decade

الثلاثاء 3/5

No

2- Port networks:-

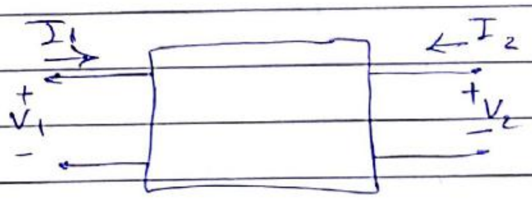
⇒ 1 Port network :-



⇒ 2 Port network :-

Impedance Parameter [Z - Parameters]

$V_1 = Z_{11} I_1 + Z_{12} I_2$



$V_2 = Z_{22} I_2 + Z_{21} I_1$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \underbrace{\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}}_{\text{System}} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$Z_{11} = \frac{V_1}{I} \Big|_{I_2 = 0} \qquad Z_{12} = \frac{V_1}{I_2} \Big|_{I_1 = 0}$$

$$Z_{21} = \frac{V_2}{I_1} \Big|_{I_2 = 0} \qquad Z_{22} = \frac{V_2}{I_2} \Big|_{I_1 = 0}$$

Scanned by CamScanner

No

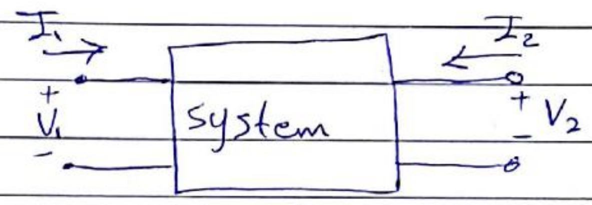
$Z_{11} \triangleq$ Open-Ckt input impedance.

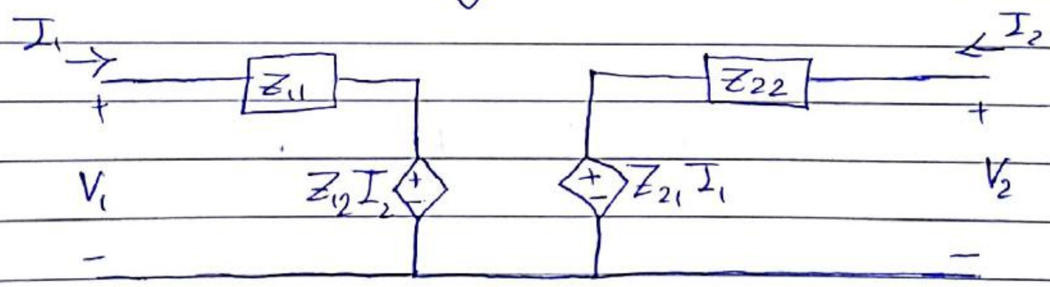
$Z_{12} \triangleq$ Open-Ckt transfer impedance from Port 1 to Port 2.

$Z_{21} \triangleq$ Open-Ckt transfer impedance from Port 2 to port 1

$Z_{22} \triangleq$ Open-Ckt output impedance.

Equivalent Ckt for Z Parameters:





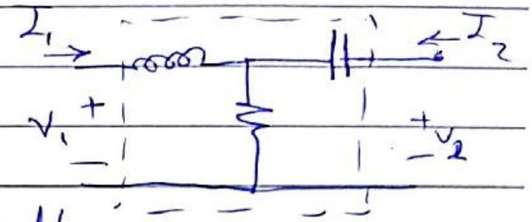
$V_1 = Z_{11} I_1 + Z_{12} I_2$ $\qquad$ $V_2 = Z_{21} I_1 + Z_{22} I_2$

Scanned by CamScanner

No

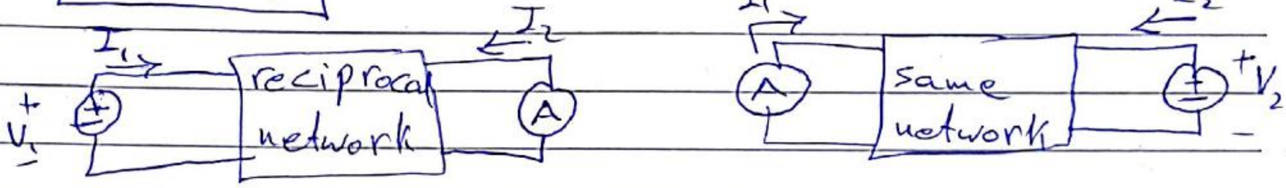
⇒ If the network has no dependent sources.

⇒ This system is called reciprocal system.



⇒ Source & effect are interchangable.

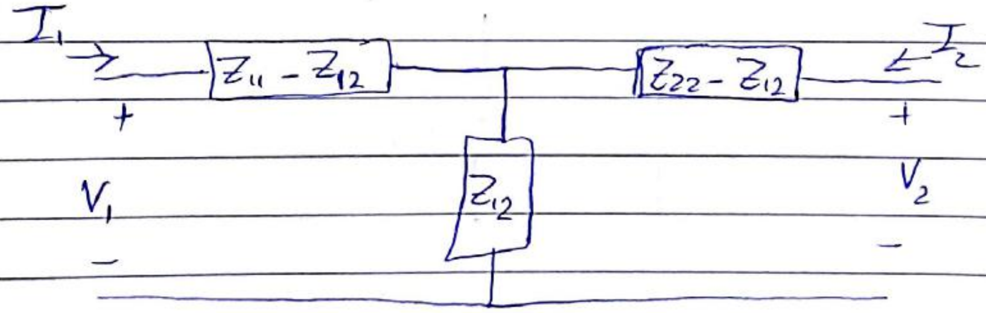
⇒ $\boxed{Z_{21} = Z_{12}}$



V_1 causes I_2 $\qquad\qquad$ V_2 causes I_1

if $V_1 = V_2$ then $I_1 = I_2$

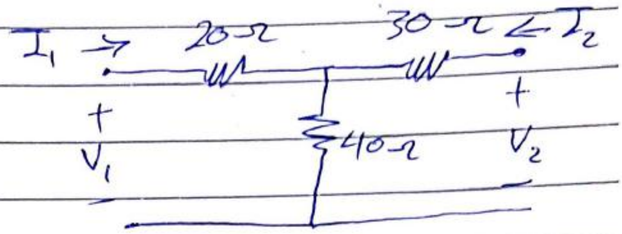
For a reciprocal network :-



No

ex) Determine the Z parameters for the Ckt shown:-

Find $Z = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$



Approach 1:-

$$Z_{11} = \frac{V_1}{I_1}\Bigg|_{I_2=0} = \frac{I_1 * (20+40)}{I_1} = 60\ \Omega$$

$$Z_{21} = \frac{V_2}{I_1}\Bigg|_{I_2=0} = \frac{40 * I_1}{I_1} = 40\ \Omega$$

$$Z_{12} = \frac{V_1}{I_2}\Bigg|_{I_1=0} = \frac{(30+40)\,I_2}{I_2} = 70\ \Omega$$

$$Z_{22} = \frac{V_2}{I_2}\Bigg|_{I_1=0} = \frac{(30+40)\,I_2}{I_2} = 70\ \Omega$$

$$Z = \begin{bmatrix} 60 & 40 \\ 40 & 70 \end{bmatrix}$$

Approach 2:

$40 = Z_{12} = Z_{21}$ [reciprocal]

$20 = Z_{11} - Z_{12} \Rightarrow Z_{11} = 60\ \Omega$

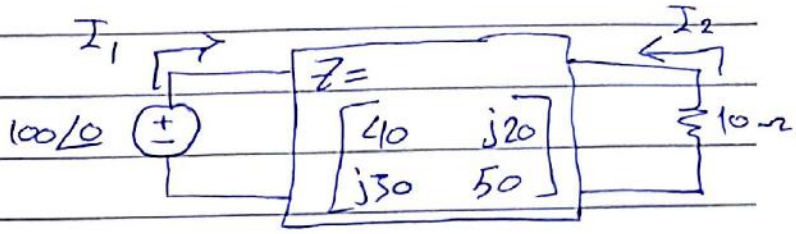
$30 = Z_{22} - Z_{12} \Rightarrow Z_{22} = 70\ \Omega$

No

ex) Find I_1 & I_2 in the shown network

$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$



$V_1 = 100\angle 0$

$V_2 = -10 I_2$

$\to 100\angle 0 = 40 I_1 + j20 I_2 \quad \Rightarrow \quad I_1 = 2\angle 0$ A

$\to -10 I_2 = j30 I_1 + 50 I_2 \quad\quad I_2 = 1\angle -90$ A

Y-Parameters [~~adm~~ admittance Parameters].

→ sometimes Z-Parameters are not easy to find.

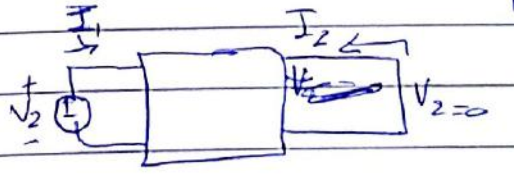
$$Y = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \qquad \boxed{Y^{-1} = Z}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \underbrace{\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix}}_{\text{system Y-Parameters.}} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$I_1 = y_{11} V_1 + y_{12} V_2$

$I_2 = y_{21} V_1 + y_{22} V_2$

$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0} \qquad\qquad y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$



Scanned by CamScanner

$$y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} \qquad y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$$

$y_{11} \triangleq$ Short Ckt input admittance.

$y_{12} \triangleq$ Short ckt transfer admittance from Port 1 to Port 2.

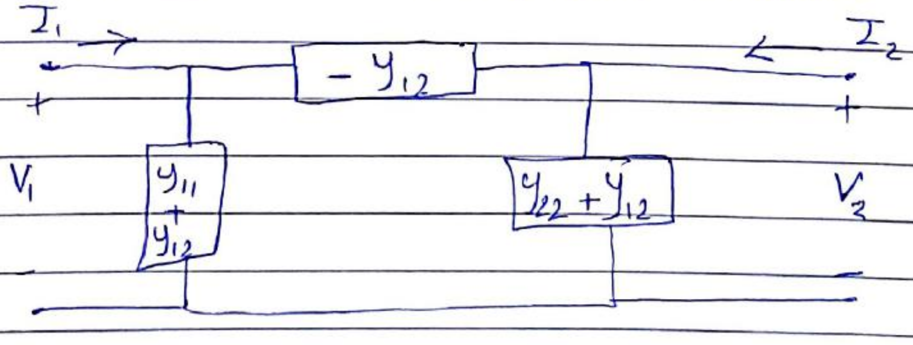
$y_{21} \triangleq$ Short ckt transfer admittance from Port 2 to Port 1.

$y_{22} \triangleq$ short-ckt output admittance.

⇒ if the network has no dependent sources.
⇒ it is call reciprocal network.

⇒ $\boxed{Y_{12} = Y_{21}}$

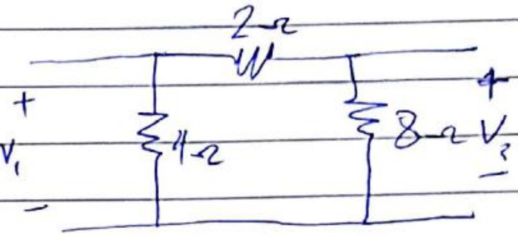
⇒ Equivalent Ckt for a reciprocal network.



No

ex obtain the Y- Parameters for the system network.

$$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0} = \frac{I_1}{8/6\, I_1}$$



$$= \frac{3}{4} \; S^{1}\,(\mho)$$

$$V_1 = I_1 * \frac{4*2}{4+2} = \frac{8}{6} I_1$$

$$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = \frac{-4/6\, I_1}{8/6\, I_1} = -0.5 \; S^{1}$$

$$-I_2 = \frac{4}{2+4} I_1 = \frac{4}{6} I_1$$

Scanned by CamScanner

الخميس

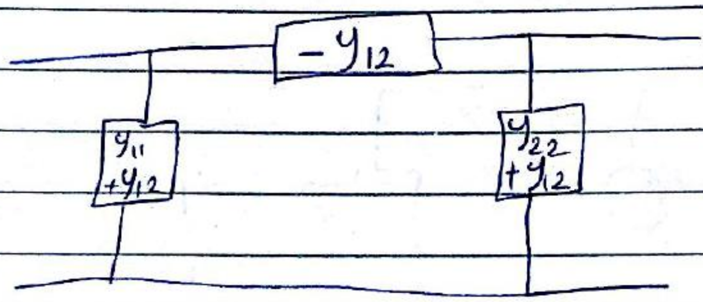
No

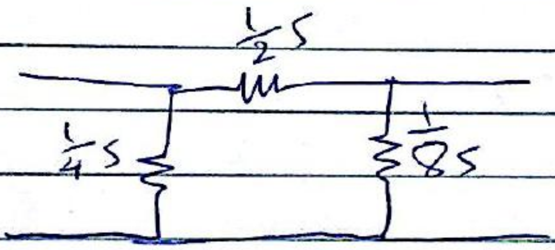
$$Y = \begin{bmatrix} 0.75 & -0.5 \\ -0.5 & 0.625 \end{bmatrix}$$

بال Y دائماً بنعمل short ckt و current source

بال Z " " open ckt و voltage source

approach 2 :-





$-y_{12} = \frac{1}{2}$, $y_{12} = -0.5 = y_{21}$

, $\frac{1}{4} = y_{11} + y_{12} \Rightarrow y_{11} = 0.75$

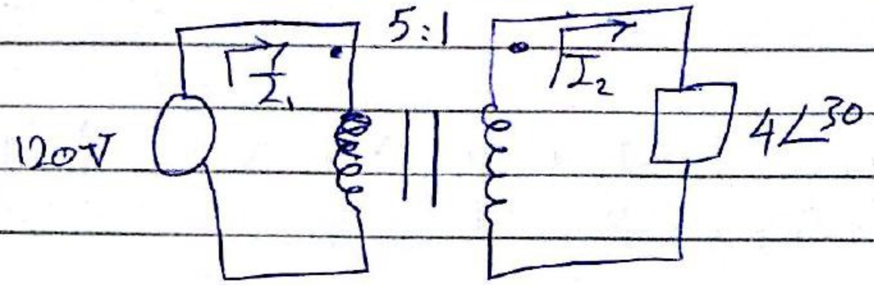
$\frac{1}{8} = y_{22} + y_{12} \Rightarrow y_{22} = 0.625$

انتهت المادة #

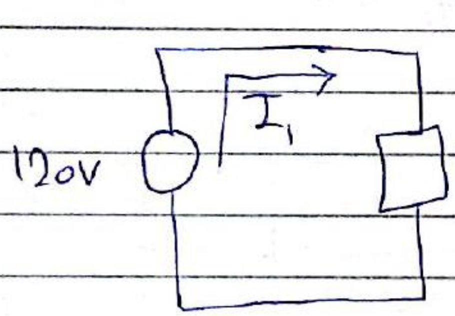
Scanned by CamScanner

No مراجعة وحل امثلة

(ex) Find I_1 & I_2



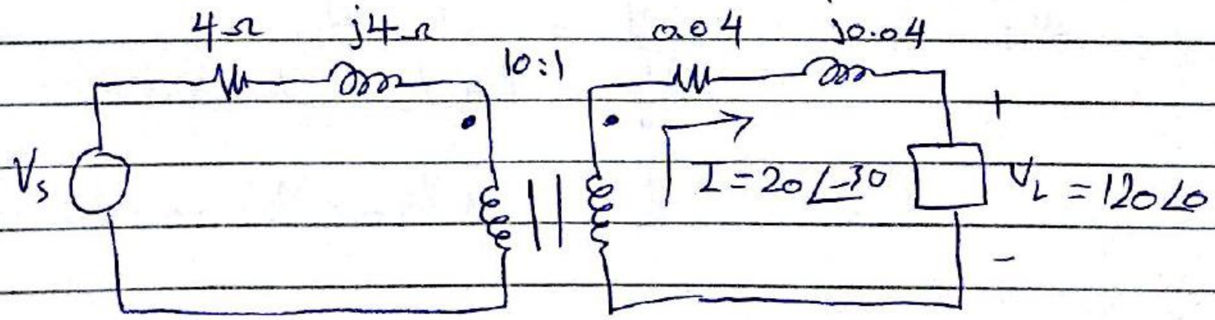
Sol :-



$$Z_L = \frac{4\angle 30}{(1/5)^2} = 100\angle 30$$

$$I_1 = \frac{120\angle 0}{100\angle 30} = 1.2\angle -30$$

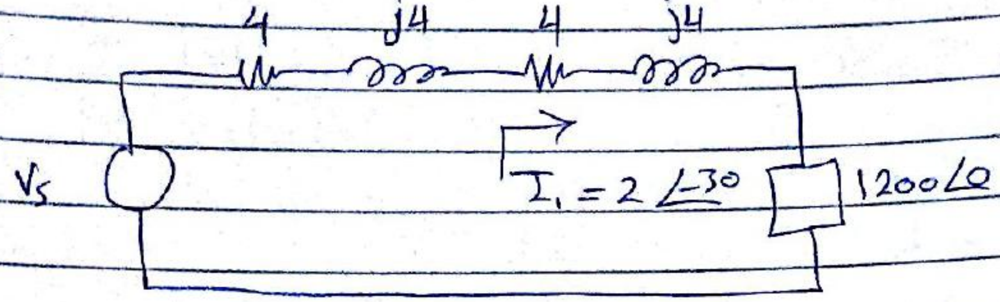
(ex) For the ckt shown find V_s :-



$$R_{ref} = \frac{0.04}{(1/10)^2} = 4\Omega \qquad V_{L\,ref} = 120 * 10 = 1200$$

$$X_{ref} = \frac{j0.04}{(1/10)^2} = j4 \qquad I_1 = I_L/10 = 2\angle -30$$

No



$$V_s = (8+j8)I_1 + 1200\angle 0 = 1222\angle 0.275$$

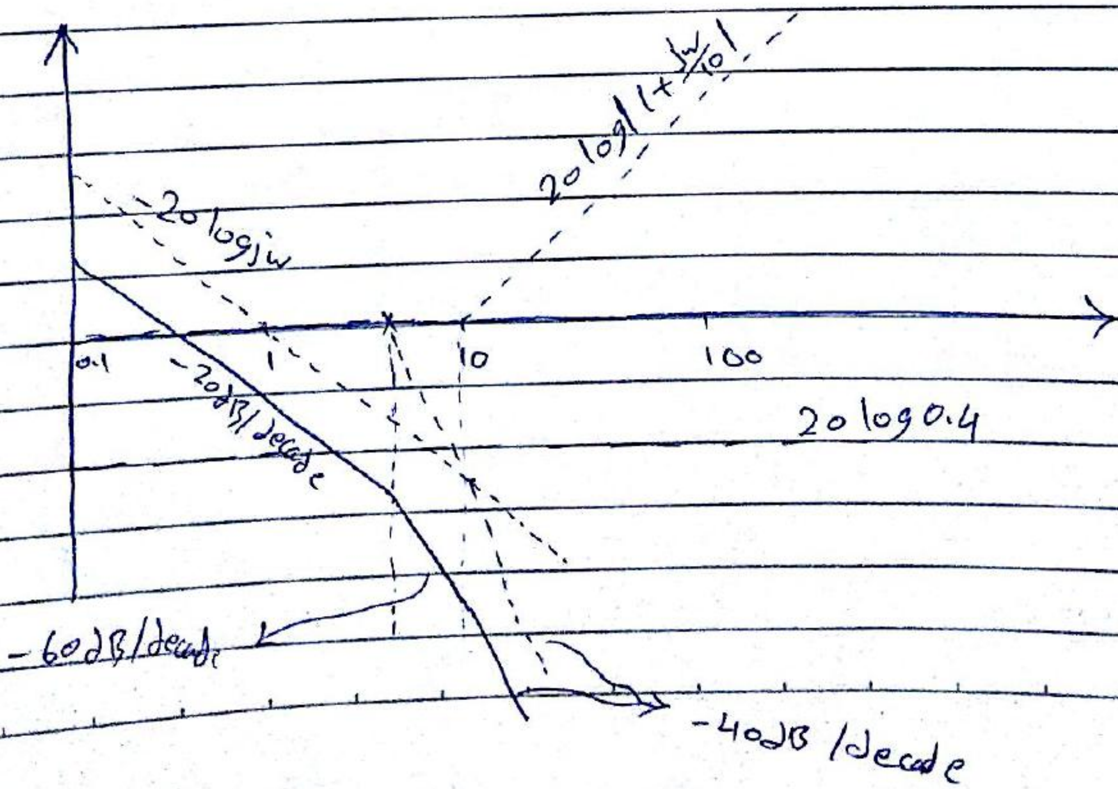
(ex) obtain the Bode Plots for :-

$$H(w) = \frac{jw+10}{jw(jw+5)^2}$$

sol : $H(w) = \dfrac{10\left(1+\frac{jw}{10}\right)}{jw * 25\left(1+\frac{jw}{5}\right)^2} = \dfrac{0.4\left(1+\frac{jw}{10}\right)}{jw\left(1+\frac{jw}{5}\right)^2}$

$$H(w)_{dB} = 20\log 0.4 + 20\log\left(1+\frac{jw}{10}\right) - 20\log jw$$

$$-40\log\left(1+\frac{jw}{5}\right) \leftarrow -20\log\left(1+\frac{jw}{5}\right)^2$$

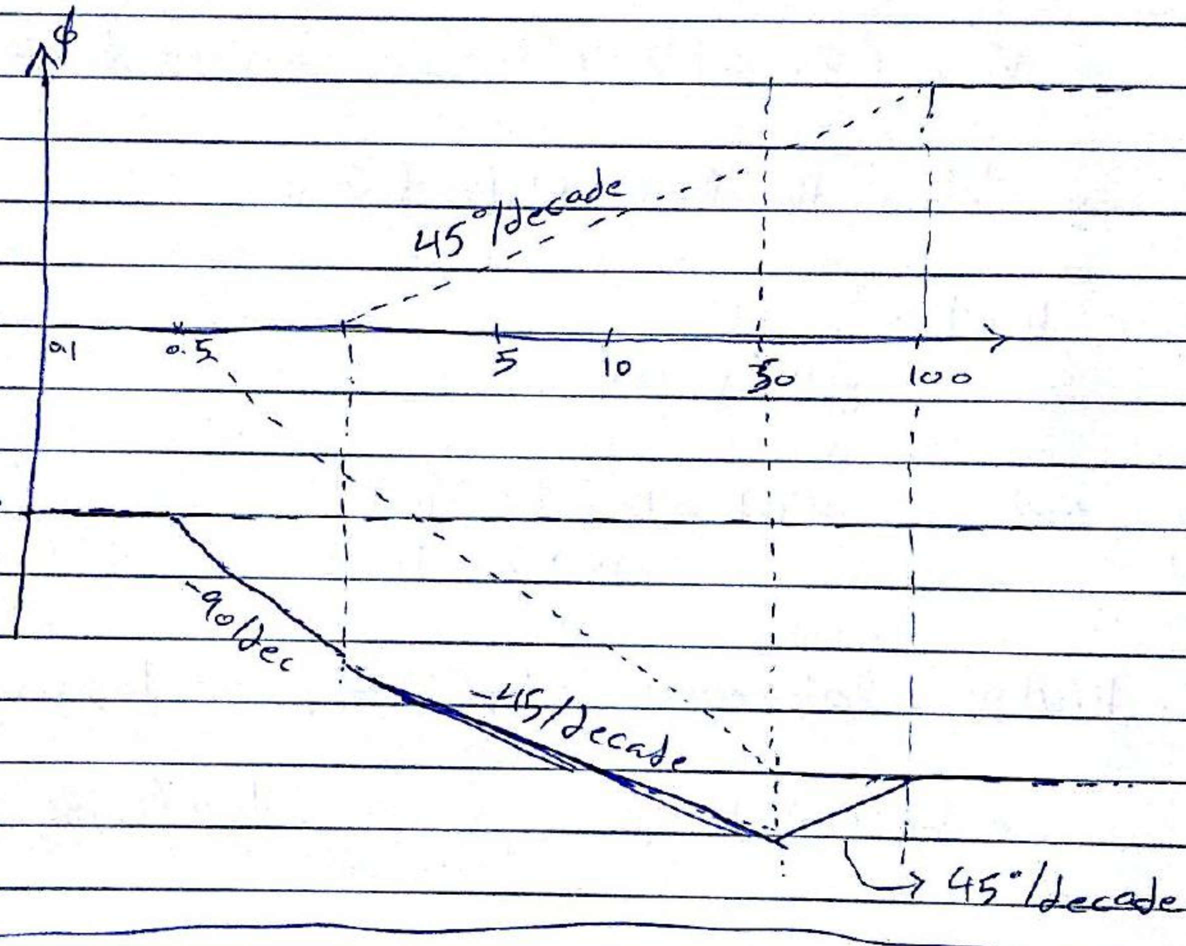


Scanned by CamScanner

No

$$H(7) = 20\log(0.4) + 20\log\left|1 + j\tfrac{7}{10}\right| - 20\log|7| - 40\log\left|1 + j\tfrac{7}{5}\right|$$

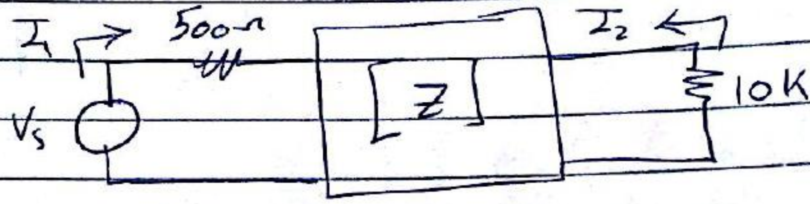
$$\phi = 0 + \tan^{-1}\frac{w}{10} - 90 - 2\tan^{-1}\frac{w}{5}$$



No

(ex) Z is given as $\begin{bmatrix} 10^3 & 10 \\ -10^6 & 10^4 \end{bmatrix} \Omega$,

Find Voltage, current & Power gains then find the input impedance for the Ckt shown.



sol :

$G_I = \frac{I_2}{I_1}$

$G_V = \frac{V_2}{V_1}$

* الفكرة من السؤال هي ايجاد العلاقات

$G_P = G_I G_V$

$V_1 = 10^3 I_1 + 10 I_2$

$V_2 = -10^6 I_1 + 10^4 I_2$

$V_s = 500 I_2 + V_1$

$V_2 = -10^4 I_2$

$-10^4 I_2 = -10^6 I_1 + 10^4 I_2$

$I_2 = \frac{10^6}{2 * 10^4} I_1 = 50 I_1$

$G_I = \frac{50 I_1}{I_1} = 50$

$V_1 = 10^3 I_1 + 10(\underbrace{50 I_1}_{I_2}) = 1500 I_1$

$V_2 = -10^4 * 50 I_1$

$G_V = \frac{V_2}{V_1} = \frac{-10^4 * 50 I_1}{1500 I_1} = -333$

$G_P = 333 * 50 = 16650$

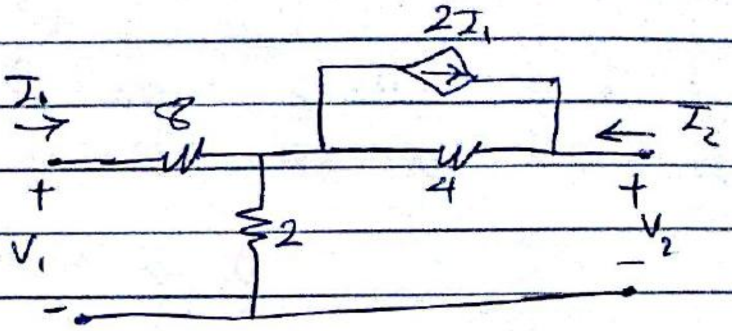
$Z_{in} = \frac{V_1}{I_1} = \frac{1500 I_1}{I_1}$

$= 1500 \Omega$

Scanned by CamScanner

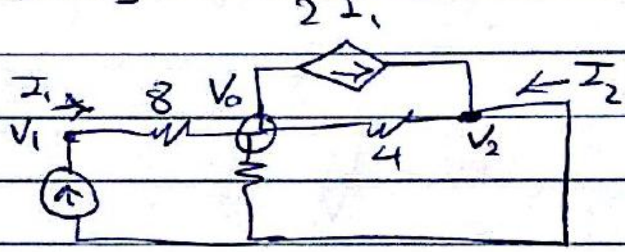
No

ex) Determine the Y-parameters for the 2-port network shown:-



① to find y_{11} & y_{21} ⇒
short CKt the output $[V_2 = 0]$

$$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$$



$$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$$

at node V_o :-

$$\frac{V_1 - V_o}{8} + \frac{-V_o}{2} + \frac{\cancel{V_2} - V_o}{4} - 2\underbrace{I_1}_{\frac{V_1 - V_o}{8}} = 0$$

$$\boxed{V_1 = -5V_o}$$

$$I_1 = \frac{-5V_o - V_o}{8} = \frac{-3}{4} V_o$$

$$y_{11} = \frac{\frac{-3}{4} V_o}{-5V_o} = 0.15 \text{ S}$$

at node V_2 :

$$\frac{V_o - V_2}{4} + I_2 + 2\underbrace{I_1}_{\frac{V_1 - V_o}{8}} = 0$$

$$I_2 = 1.25 V_o$$

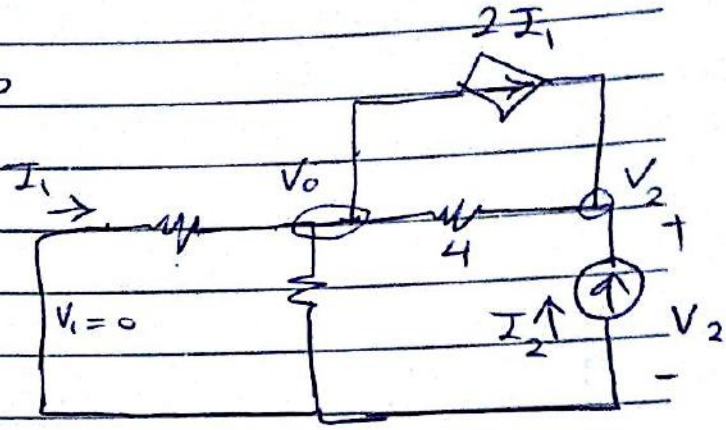
Scanned by CamScanner

No

$$y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0} = \frac{1.25\ V_o}{-5\ V_o} = -0.25\ S$$

$y_{12} \neq y_{21}$ because the dependent source

to find y_{12} & y_{22} set $V_1 = 0$



$$y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0}$$

$$y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$$

at node V_o $\Rightarrow$

$$\frac{\overset{0}{\cancel{V_1}} - V_o}{8} - \frac{V_o}{2} + \frac{V_2 - V_o}{4} - 2I_1 = 0 \qquad I_1 = \frac{\overset{0}{\cancel{V_1}} - V_o}{8}$$

$V_2 = 2.5\ V_o$

$$y_{12} = \frac{I_1}{V_2} = \frac{-V_o/8}{2.5V_o} = -0.05\ S$$

@ node V_2 :- $\frac{V_o - \overset{2.5V_o}{V_2}}{4} + 2\overset{-\frac{V_o}{8}}{I_1} + I_2 = 0$

$I_2 = 0.626\ V_o$

$$y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$$

$$= \frac{0.625 V_o}{2.5\ V_o} = 0.25\ S$$

$$Y = \begin{bmatrix} 0.15 & 0.05 \\ -0.25 & 0.25 \end{bmatrix}$$

Scanned by CamScanner