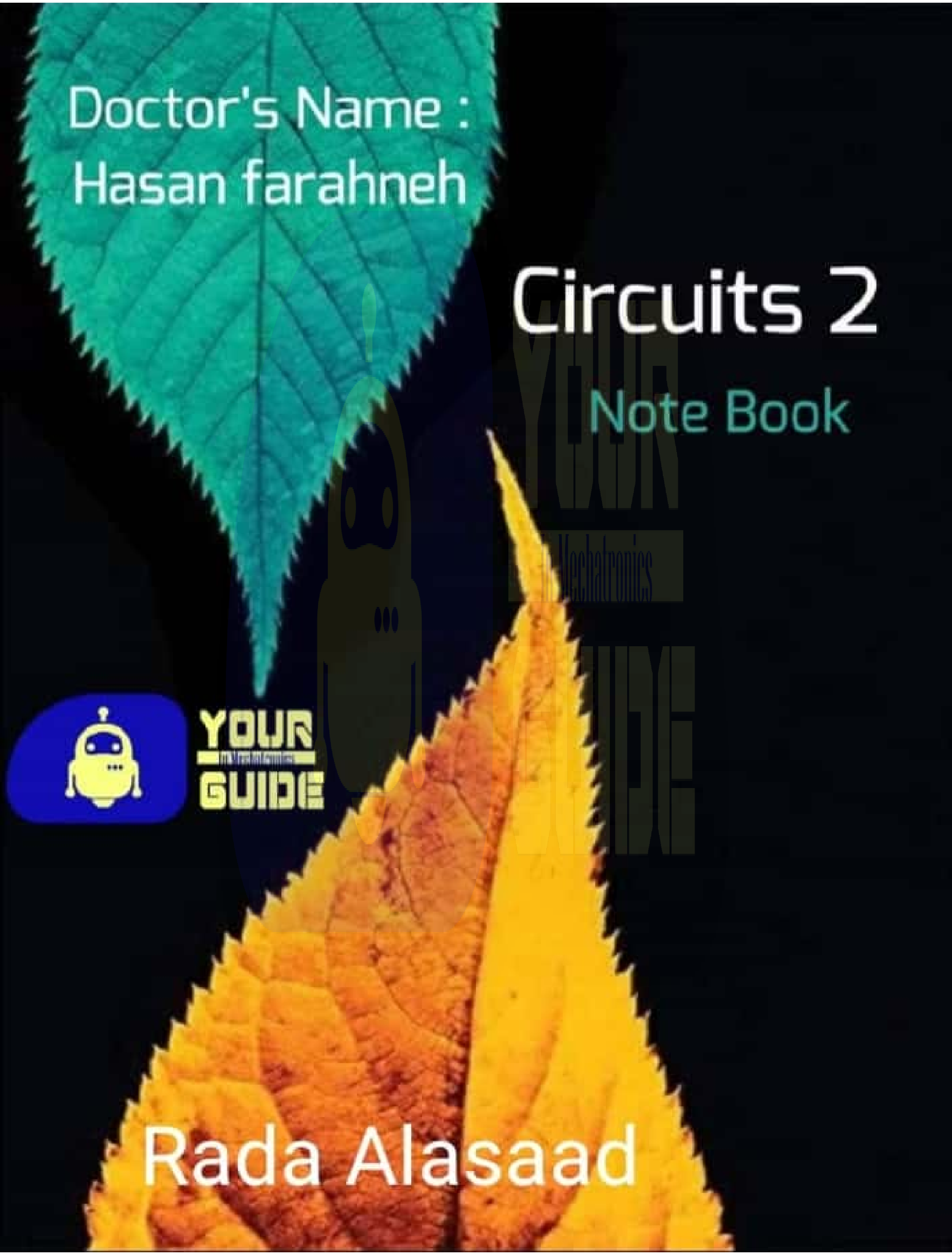


Doctor's Name :
Hasan farahneh

Circuits 2

Note Book

Rada Alasaad

No. Revision

Tuesday
11/6/2019

1

sinusoidal → sin
sinusoidal → cos

$V(t) = V_m \sin(\omega t + \theta)$ → phase shift

$V(t)$ ↓ instantaneous

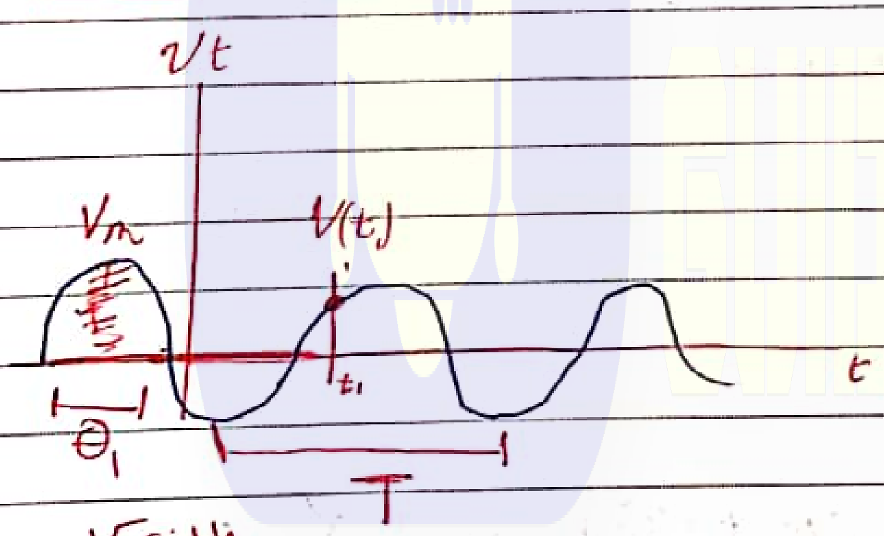
V_m ↳ max

ω ↳ Angular freq

$\boxed{\omega = \frac{2\pi}{T}}$ → perodic time

$\boxed{T = \frac{1}{f}}$

$\boxed{\omega = 2\pi f}$



Veraible

$\begin{cases} t \\ \omega \end{cases}$

t_1

ω_0 → ثابتة

$V(t_1)$ → قيمة معينة

2

No.

phasor / polar form:-

$v(t) = V_m \cos(\omega t + \theta)$ Time domine

vector ← $\bar{V} = V_m \angle \theta$

$$\begin{cases} \sin x = \cos(x - 90^\circ) \\ -\sin x = \cos(x + 90^\circ) \\ -\cos x = \cos(x \mp 180^\circ) \end{cases}$$

$v(t) = V_m \cos(\omega t + \theta_1)$

$i(t) = I_m \cos(\omega t + \theta_2)$

لازم متشابهين

Two signles

① لازم يكونوا نفس الشكل sin, sin / cos, cos

② نفس ω

ex:- $v(t) = 4\cos(100t - 30^\circ) \rightarrow 4\angle -30$

$i(t) = 6\sin(100t + 70^\circ)$

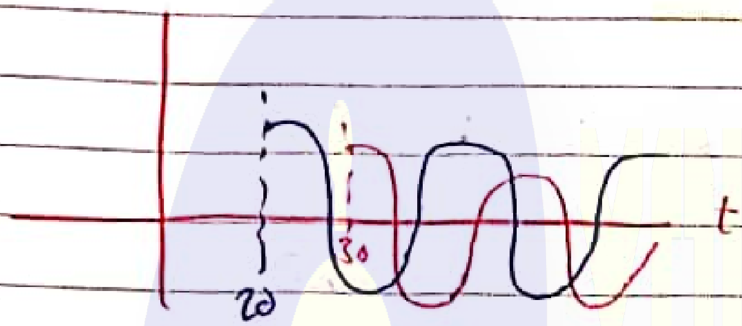
↓

$i(t) = 6\cos(100t + 70^\circ - 90^\circ)$

$i(t) = 6\cos(100t - 20^\circ)$

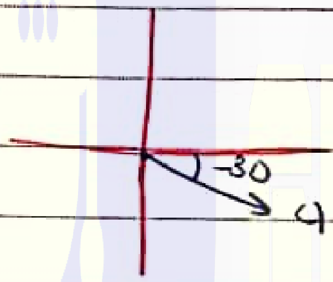
No.

3



i Leads V by 10°
V Lags i by 10°

$4 \measuredangle -30$



4

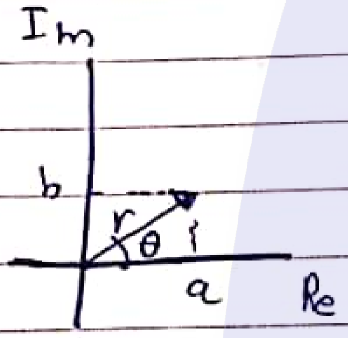
No.

Complex / Cartaizian

$Z = a + jb \longrightarrow Z = |r| \angle \theta$

$a = r\cos\theta$

$b = r\sin\theta$



$$\boxed{r = \sqrt{a^2 + b^2}}$$

$$\boxed{\theta = \tan^{-1}\frac{b}{a}}$$

ex: $v_1 = 4\cos(100t - 30^\circ)$ $\quad v_2 = 6\sin(100t)$

$6\cos(100t - 90^\circ)$

$v_1(t) + v_2(t)$

Sol:- $v_1 = 4\angle -30^\circ$

$v_2 = 6\angle -90^\circ$

$v_1 + v_2 = 8.7\angle -66.5^\circ$ time domine $8.7\cos(100t - 66.5^\circ)$

5

No.

Load = (1) Resister — R(Ω)
(2) Inductor — L(H)
(3) capaciter — C(F)

} Impedance

- Resister $Z_R = R\ \Omega$
- inductor $Z_L = j\omega L = \omega L \angle 90^\circ$
- capaciter $Z_C = \frac{1}{j\omega C} = \frac{1}{\omega C} \angle -90^\circ$

$j = i = \sqrt{-1}$

$\overset{a}{0} + \overset{b}{j4} = 4 \angle 90^\circ$

$\overset{a}{3} + \overset{b}{j4} = 5 \angle 53.00^\circ$

$0 + -\overset{b}{j4} = 4 \angle -90^\circ$

(1) $A\angle\theta_1 \cdot B\angle\theta_2 = |A||B| \angle \theta_1 + \theta_2$

(2) $\frac{A\angle\theta_1}{B\angle\theta_2} = \frac{|A|}{|B|} \angle \theta_1 - \theta_2$

No.

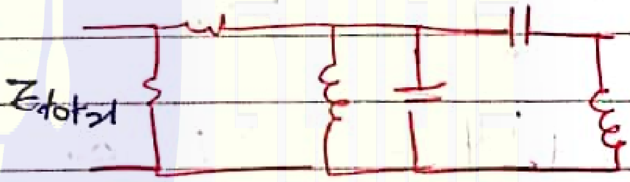
(6)

- $\boxed{\text{in } L \text{ the } V_L \text{ lead } i_L \text{ by } 90^\circ}$

- $\boxed{\text{in } C \text{ the } I_C \text{ lead } V_C \text{ by } 90^\circ}$

- $\boxed{Z = \frac{V}{I}}$ - $\boxed{Z = \frac{V_L \angle \theta_L}{I_L \angle \theta_L}}$

- $\boxed{Z = \omega L \angle \theta_1 - \theta_2 = \omega L \angle 90^\circ}$



- $\angle +\theta$

  inductive load

- $\angle -\theta$

  Capacitive load

- $\angle 0$

  Resistive load   in phase the V, I are the same

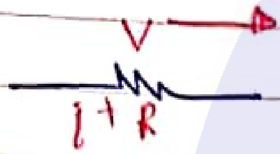
7

No.

Tuesday
11/6/2019

- Chapter 11

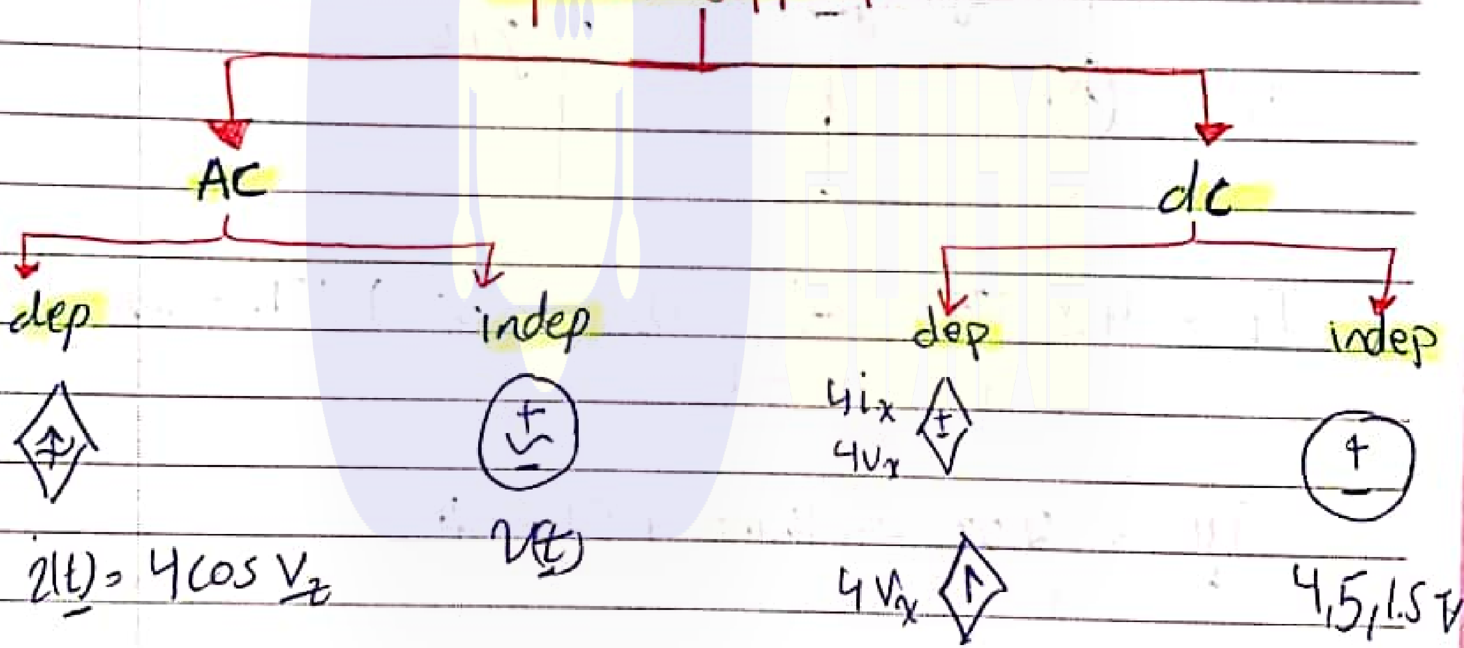
- AC - power



مقدار الشغل المبذول لنقل
شحنة مقدارها 1C من
الى نقطة معينة

$P = I^2R$
$P = V^2/R$ → DC
$P = IV$

power supplied



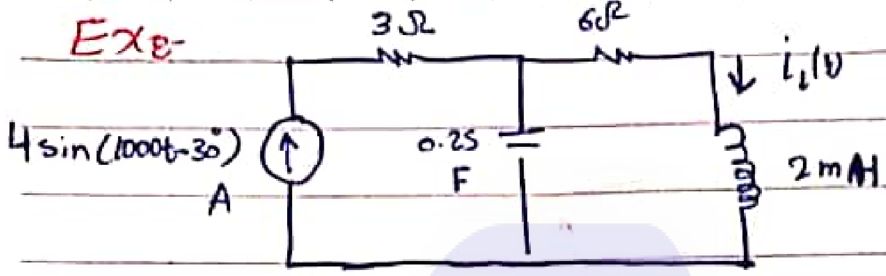
smile

8

No.

12/6/2019

Ex:-



ما بصير احل اي دارة وهي ب time domain

بحولها ← phasor form

sol:

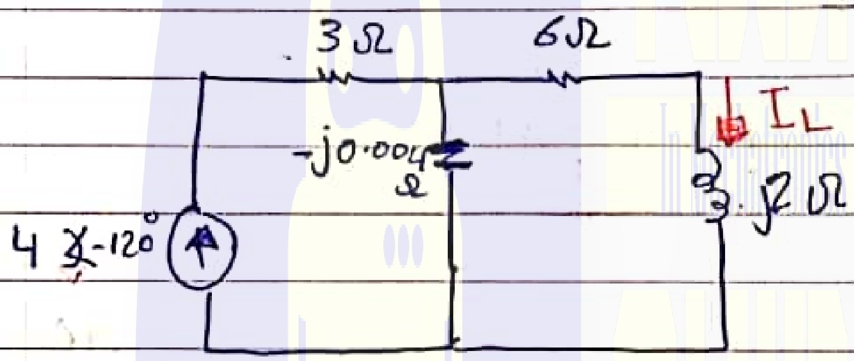
① $4\cos(1000t - 30° - 90°)$

$4\cos(1000t - 120°)$

$4 \angle -120°$

② $C = \frac{-j}{\omega C} = -j4\times10^{-3}\,\Omega$

③ $L = j\omega L = j2\,\Omega$



$$I_L = \frac{4\angle -120° \, (-j0.004)}{6 + j2 - j0.004} = 2.53 \angle 131.6 \text{ mA}$$

$i_L(t) = 2.53 \cos(1000t + 131.6)\,\text{mA}$

$\boxed{V_L(t) = L \frac{di}{dt}}$ ✗

$\boxed{V_L = j2 \times I_L}$ ✓

$V_L(t) = j2(2.53 \angle 131.6)$

$V_L(t) = 5.06 \angle 221.6 \text{ mV}$

↓

$5.06 \cos(1000t + 221.6)$ mA

smile

9

No.

Instantaneous power

$p(t) = V(t)\, i(t)$

$p_L(t) = V_L(t)\, i_L(t)$

V أو i

f لتبع

للمور صحيح

تكملة السؤال السابق

conut...

$\cos A \cdot \cos B = 0.5 \cos(A+B) + 0.5 \cos(A-B)$

$p(t) = V(t)\, i(t)$

$= 5.06 \cos(1000t + \overset{\theta_V}{221.6})\,(2.53 \cos(1000t + \overset{\theta_A}{131.6}))$

$\frac{12.8}{2} \cos(1000t + \overset{\theta_V+\theta_I}{353.2}) + \frac{12.8}{2} \cos(\overset{\theta_v - \theta_i}{221.6 - 131.6})$

Ac part + dc part

in general form:

$v(t) = V_m \cos(\omega t + \theta_v)$

$i(t) = I_m \cos(\omega t + \theta_i)$

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

$V_m \cos(\omega t + \theta_v)\, I_m \cos(\omega t + \theta_i)$

$\underbrace{\frac{V_m I_m}{2} \cos(2\omega t + \theta_v + \theta_i)}_{\text{Ac part}} + \underbrace{\frac{V_m I_m}{2} \cos(\theta_v - \theta_i)}_{\text{Dc-part}}$

Dc-part

Aaverge power

10

سؤال السنوات

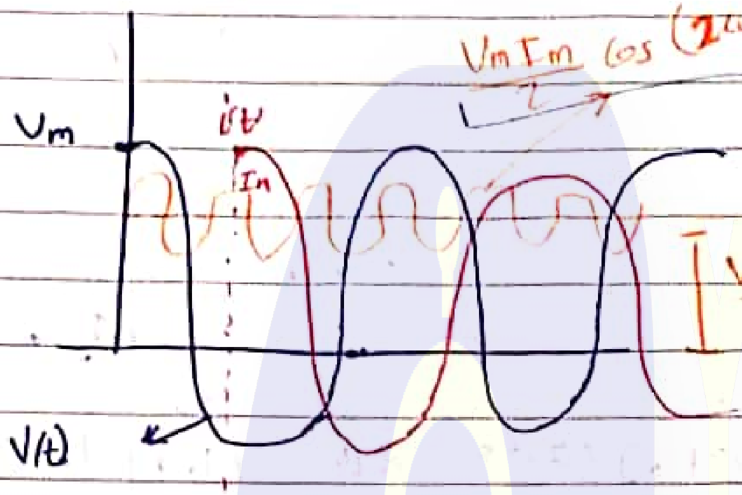
No.

The ferquency of p(t) is twice of the ferquency of v(t) or i(t)

$\frac{V_m I_m}{2}\cos(2\omega t+\theta_v+\theta_i)$

ماقي Avg power في

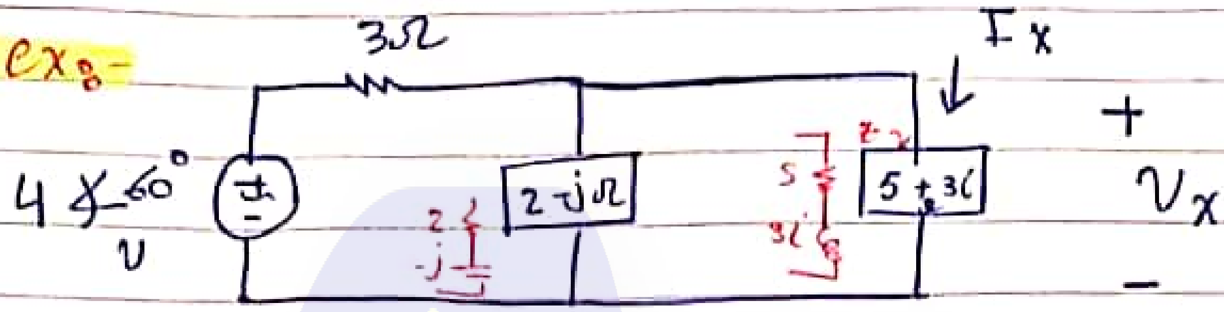
صفر : L, C



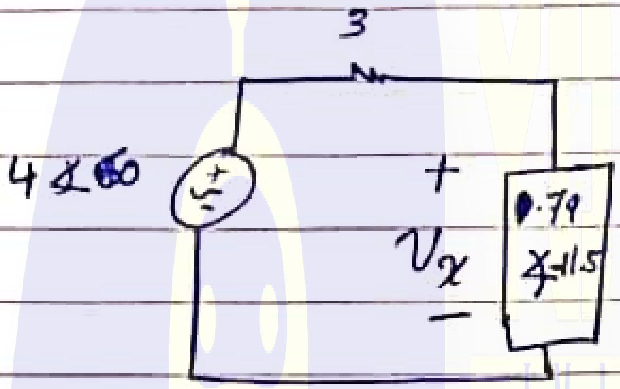
$\frac{V_m I_m}{2}\cos(\theta_v-\theta_i)$

Aavrange power في
L, C
صفر =

ex:-



Sol:-



$$V_x = \frac{4\angle 60\,(1.79\angle -11.5)}{3+(1.75-0.35i)}$$ $1.75-0.35i$

$V_x = 1.5\angle 53$ V

$$I_x = \frac{1.5\angle 53}{5+3i} = 0.25\angle 22$$

power Avg ← $P_x = 0.5\, V_m I_m \cos(\theta_v - \theta_i)$

$0.5\ 1.5 * 0.25(\cos(53-22))$

$P_x = 0.16$ W   5 طالعة ق

ق مقاومة

ϕ = V, I in phase Cw. Resistance shift ϕ - الزوايا

(13) No. Sunday 16/5/2019

$I = I_m \angle \theta \longrightarrow a + jb$

I^* : conjecte $I_m \angle -\theta \longrightarrow a - jb$

$P_{av} = \frac{1}{2} I_m V_m \cos(\theta_v - \theta_i)$

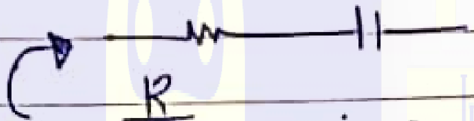
$\downarrow$

$P_{av} = \frac{1}{2} V I^*$ as avector

$\frac{1}{2} V_m \angle \theta_v \; I_m \angle \theta_i$

$4\cos(\omega t + 10)$

$4 \angle 10$



exg- $Z = \underset{R}{30} - 70i \; \Omega$

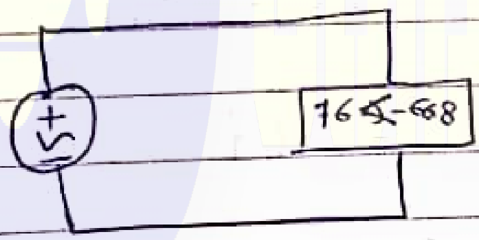
$76.1 \angle -66.8$

مجموع البوزر كله تاكد

$+ \; 0 =$

$V = 120 \angle 0$

find I :-



$\frac{1}{2} I_m V_m \cos(\theta_v - \theta_i)$

current خاطئ (-)

$I = \frac{V}{Z} = \frac{120 \angle 0}{76 \angle -66.8} = 1.576 \angle 66.8 \; A$

Find power avarge $P = \frac{1}{2} I_m V_m \cos(\theta_v - \theta_i)$

$\frac{1}{2} \; 1.576 \; 120 \left(\cos(0 - 66.8)\right)$

$37.25 \; W$ → صابقيني

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

smile

(14)

No.

$4j \Rightarrow 4\angle 90$

$-4j = 4\angle -90$

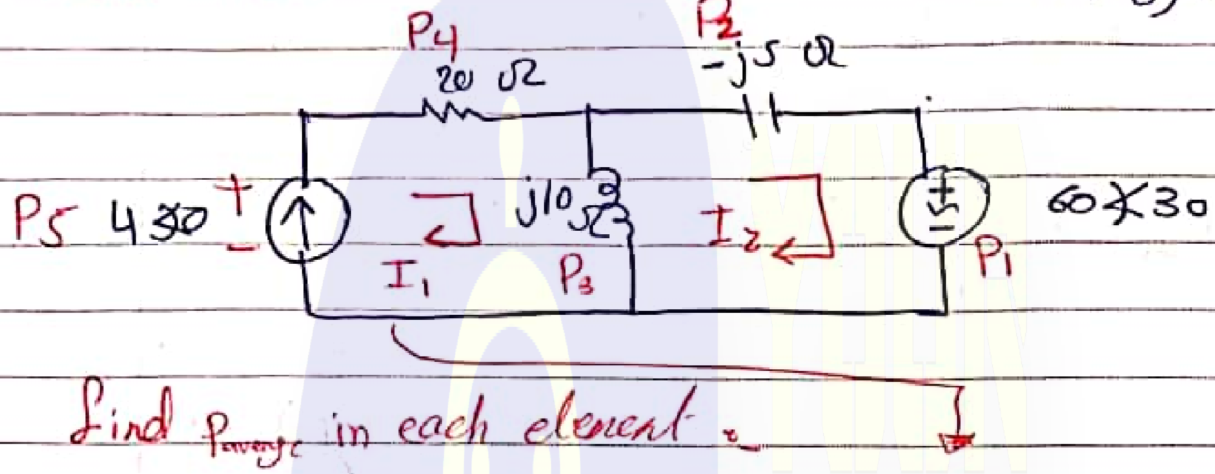
$3 = 3\angle 0$

$-3 = 3\angle 180$

اذا كانت (+θ) بنطرح 180 ⟸ دائما خلي الزاوية اقل منه 180

اذا كانت (−θ) بنزيد 180

exs- 11.4



Find P_{avrage} in each element.

$I_1 = 4\angle 0$ A

$-V_x + 20 I_1 + j10(I_1 - I_2) = 0$

at mesh 2

$-j5 I_2 + 60\angle 30 + j10(I_2 - I_1) = 0$

$5j\, I_2 - 10j(4\angle 0) = 60\angle -150$

$5j\, I_2 - 40j = 60\angle -150$

$5j\, I_2 = 60\angle -150 + 40j$

$I_2 = 10.58\angle 79$ A

15

No.

$P_1 = 0.5\, I_m V_m \cos(\theta_v - \theta_i)$

$= 0.5(60)(10.5)\cos(30-79) = 206.65\,W.$

$P_2 = 0\,W$

$P_3 = 0\,W$

$P4 = 0.5\, I_m^2 R = 0.5\, 4^2 \times 20 = 160\,W$

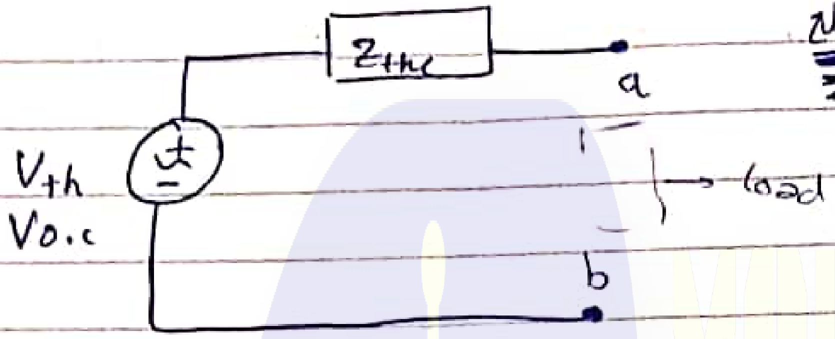
$P_5 = \Longrightarrow P_1 + P_2 + P_3 + P_4 + P_5 = 0$

$206.65 + 160 + 0 + 0 + P_5 = 0$

$\boxed{P_5 = 366.65\,W}$

Q = 11.4 [redacted]

Thevenin's



عشان ألاقي Z_{th} { Current o.c / Voltage s.c

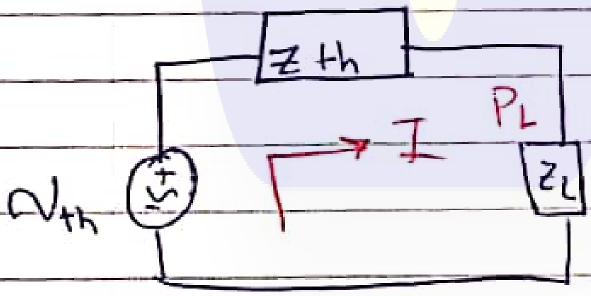
Max power transfer:

dc.

$$\boxed{R_L = R_{th}}$$

$$\boxed{P_{max} = \frac{V_{th}^2}{4R_{th}}}$$

thevenin eq. Ac



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

$$P_L = 1/2\, V_L I^* = 0.5\, \frac{V_{th} Z_L}{Z_L + Z_{th}} \frac{V_{th}}{Z_{th} + Z_L}$$

17

No.

To have Max power

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

$$P_{max} = \frac{|V_{th}|^2}{8 R_{th}} \quad \rightarrow \text{mag}$$

if

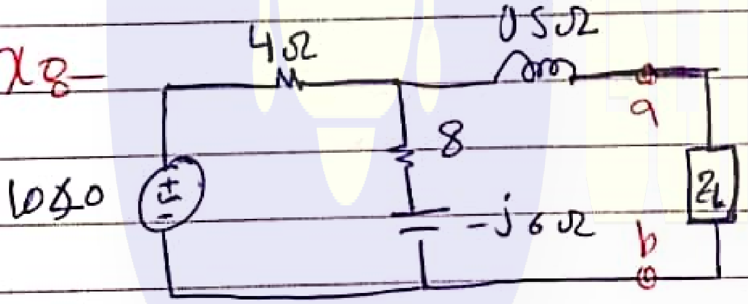
$Z_{th} = 8 - j10\ \Omega$

$Z_L = 8 - j10\ \Omega$

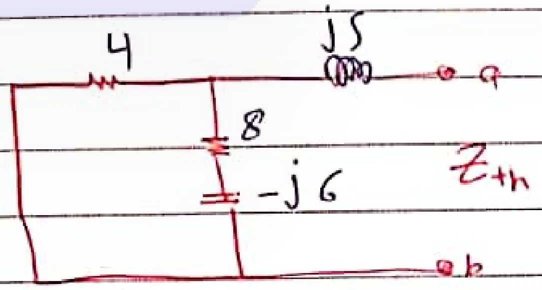
$Z_{th} = 5 \angle -30^\circ\ \Omega$

$Z_L = 5 \angle 30^\circ\ \Omega$

ex8-



sol



$Z_{th} = 4 \,||\, (8 - j6) + j5 = 2.933 + j4.46\ \Omega$

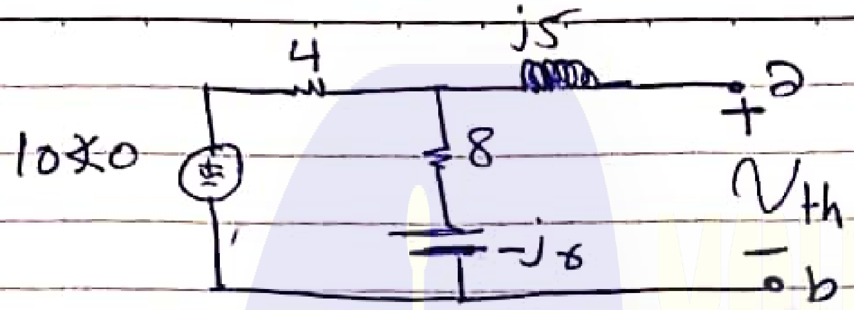
To have Max power

$Z_L = Z_{th}^* = 2.933 - j4.46\ \Omega$

(18)

No.

Current source لـ V حولنا



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

$$V_{th} = (7.45)\angle -10.3\,V$$

$$\text{Power max} = \frac{|7.45|^2}{8(2.433)}$$

Z_{th} = Real Part and Img

R = Real

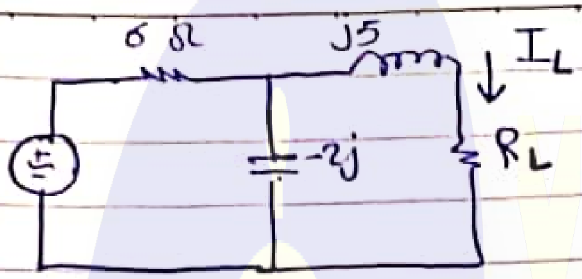
١٩

No.

17/6/2019

Monday

Ex:-



$Z_{th} = R_{th} + j X_{th}$

For pure resistive load

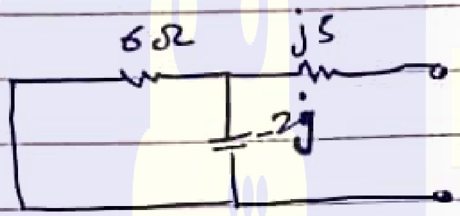
$R_L = |Z_{th}| = \sqrt{R_{th}^2 + j X_{th}^2}$

* Assume $Z_{th} = 3 + j4\ \Omega$

$R_L = \sqrt{3^2 + 4^2} = 5\ \Omega$

Find R_L to transfer Max power

Sol:-



$Z_{th} = (6 // -2j) + j5 = 3.2 \angle 79.38$

$Z_{th} = 0.6 + j3.2\ \Omega$

R_L = (for max power) $= |Z_{th}^*| = \sqrt{0.6^2 + 3.2^2} = 3.255\ \Omega$

$\text{Power max} = \dfrac{|V_{th}|^2}{8 R_{th}} = 0.5\, I_L^2 R_L$

20

No.

17/6/2019
Monday

* Root Mean squared value (rms)

$v(t) = \underbrace{V_m}_{\text{max value}} \cos(\omega t + \theta)$

dc $\cos/\sin = 0$

$x(t) = X_m \cos(\omega t + \theta)$

effective value $X_{eff} = X_{rms} =$ [redacted] $= \sqrt{\frac{1}{T}\int_0^T x^2(t)\, dt}$

for sinusoidal signal

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

find $V_{rms} = V_{eff}$

تكاملها (من زي كامله = صفر

$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V_m^2 \cos^2 \omega t\, dt} = \sqrt{\frac{V_m^2}{2T}\int_0^T (1 - \cos 2\omega t)\, dt}$

$= \sqrt{\frac{V_m^2}{2T}\, t \Big]_0^T}$

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

No.

ex: $v(t) = 10\cos(\omega t + 30^\circ)$ $i(t) = 8\cos(\omega t + 60^\circ)$

$v_{max} = 10$

$v_{rms} = \frac{10}{\sqrt{2}}$

* $P_{av} = 1/2\ V\ I^*$

مرافق التطاعل

V_m ع

* $P = 1/2\ V_m\ I_m\ \cos(\theta_v - \theta_i)$

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

$V_m = \sqrt{2} V_{rms}$

$= \cancel{0.5}(\sqrt{2}\,V_{rms}\,\sqrt{2}\,I_{rms}\,\cos(\theta_v - \theta_i))$

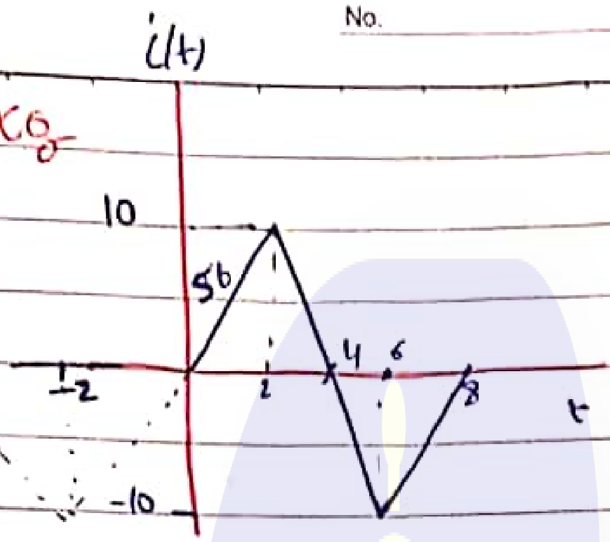
① $\boxed{P_{av} = V_{rms}\,I_{rms}\,\cos(\theta_v - \theta_i)}$

② $\boxed{P_{av} = V_{eff} * I_{eff}}$

22

No.

exo



$$i_{rms} = i_{eff} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt} = \sqrt{\frac{1}{8}\int_{-2}^{2} (5t)^2\,dt + \int_2^6 (-5t+20)^2\,dt}$$

$$= \sqrt{\frac{1}{8}\int_{-2}^{2} 25t^2\,dt + \int_2^6 25t^2 - 200t + 400\,dt}$$

$$= \sqrt{\frac{1}{8}\left(\left(\frac{25}{3}t^3\,dt\right)\Big]_{-2}^{2} + \left(\frac{25t^3}{3} + \frac{200t^2}{2} + 400t\right)\Big]_2^6\right)}$$

$= 5.77\,A$

$dc = 0$

Max values 10

$P_{av} = 1/2 \, V_m I_m \cos(\theta_v - \theta_i)$

$= 1/2 \, Re[V I^*]$

* Apparent power

$S = V_{eff} \, I_{eff}$ (VA)

$S = (1/2) V_m I_m$ (VA)

* reactive power

$Q = (1/2) V_m I_m \sin(\theta_v - \theta_i)$ (VAR)

$Q = I_{eff} V_{eff} \sin(\theta_v - \theta_i)$ (VAR)

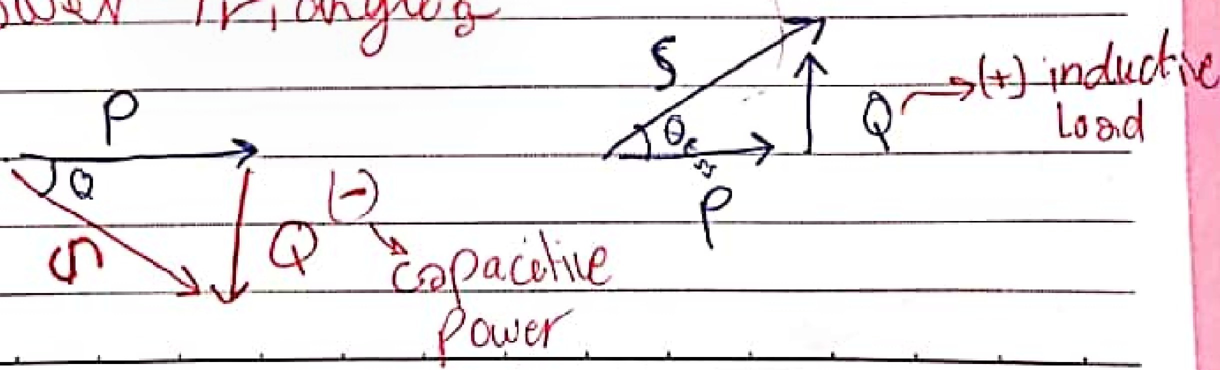
* complex power:-

average power

$S = P \mp jQ$ → reactive power = (VA)

Apparent power $|S|$

* power Triangle:



24

No.

* power factor: (pf)

$\cos(\theta_v - \theta_i) = \cos(\theta_z)$

↳ total

PF

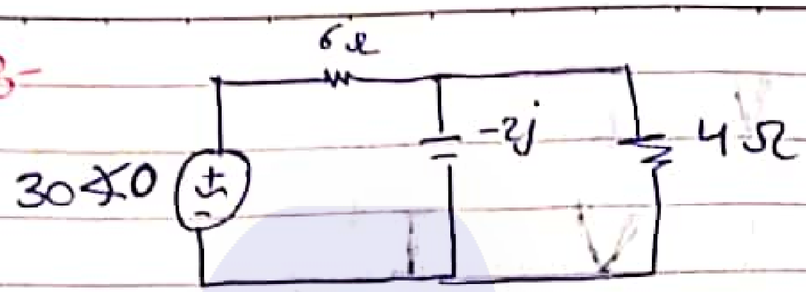
$\theta_z < 0$ Leading power factor (capacitive load)

$\boxed{\cos\theta = \frac{P}{S}}$ *

$\theta_z > 0$ Lagging power factor (inductive load).

$\theta_z = 0$ pure resistive load.

* exs-



p.f
$(0 \leq pf \leq 1)$

find p.f.

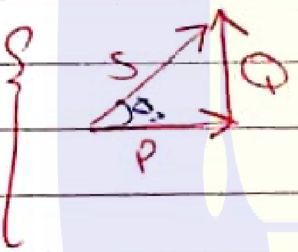
كل ما زاد p.f كل ما أحسن

$Z_{total} = (4 \parallel -2j) + 6$

$Z_T = 7 \angle -13.24$

power factor = $\cos(-13.24) = .9734$

leading



$P_{av} = |S| \cos \theta$

$Q = |S| \sin \theta$

$\ominus$ P_{avg} ما في (reactive power) L , C بتختص ب Q
L , C

L → (+), C → (-)

ما في rective power $\ominus$ risister و في P_{avg} في ...

No.

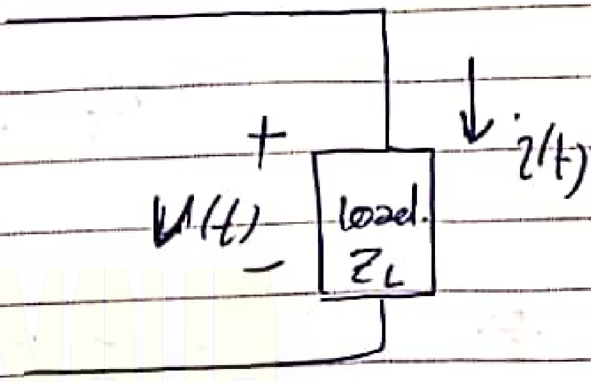
$$S = V_{rms} I^*_{rms}$$

$$= 1/2\, V_{max} I^*_{max}$$

27

No.

ex8-



$v(t) = 60\cos(\omega t - 10^\circ)$ $\quad 60\angle -10$

$i(t) = 1.5\cos(\omega t + 50^\circ)$ $\quad 1.5\angle 50$ $\quad I^* = 1.5\angle -5$

find S, appereant p, P, Q, P.F, Z

draw power tringle

Sol8- $V_{rms} = \frac{60}{\sqrt{2}} = 42.42$ V

$I_{rms} = \frac{1.5}{\sqrt{2}} = 1.06$ A

$S = V_{rms} I^*_{rms} = 42.42\angle -10 \quad 1.06\angle -50$

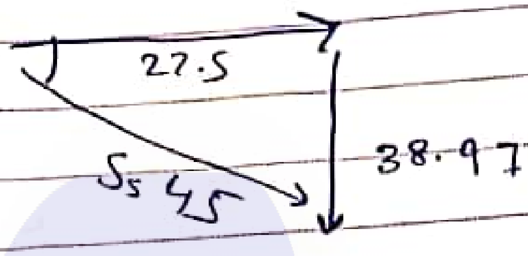
$= 45\angle -60$

$PF = \cos(-60) = 1/2$ leading

apperent power $= |S| = 45$ VA

$P_{av} = |S| \cos(-60) = 22.5$ W

$Q = |S| \sin(-60) = -38.97$ VAR



$$Z_s \frac{V}{I} , \frac{60 \measuredangle -10}{1.5 \measuredangle -60} s \; 40 \measuredangle -60$$

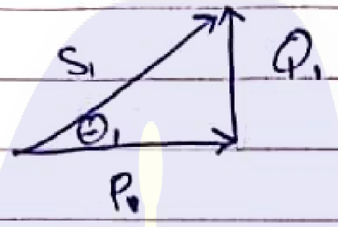
$$20 - j34.64\,\Omega$$

زاويه Z_{total} نفسها زاويه ال pf

$P_{ave} s \; 1/2 |I^2| R$

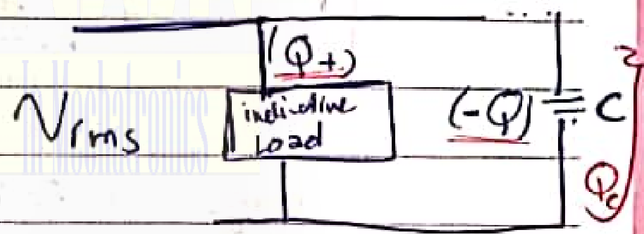
$Q s \; 1/2 (I^2) |I_m|^2$

* power factor correction :

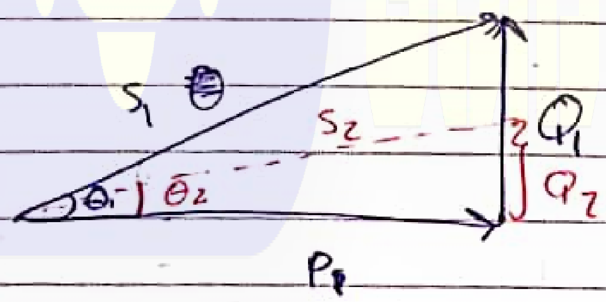


$P_1 = S_1 \cos\theta_1$

$Q_1 = S_1 \sin\theta_1$



* if we have an inductive load, we have to connected a C in parallel



$\tan\theta = \frac{Q}{P}$

$\tan\theta_1 = \frac{Q_1}{P}$

$\tan\theta_2 = \frac{Q_2}{P}$

$Q_c = Q_1 - Q_2$

$P = S_2 \cos\theta_2$

$\cancel{Q_c = Q_1 - Q_2}$

$Z_C = \frac{1}{j\omega C}$ impedance

$|Z_C| \to X_C = \frac{1}{\omega C}$ No. reactance

30

$Q_C = Q_1 - Q_2$ $\qquad P = \frac{V^2}{R}$

$Q_C = (P\tan\theta_1 - P\tan\theta_2)$ $\qquad Q = \frac{V_{rms}^2}{X_C}$

$\frac{V_{rms}^2}{1/\omega C} = P(\tan\theta_1 - \tan\theta_2)$

$\omega C V_{rms}^2 = P(\tan\theta_1 - \tan\theta_2)$

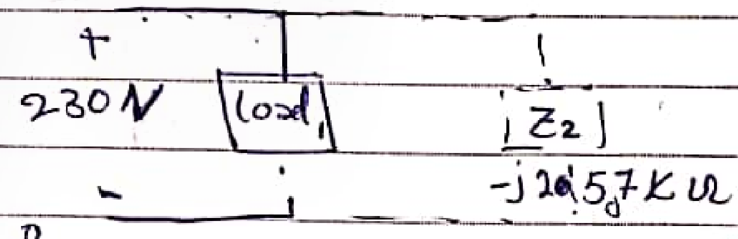
$$\boxed{C = \frac{P(\tan\theta_1 - \tan\theta_2)}{V_{rms}^2\ \omega}}$$

ex.:- $P = 50\ kW$, $p.f_{old} = (0.8)$ Lag (inductive) load

$V_{rms} = 230\ V$

$p.f_{new} = (0.95\ Lag)$

Sol



$\theta_1 = \cos^{-1} .8 = 36.9^\circ$

$\theta_2 = \cos^{-1} .95 = 18.19^\circ$

31

No.

$P = S_1 \cos \theta_1$

$|S_1| = \frac{P}{\cos\theta} = 62.5$

$S = 62.5 \measuredangle 36.9$ KVA

$Q_1 = S \sin\theta = 62.5 \sin(36.9) = 37.5$ KVA

$S_2 = \frac{P}{\cos\theta_2} = \frac{50}{\cos 18.9} = 52.6$ KVA

$Q_2 = S_2 \sin\theta_2 = 16.4$ KVA

$Q_c = 37.5 - 16.4 = 21.1$

capoit

$Q_c = \frac{V_{rm}^2}{|Z_c|} = Z_c = \frac{230^2}{21.1} = 2507.1$ KΩ

2.507 KΩ

32

واجب ارسمي

No.

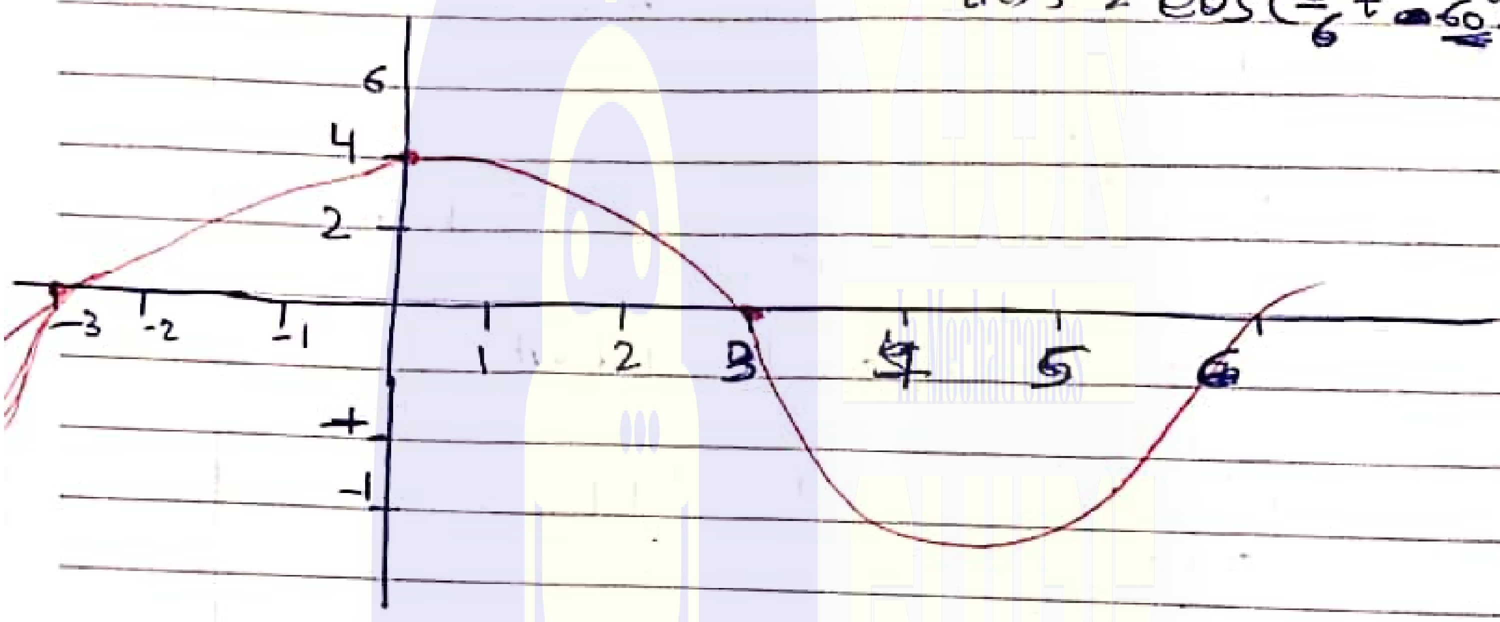
ex_8 سؤال امتحان

$$v = 4\cos\left(\frac{\pi}{6}t\right)$$

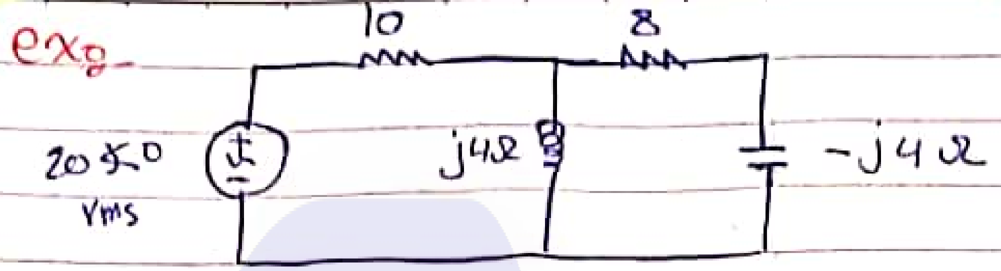
$$Z = 2\angle 60\ \Omega$$

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

$$i(t) = 2\cos\left(\frac{\pi}{6}t - 60^\circ\right)$$



ex:-



Find p.F?

Sol:- $Z_{total} = [-j4 + 8 // j4] + 10 = 12 + 4i$

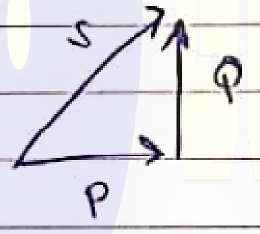
$12.64 \angle 18.4$

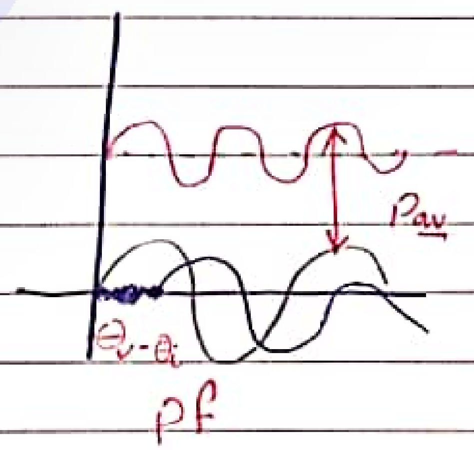
① $p.f = \cos(18.43) = 0.95$ Lag

② $I = \frac{V_s}{Z} = \frac{120 \angle 0}{12.64 \angle 18.43} = 9.48 \angle -18.43°$

$S = V I^* = 120 \angle 0 * 4.48 \angle 18.43°$ VA

$p = S \cos\theta$





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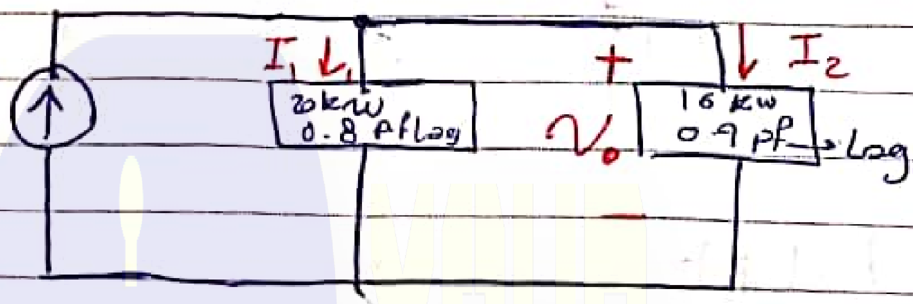
No.

ex:-

find V_o and input p.f

تحديد power source

$12\angle 0\ A$ rms



Sol

$$P = |I||V| \underbrace{(\cos(\theta_v - \theta_i))}_{p.f}$$

$$P_1 = I_1 V_o\, 0.8 = 20k$$

$$P_2 = I_2 V_o\, 0.9 = 16k$$

$$I_1 + I_2 = 12 \angle 0$$

I ← P بس أطلع V_o بقدر أطلع

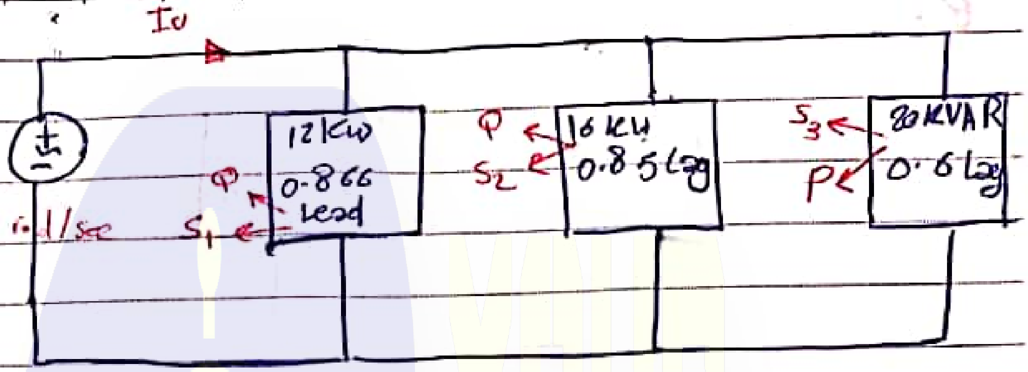
ex:-

Voltage source

S_T

$110\angle 0$

$\omega = 100$ rad/sec



Sol: $Z = R \pm jX$

$P = \frac{V^2}{R}$, $Q = \frac{V^2}{X}$

$S_1 = \frac{P_1}{\cos\theta} = \frac{12}{0.866} = 13.8\angle -\cos^{-1} 0.8$ $\boxed{S = 13.8\angle -30^\circ \text{ KVA}}$

$S_2 = 18.3 \angle +\cos^{-1} 0.8 \quad \boxed{S_2 = 18.8 \angle 31.7^\circ}$

$S_3 = \frac{Q}{\sin\theta}$ $\boxed{S_3 = 25\angle 53.1^\circ}$ $\quad Z = R + jX$

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

$\theta = \cos^{-1}(.6) = 53.1$

$S_T = S_1 + S_2 + S_3$

$48.7 \angle 28.09$ KVA

$= P + jQ$

P.F $= \cos(28.09) = 0.88$

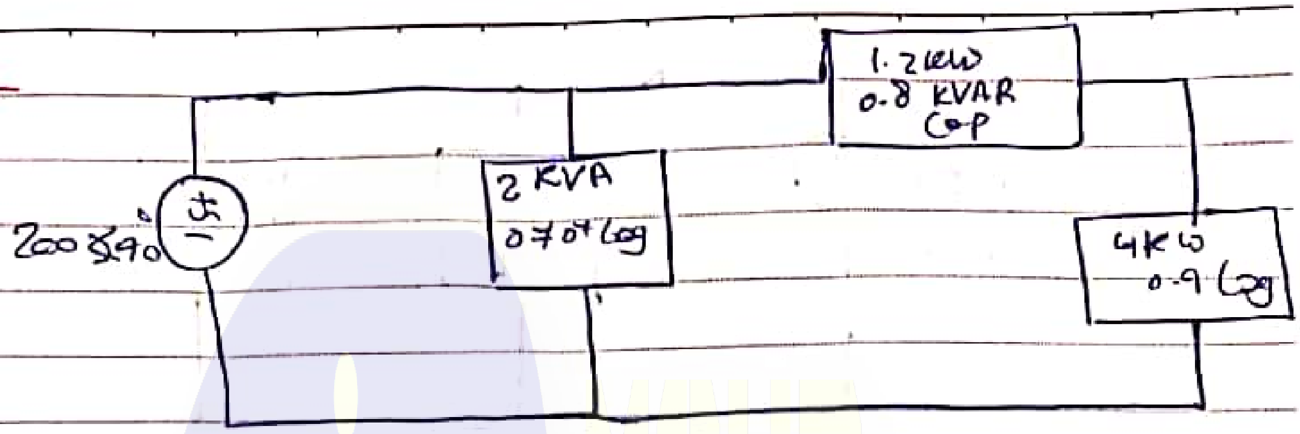
Let correct the P.F $\rightarrow 0.95$

$$C = \frac{P(\tan\theta_{old} - \tan\theta_{new})}{V_{rms}^2\,\omega}$$

No.

36

Q:-



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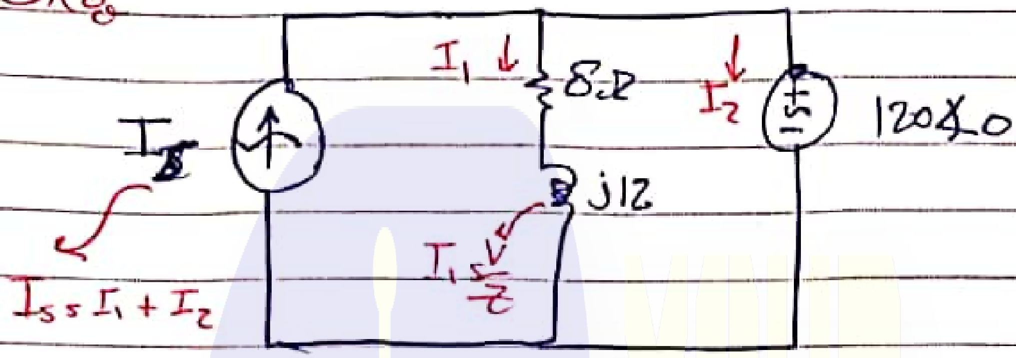
No.

ex:



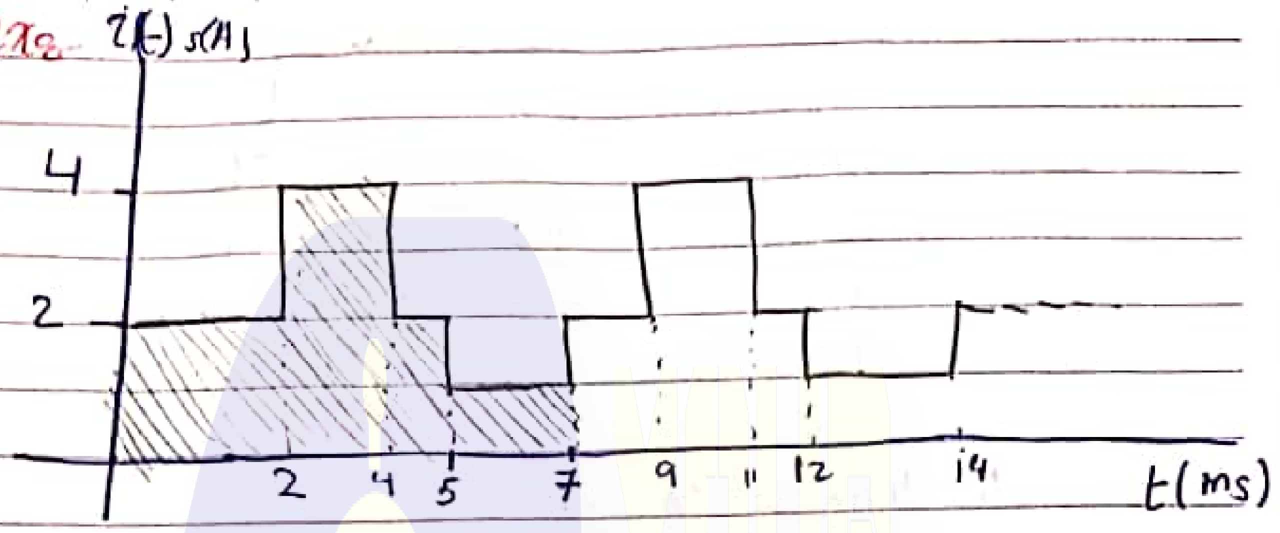
* 2.5 kW , 0.4 KVAR Loading

find I_s ?

$S = 2.5 + 0.4j$

$S = V I_2^*$

Monday 24/6/2019

ex: 

Find $T, f, \omega, I_{av}, I_{rms}$

sol:

$T = 7\,ms$

$f = \frac{1}{T} = \frac{1}{7} \times 10^{3}\ Hz$

$\omega = 2\pi f = \frac{2\pi}{7} \times 10^{-3}$ rad/sec

$I_{av} = \frac{1}{T}\int_0^T i(t)\,dt$ = Area under the curve.

$= \frac{(2\times2) + (2\times4) + (1\times2) + (2\times1)}{7}$

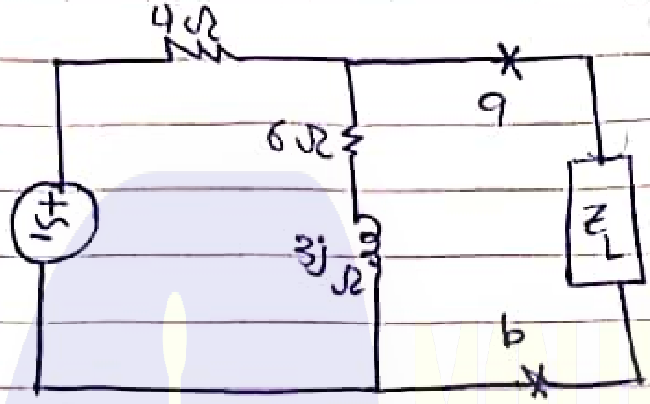
$= \frac{16}{7} = 2.28A$

$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt} = \sqrt{\frac{1}{7}\left(\int_0^2 2^2\,dt + \int_2^4 4^2\,dt + \int_4^5 2^2\,dt + \int_5^7 1^2\,dt\right)}$

(39)

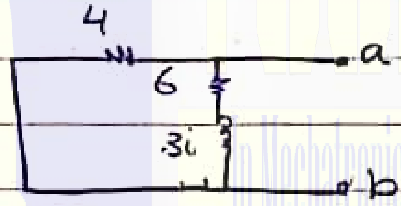
No.

ex :-



Find the thevenin equivalent &

Sol: $Z_{the} \rightarrow$

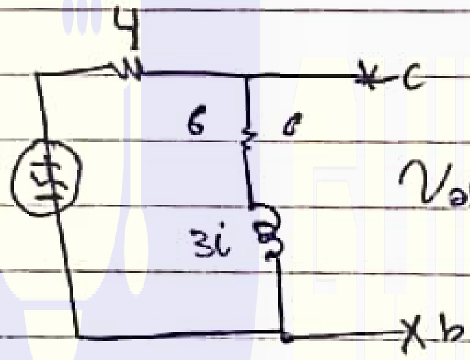


$Z_{th} = 4 \parallel (6+3j)$

$= \dfrac{24+12i}{10+j3}\ \Omega$

$= 2.57 \angle 9.86^\circ\ \Omega$

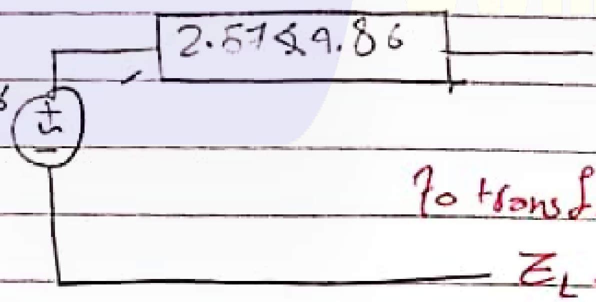
$10\angle 0$



$V_{ab} = V_{o.c} = V_{th} = \dfrac{10\angle 0 (6+3i)}{4+6+3i}$

$6.42 \angle 9.86$

$6.42\angle 9.86$



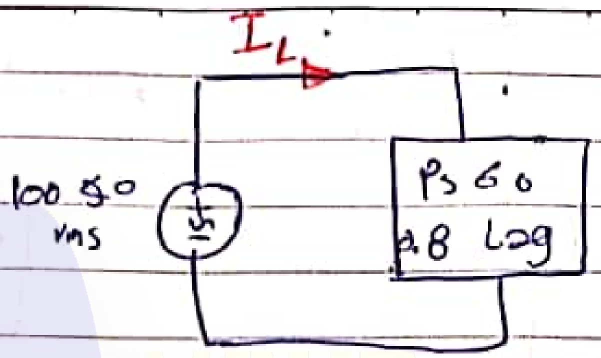
To transfer max power

$Z_L = Z_{th}^{*} = 2.57 \angle -9.86^\circ$

$P_{max} = \dfrac{|V_{th}|^2}{8R_L}$

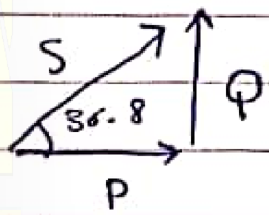
No.

ex:



how to Find I_L ?

sol:



$|S| = \frac{60}{0.8} = 75$

$S = 75\angle 36.8 = I^*_{rms} \, V^*_{rms}$

$75\angle 36.8 = 100\angle 0 \; I^*_{rms}$

$I^*_L = 0.75\angle 36.8^\circ$

$I_L = 0.75\angle -36.8^\circ$

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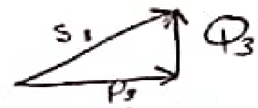
$S_1 = 100 + j200$

$223\angle 63.4$ VA



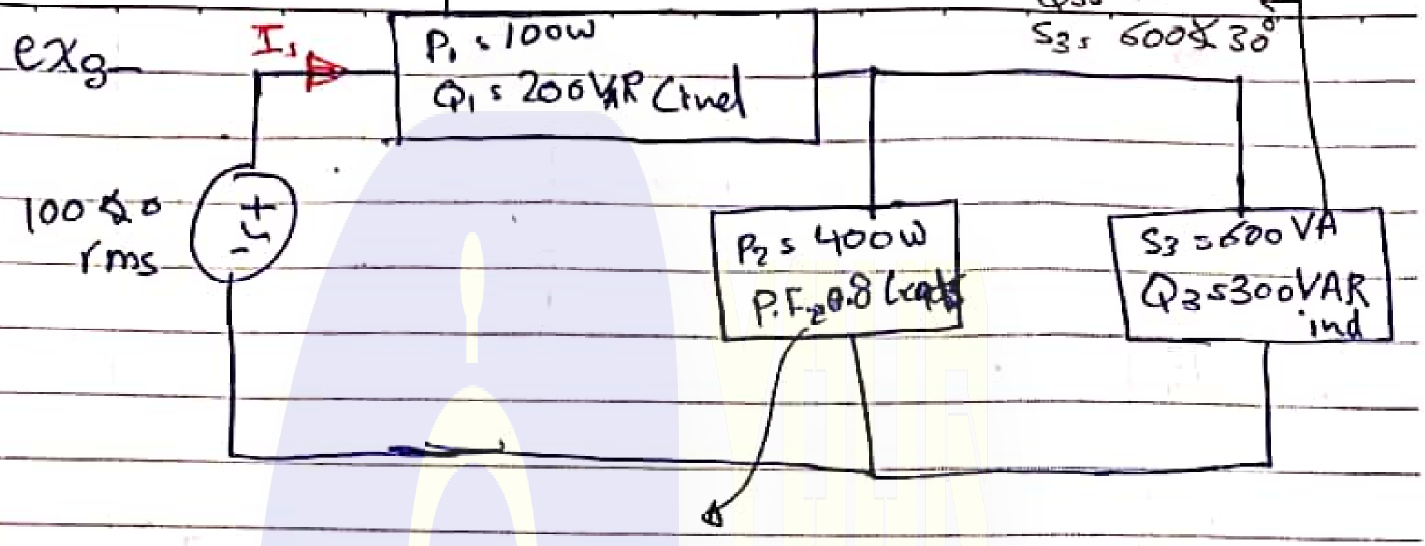
$\sin\theta_3 = \frac{Q}{S} = \frac{1}{2}$

$\theta_3 = 30^\circ$

$S_3 = 600\angle 30^\circ$

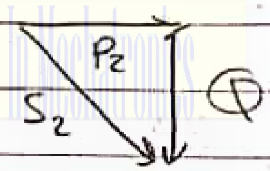
No.

ex:



Sol:

$\cos^{-1}(0.8) = 36.8 = S = \frac{P}{P.F} = 500\angle -36.8$ VA



$S_T = S_1 + S_2 + S_3 = 1039.6\angle 11.11$ VA

$S = V I_s^*$

$1039.6\angle 11.11 = 100\angle 0 \; I_s^*$

$I_s^* = 10.39\angle 11.11$ A

$\boxed{I_s} = 10.39\angle -11.11$ A

$P.F_{source} = \cos(11.11) = .981$ Lag

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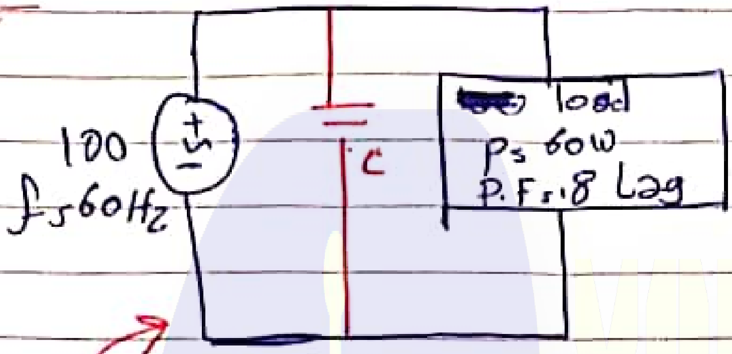
No.

Ex:



To correct the power factor to Be 0.9:
We add a capacitive load in parallel

Sol: $P = 0.5 I V \underbrace{\cos(\theta_v - \theta_i)}_{P.F}$

$60 = 0.5\, I\, (100)(0.8)$

$I = \frac{120}{80} = 1.5A$

$$C = \frac{P(\tan(\theta_{old}) - \tan(\theta_{new}))}{V_{rms}^2\, \omega}$$

$X_C = \frac{1}{\omega C}$

$I_C = \frac{V_C}{\frac{1}{j\omega C}} = \frac{100\angle 0}{\frac{1}{j\omega C}}$

$\theta_{old} = \cos(.8)$

$\theta_{new} = \cos(0.9)$

$P = 60$

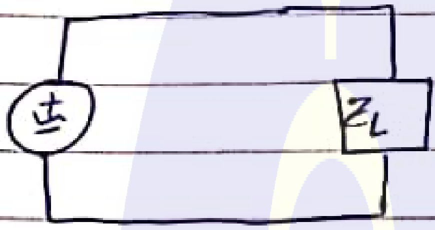
$\omega = 60(2\pi)$

$V_{rms} = \frac{100}{\sqrt{2}}\ V$

No. CHAPTER # 12

25/6/2019
Tuesday

CH # 12: Three-Phase-CKTs



one

source → load

Y → Y

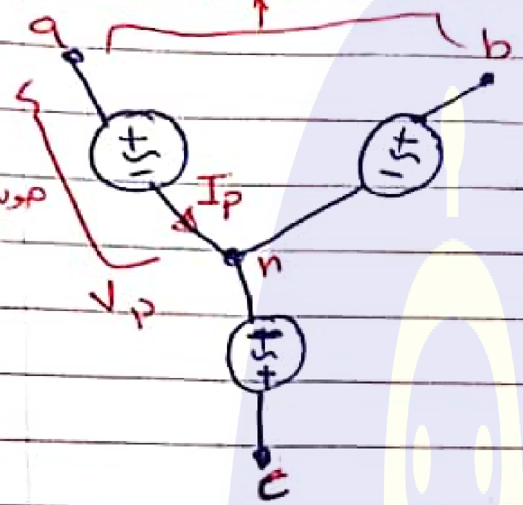
Δ → Δ

Y → Δ

Δ → Y

① Y → Y Connection

source $V_{ab} = V_{Line} = V_L$



هو نفسه عليه
وبينهم زاوية
120

$V_{an} = V_{phase} = V_p$

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

sequence phasor

Between A, B = $V_{ab} = V_{Line} = V_L$

Between A, n: $V_p = V_{phase}$

neutral

current passing = I_p

$\boxed{V_L = \sqrt{3}\, V_p}$

Sequence

Postive sequence

$V_{an} \angle 0$

$V_{bn} \angle \theta - 120^\circ$

$V_{cn} \angle \theta - 240^\circ$

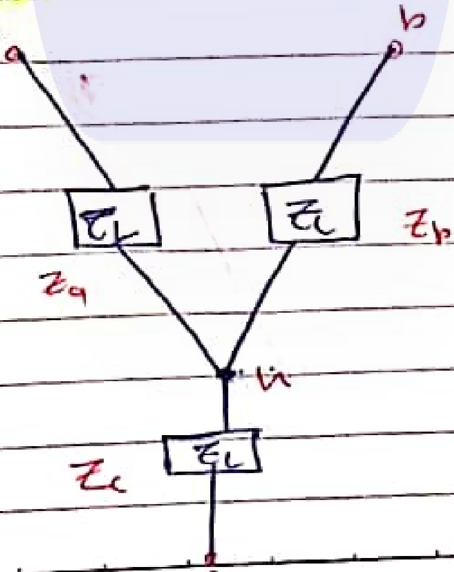
negative sequence

$V_{an} \angle \theta$

$V_{bn} \angle \theta + 120^\circ$

$V_{cn} \angle \theta + 240^\circ$

Load



دول متساوين
في القيمة والزاوية
في حالة
Balance.

Balanced Load

$Z_a = Z_b = Z_c$

Balanced system:

$(\vec{V}_{an} + \vec{V}_{bn} + \vec{V}_{cn}) = 0$

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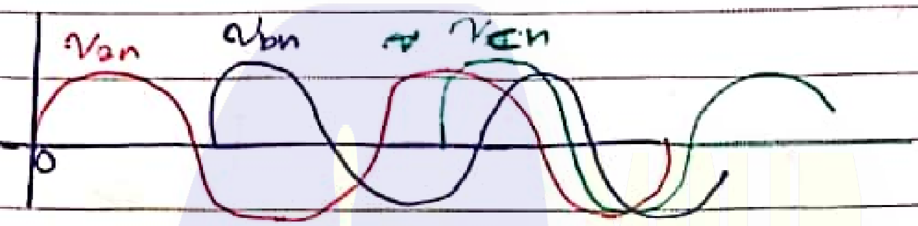
No.

$\boxed{Z_\Delta = 3 Z_y} \longrightarrow \boxed{Z_y = \frac{Z_\Delta}{3}}$



+ve

ex.- $V_{an} = 10 \angle 0$

$V_{bn} = 10 \angle -120$

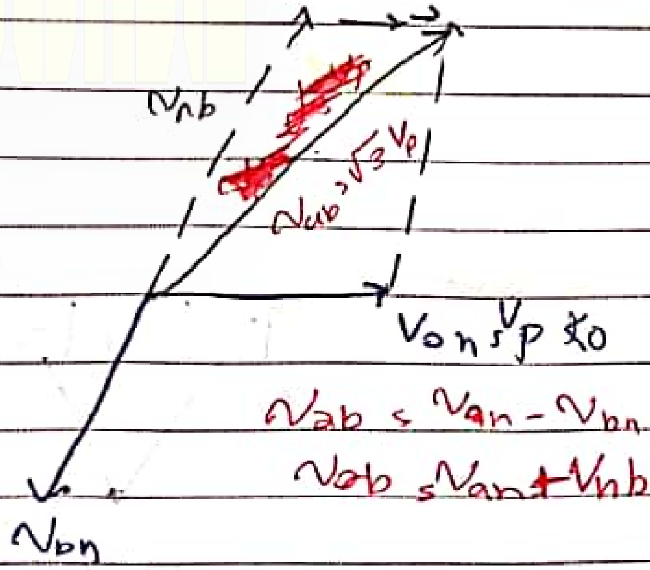
$V_{cn} = 10 \angle -240$

ex= Let +ve

$V_{an} = 10 \angle 135^\circ$

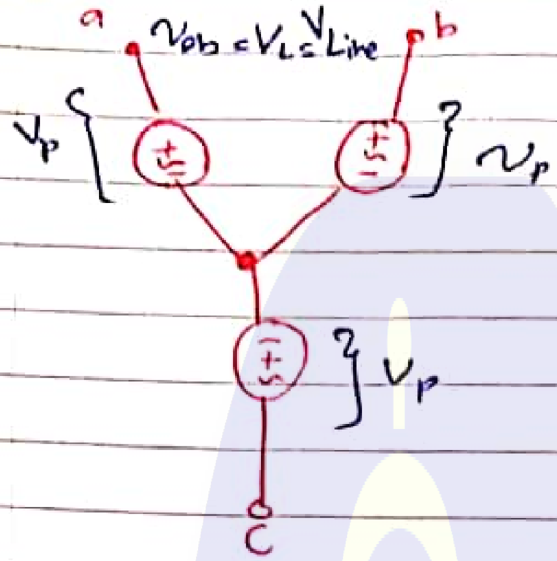
$V_{bn} = 10 \angle 15$

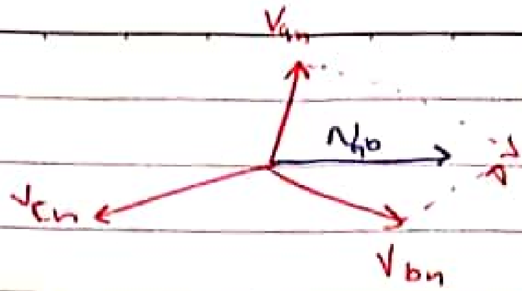
$V_{cn} = 10 \angle -105^\circ$



$V_{ab} = V_{an} - V_{bn}$

$V_{ab} = V_{an} + V_{nb}$





$v_{ab} = \sqrt{3}\, v_p$

$v_{ca} = \sqrt{3}\, V_p$

$v_{bc} = \sqrt{3}\, V_p$

$v_{ab} = \sqrt{3}\, V_p \angle 30+\theta$

ex: $V_{an} = 5 \angle 60$

sol: $V_{ab} = \sqrt{3}\ 5 \angle 90^\circ$

+ve = -12

ex: $V_{an} = 10 \angle 0$ $\quad V_{ab} = \sqrt{3}\ 10 \angle 30$

$V_{bn} = 10 \angle -120$ $\quad V_{bc} = \sqrt{3}\ 10 \angle -90$

$V_{cn} = 10 \angle -240$ $\quad V_{ca} = \sqrt{3}\ 10 \angle -21$

+30

-30

ex: $V_{an} = 5/\sqrt{3} \angle 150$ $\quad V_{ab} = 5 \angle 180$

$V_{bn} = 5/\sqrt{3} \angle 30$ $\quad V_{bc} = 5 \angle 60$

$V_{cn} = 5/\sqrt{3} \angle -90$ $\quad V_{ca}\ 5 \angle -60$

$Y \rightarrow Y$ $\quad I_L = I_p$

$V_L = \sqrt{3}\, V_p$

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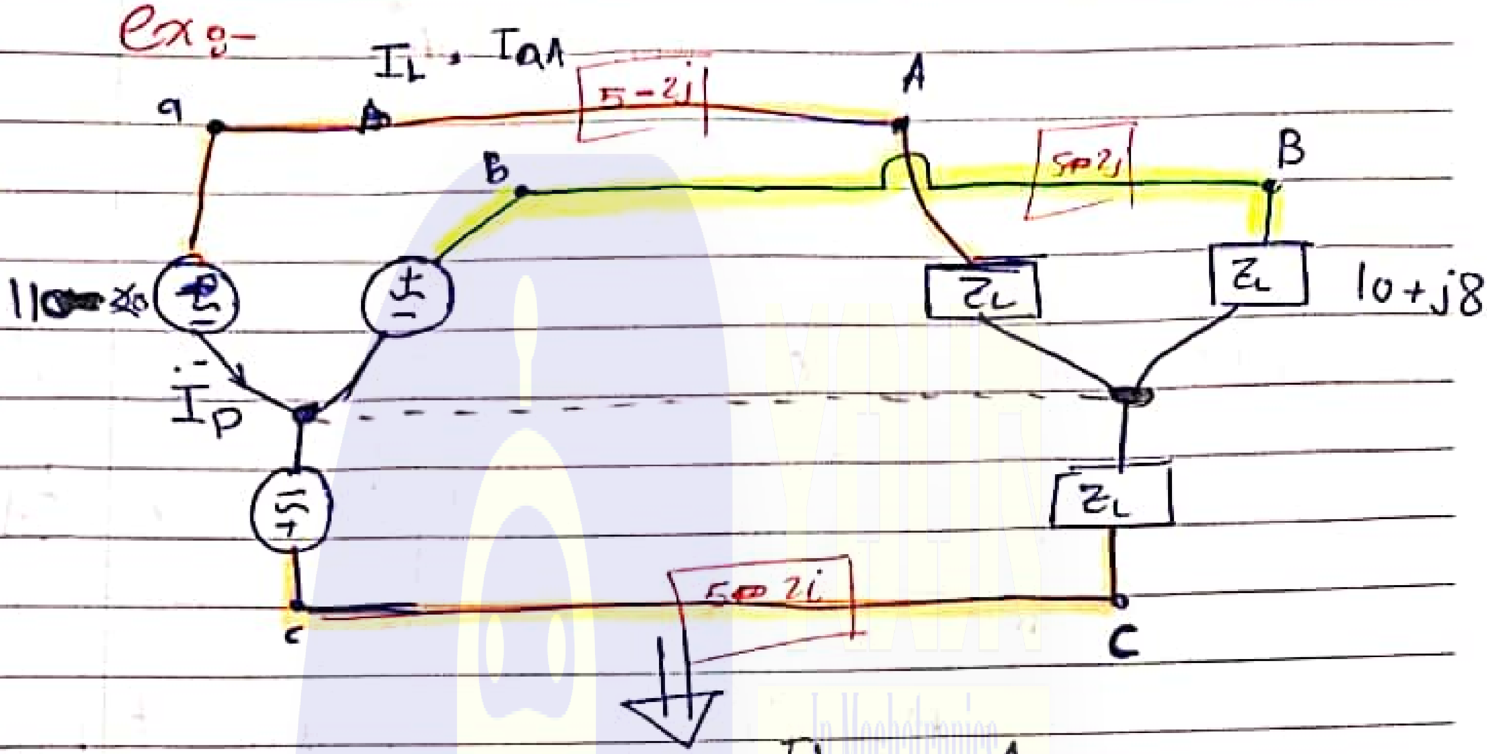
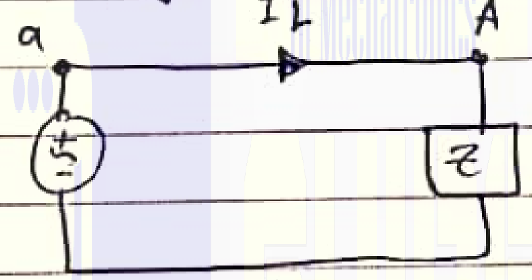
No.

ex:-





Y−Y $\quad I_L = I_p$

$V_L = \sqrt{3}\, V_p$

$I_{aA} = |I| \angle \theta$

$I_{bB} = |I| \angle \theta - 120^\circ$

$I_{cC} = |I| \angle \theta - 240^\circ$

لو مضافة $5-2i$ مع كل لاينات

$aA,\ bB,\ cC$

$I_{aA} = \dfrac{V_{an}}{Z_{line} + Z_{Load}}$

$I_{aA} = \dfrac{100\angle 0}{10+j8} = 8.6\angle -38.6A$

$I_{bB} = 8.6\angle -158.6A$

$I_{cC} = 8.6\angle -278.6A$

$= \dfrac{100\angle 0}{5-2i+10+8i}$

$I_{aA} + I_{bB} + I_{C} = 0 = I_{nN}$ $\quad 6.8\angle -21.8^\circ$

smile

45

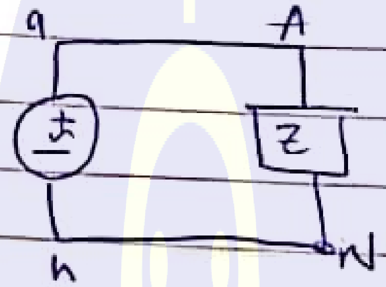
No.

(1) power per Phase $= S = V I^*$

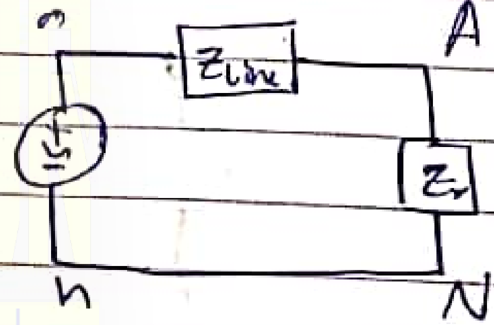
$= V_{AN} \times I_{aA}^*$

$1100\angle 0 \times (8.6 \angle 38.6) VA$

Note



$V_{an} = V_{AN}$

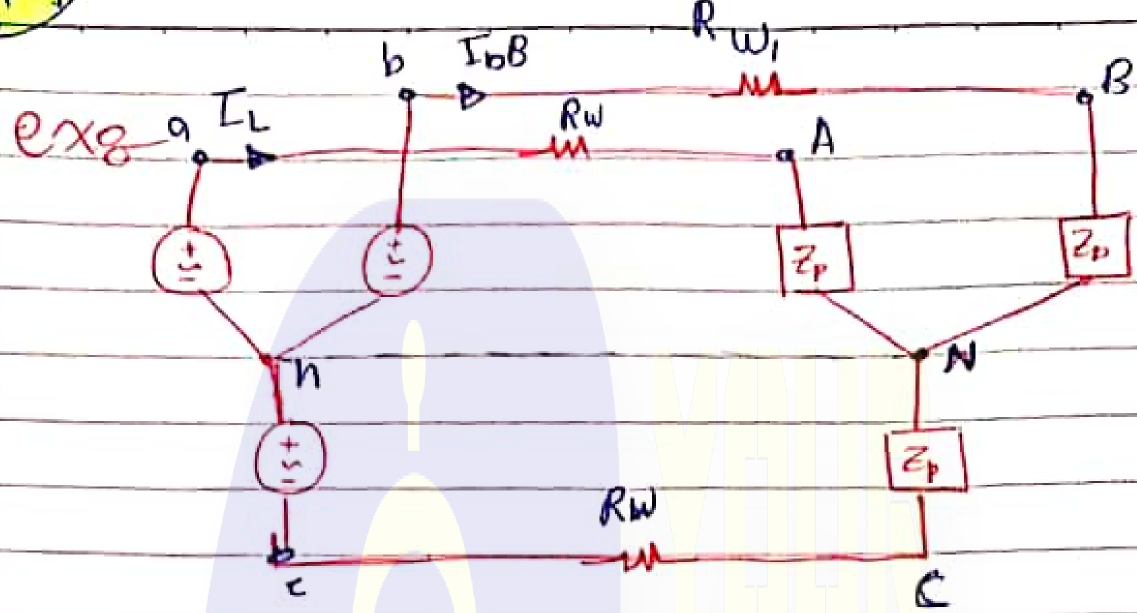


$V_{AN} \neq V_{an}$

49

No.

exa 8



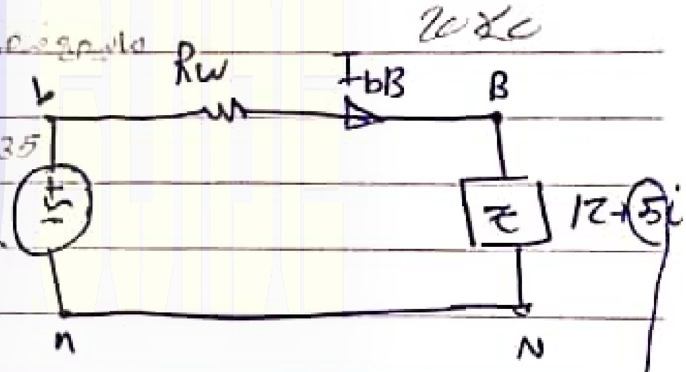
$Z_p = 12 + 5i\ \Omega$

$I_{bB_{rms}} = 20 \angle 0\ A$

$P.F = 0.935$ from source.

Find: R_w, V_{bn}, $V_{AB} - V_T$

Sol:-

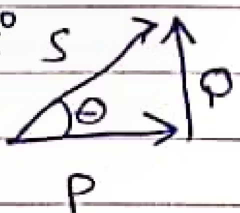


$-V_{bn} + I_{bB} R_w + I_{bB}(12+5i) = 0$

$V_{BN} = I_{bB} Z_p$

$V_{AN} = I_{an} Z_p$ $\rightarrow$ $V_{AB} = V_{An} - V_{BN}$

① $= \cos^{-1}(0.935) = 20.7^\circ$



$\tan\theta = 0.37 = \frac{Q}{P}$

$\frac{|I|^2 (X_L)}{P}$

$P = \frac{20^2\, 5}{0.37} = 5405\ W$

$P = I^2 (R_w + 12)$

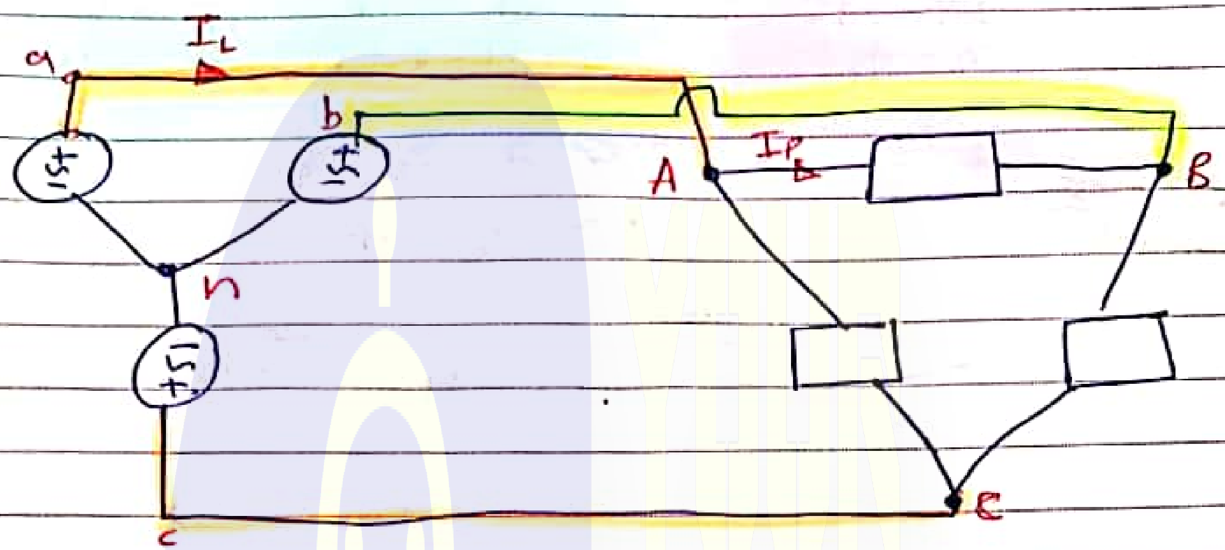
$R_w = 1.5\ \Omega$

No.

لازم أضربها بـ 3_3 < 1 S_T

S1 No. wednesday 26/6/2019

Y → Δ connection



$I_L \neq I_p$

$V_L = V_p$

(1) $I_p = |I_{AB}| = |I_{BC}| = |I_{CA}|$

(2) $V_{ab} = V_{AB}$ = (ideal trans line)

لــ بعني مابي مقاومة على الوايرات

$I_{aA} = I_{AB} - I_{CA}$

$I_{AB} = \frac{V_{AB}}{Z_p}$

exe- V_{an} 200∡60, $S_p = 2 - j$ KVA,
find V_{BC}, Z_p, $I_{aA} = I_L$?

sol

$V_{an} = 200∡60$ → $V_{ab} = \sqrt{3}\ 200∡90$

$V_{bn} = 200∡-60°$, $V_{bc} \sqrt{3}\ 200∡-30 = V_{BC}$

$V_{cn} = 200∡-180°$ $V_{CA} = \sqrt{3}\ 200∡-150$ ideal

$V_{AB} = V_{ab}$ → $V_{BC} = V_{BC}$ → $V_{CA} = V_{CA}$

$S_P = V_P \cdot I_{AB}^*$

smile for life

52

No.

$Y \to \Delta$

$I_L \neq I_p$

$V_L = V_p$

$Y \to Y$

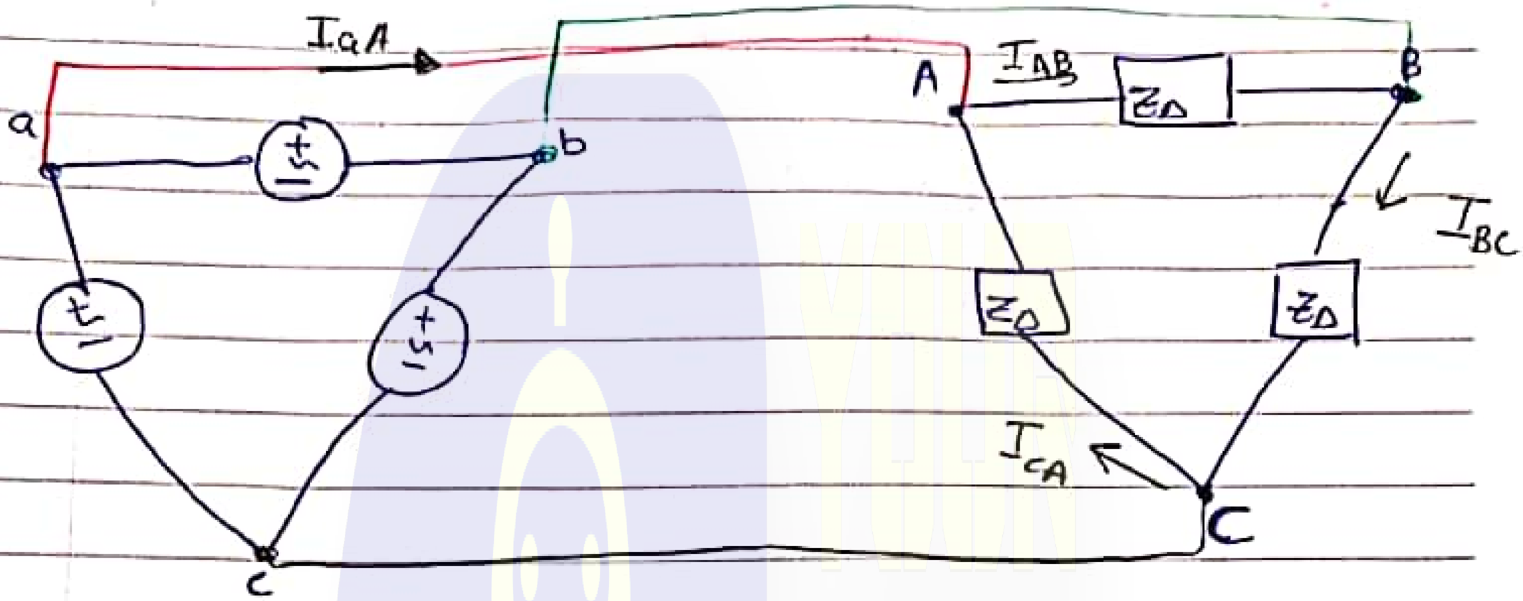
$I_L = I_p$

$V_L = \sqrt{3}\ V_p$

No.

Sunday
30/6/2019

$\Delta \rightarrow \Delta$ Connection



* $I_{AB} = \dfrac{V_{AB}}{Z_\Delta} = \dfrac{V_{ab}}{Z_\Delta}$

* $I_{aA} = I_{AB} - I_{CA} = \sqrt{3}\, I_p$

54

No.

Tabulations

Ex: $Z_\Delta = 20 - j15$, $V_{ab} = 330 \angle 0\ V$
calculate the phase current & the line current

Sol, $I_{AB} = \frac{V_{ab}}{Z_\Delta} = \frac{330 \angle 0}{20 - j15} = 13.2 \angle 36.8\ A$

$I_{BC} = 13.2 \angle -83.2\ A$

$I_L = \sqrt{3}\, I_P$

$I_{CA} = 13.2 \angle -203.2\ A$

$I_{aA} = I_{AB} - I_{CA} = 22.6 \angle 6.87\ A$

OR $\sqrt{3}\,(I_{AB}) \angle \theta - 30^\circ$

you can't use them if it wasn't a balanced load.

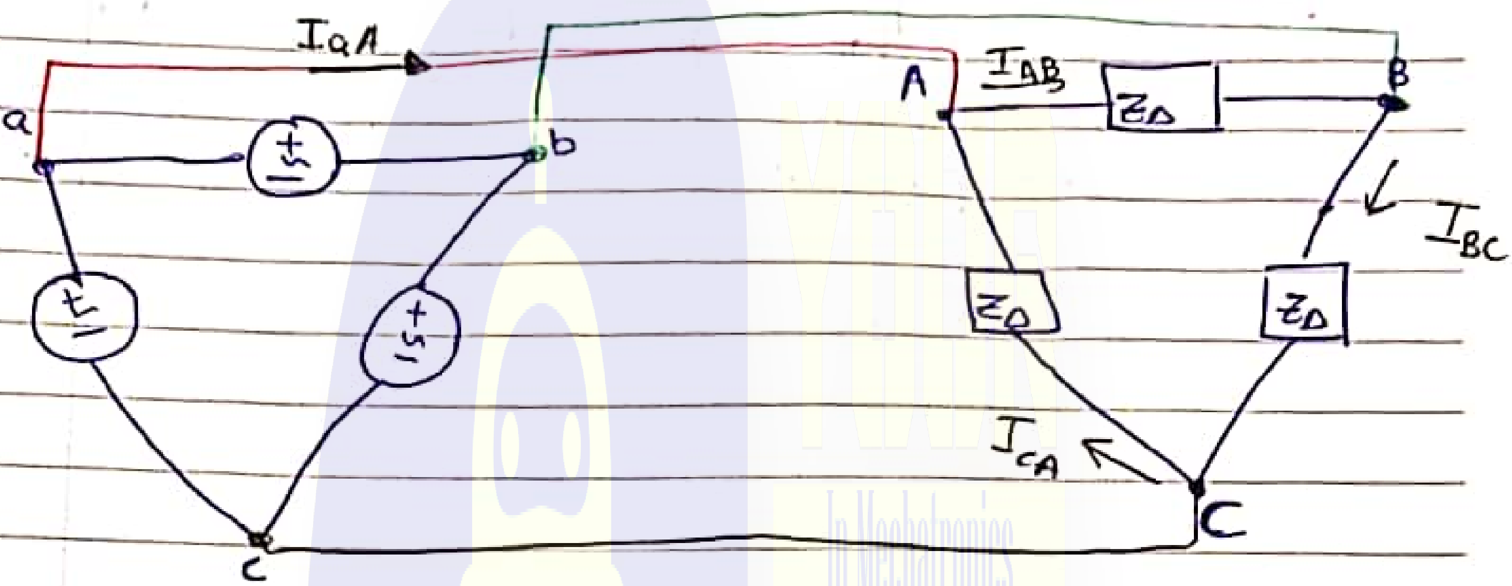
$I_{bB} = \sqrt{3}\ I_{BC} \angle \theta - 3$

$S_P = 0.5\ V_{AB}\ I_{AB}^*$

No.

Sunday
30/6/2019

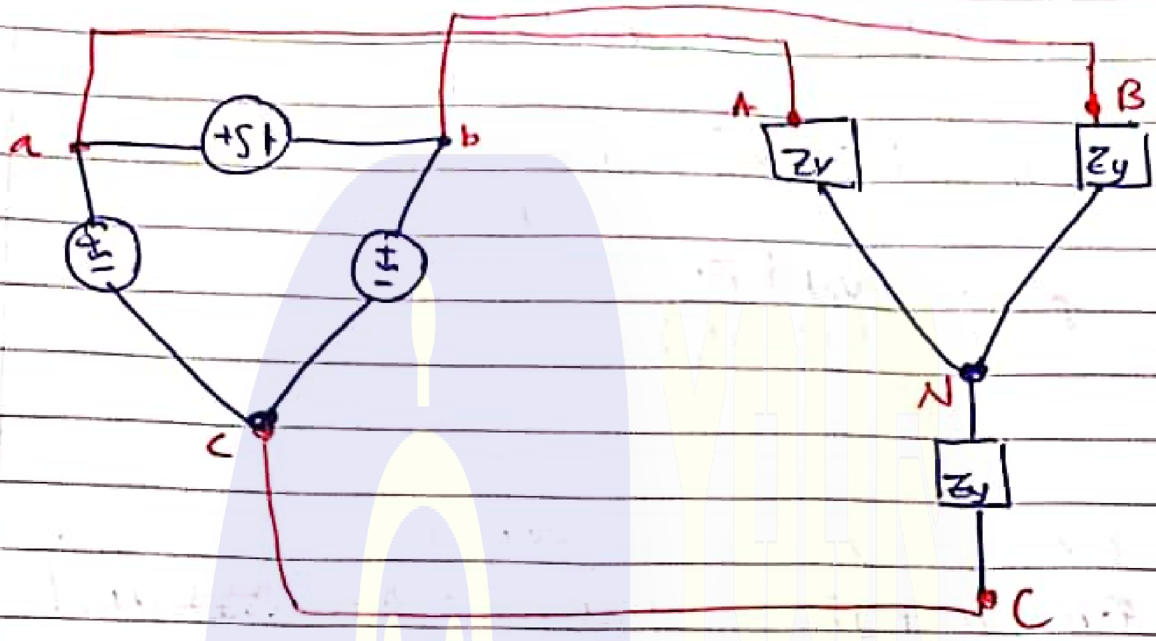
$\Delta \rightarrow \Delta$ Connection



* $I_{AB} = \dfrac{V_{AB}}{Z_\Delta} = \dfrac{V_{ab}}{Z_\Delta}$

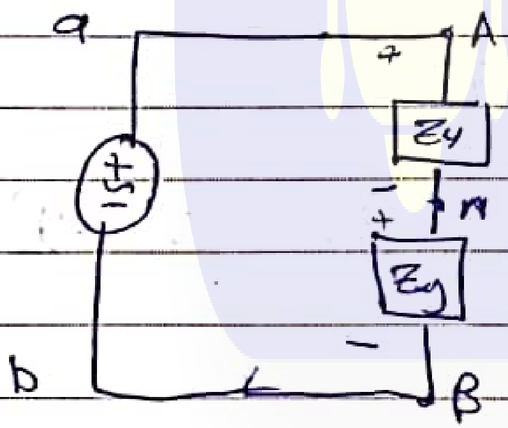
* $I_{aA} = I_{AB} - I_{CA} = \sqrt{3}\, I_P$

Δ → Y connection



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

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



$-V_{ab} + I_{AN} Z_y - I_{BN} Z_y = 0$

$Z_y (I_{aA} - I_{bB}) = V_{ab}$

$\hookrightarrow I_{aA} - I_{bB} = \frac{V_{ab}}{Z_y}$

$I_{aA} = K \angle 0 = K$

$I_{bB} = K \angle -120.$

$K \cos(-120) + jK \sin(-120)$

$0.5K - j\frac{\sqrt{3}}{2}K$

$= \frac{-K}{2}(1 + j\sqrt{3})$

$= I_{aA}(1 + j\sqrt{3})$

No.

$$I_a - \left(-\frac{I_a}{2}(1+j\sqrt{3})\right) = \frac{V_{ab}}{Z_y}$$

$$I_{aA}\left(1.5+j\frac{\sqrt{3}}{2}\right) = \frac{V_{ab}}{Z_y}$$

$$\therefore I_{aA} = \frac{V_{ab} / Z_y}{(1.5+j\frac{\sqrt{3}}{2})}$$

ex: $\Delta \to y$ لو اذا أعطى V بدون زاوية نجعلها صفر

$Z_y = 40 + j25$ $V_{ab} = 210 \angle 0$ ~~V_{ab}~~, find I_{aA}?

Sol

~~$V_{an} = \frac{210 \angle 0}{\sqrt{3}}$~~ $V_{an} = \frac{210}{\sqrt{3}} \angle 0-30$

$V_{an} = 121.2 \angle -30$

$I_{aA} = \frac{121.2 \angle -30}{40+j25} = 2.57 \angle -62^\circ A$

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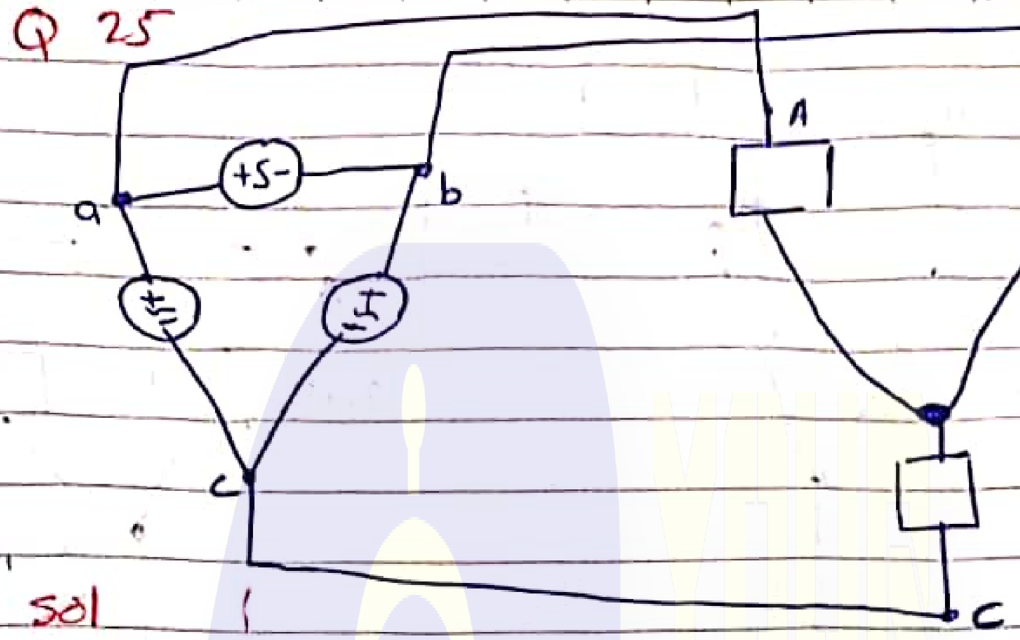
No.

Monday
1/7/2019

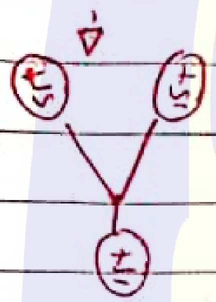
Q 25



$Z_y = 10-8j$

$V_{ab} = 440\angle$

sol



$V_{an} = \frac{440}{\sqrt{3}} \angle -20$

$I_{aA} = \frac{V_{an}}{Z_{AN}} = \frac{440/\sqrt{3} \angle -20}{10-j8} = 19.8\angle 18.$

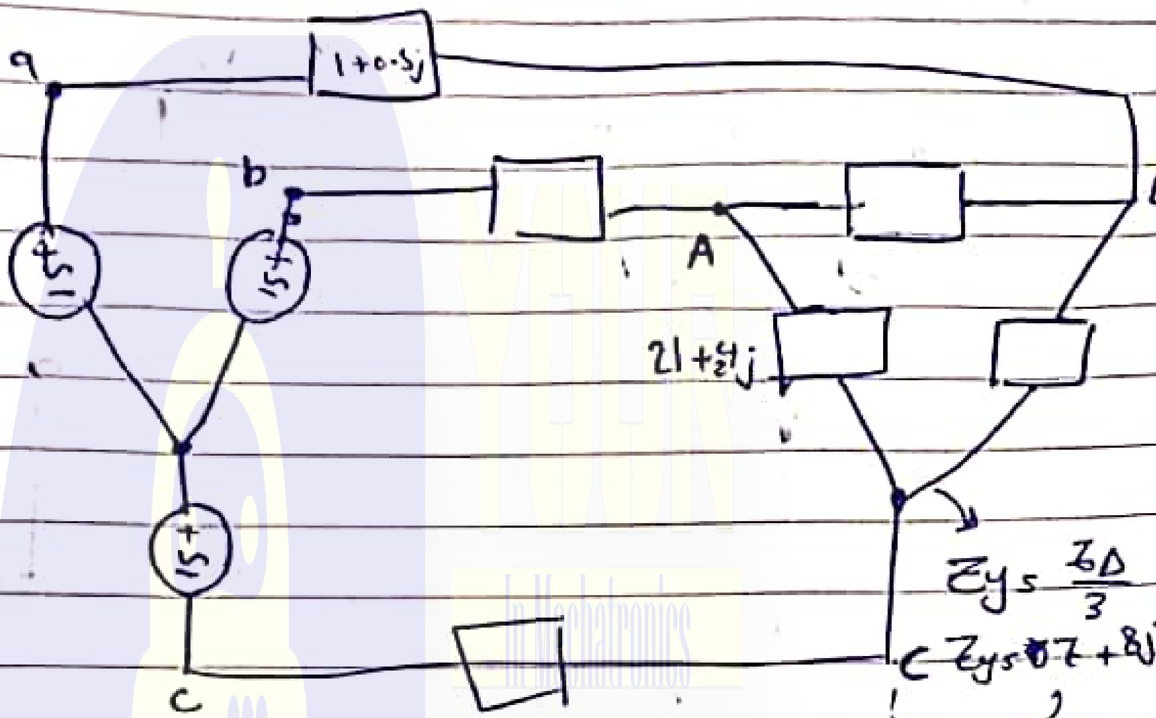
$I_{bB} = 19.8 \angle 10.35$

if there was a line imp that is equal to $3+2j$ in each line.

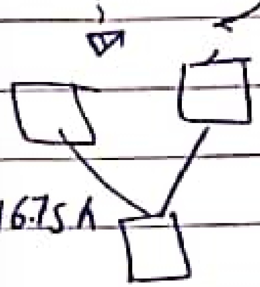
sol. $I_{aA} = \frac{440\angle -20}{3+j2} = 177 \angle 4.68.$

(59) No.

Q 40.



$V_{an} = 100\angle 0$ rms



Sol: $I_{aA} = \dfrac{100\angle 0}{1+0.5j + 7 + j8} = 8.56\angle -46.75\,A$

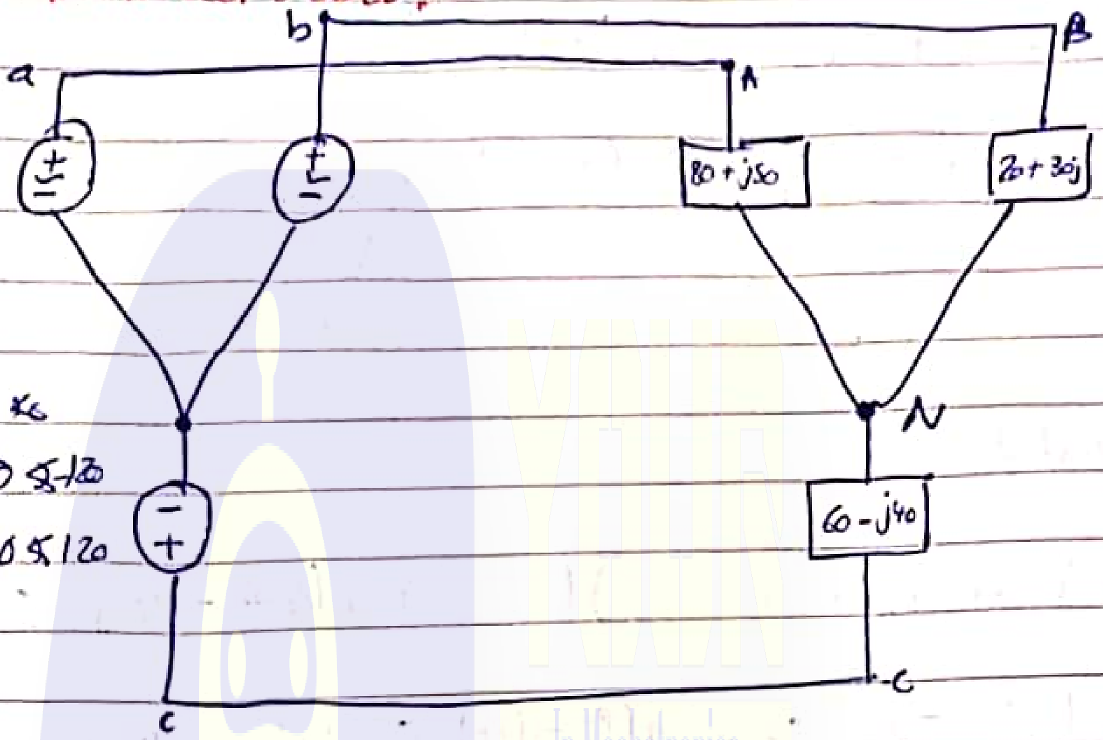
Find the average power abosorbed by the load? | $S_p = V I_{aA}^*$

$S_T = 3 V I_{aA}^*$

$P_{av} = |I_{aA}|^2 R_L \times 3$ for load

Unbalanced Load :-

ex:



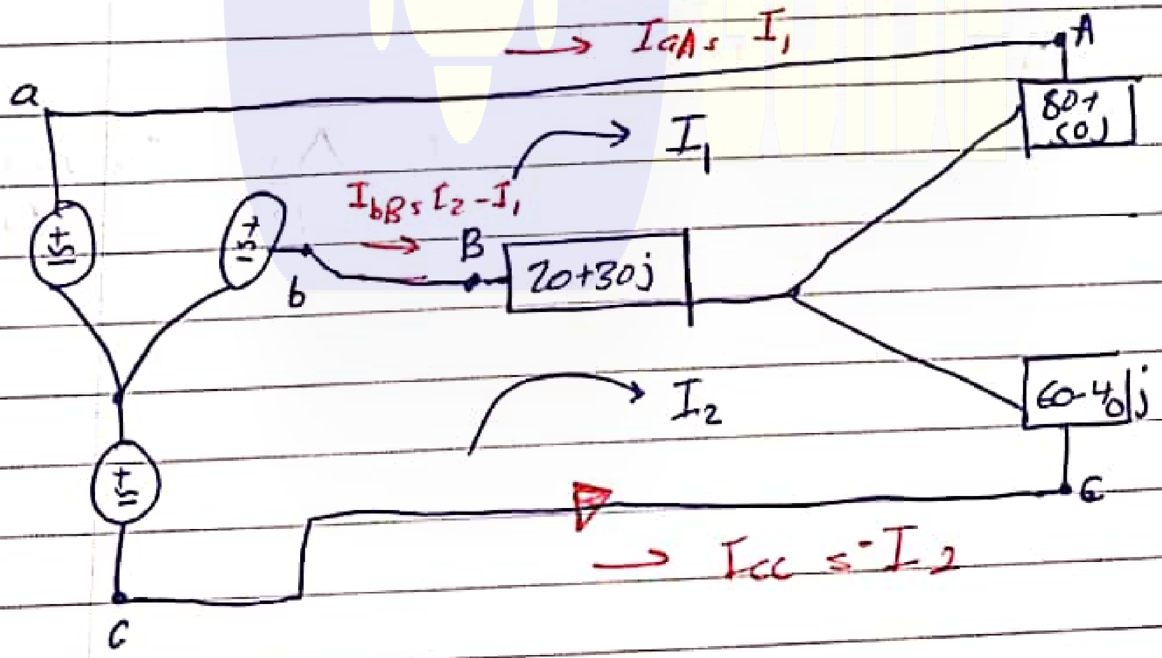
$V_{an} = 110 \angle 0$

$V_{bn} = 110 \angle -120$

$V_{cn} = 110 \angle 120$

Ac الرسمة

after mesh



(61)

No.

mesh 1

$V_{bn} - V_{an} + I_1(80+50j)(20+j20)(I_1 - I_2) = 0$

$(100+j80)\, I_1 - I_2(20+30) = V_{an} - V_{bn}$

$= V_{ab}$

$165 + j95.263$

mesh 2

$V_{cn} + V_{bn} + (20+30j)(I_2 - I_1) + (60+(-40j))\, I_2 = 0$

$(-20 - j30)I_1 + (80 - j10)\, I_2 = V_{bc} = 110\angle -120 - 110\angle 120$

$190.5\, j$

$\Delta = \begin{bmatrix} 100+j80 & -20-j30 \\ -20-30j & 80-j10 \end{bmatrix}$

$\Delta_1 = \begin{bmatrix} 165+j95.263 & -20-j30 \\ -j190.5 & 80-j10 \end{bmatrix}$

Δ_2 :

$I_1 = \dfrac{\Delta_1}{\Delta} \qquad I = \dfrac{\Delta_2}{\Delta}$

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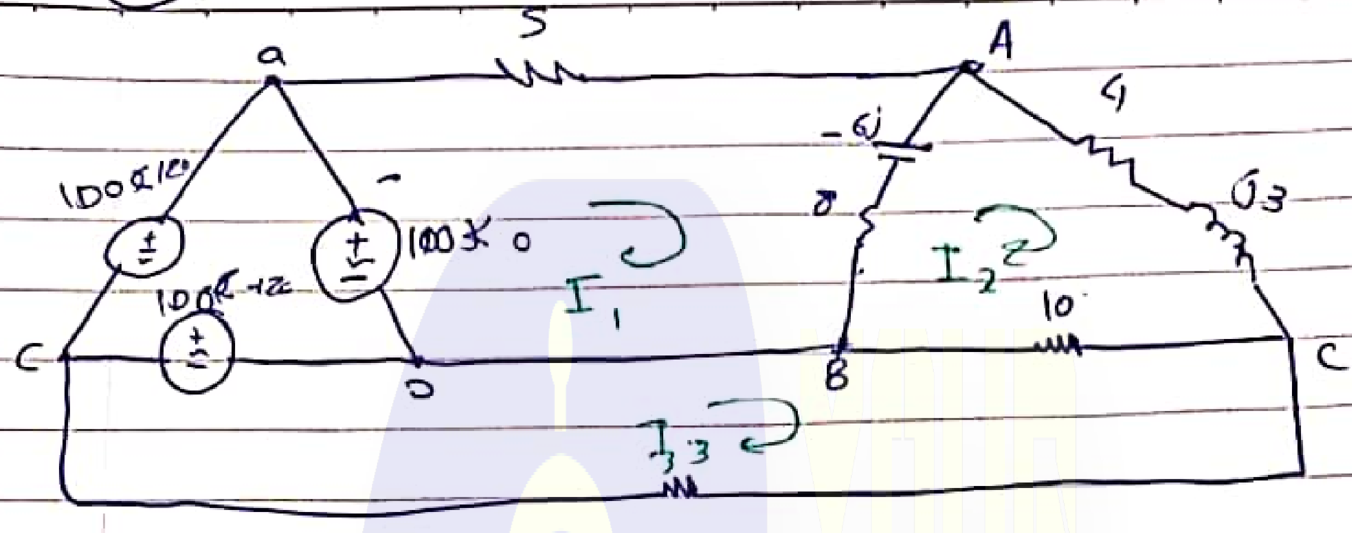
No.



Mesh 1, 2, 3, I_1, I_2, I_3

$I_2 = -I_{CA}$

$I_1 - I_2 = I_{AB}$

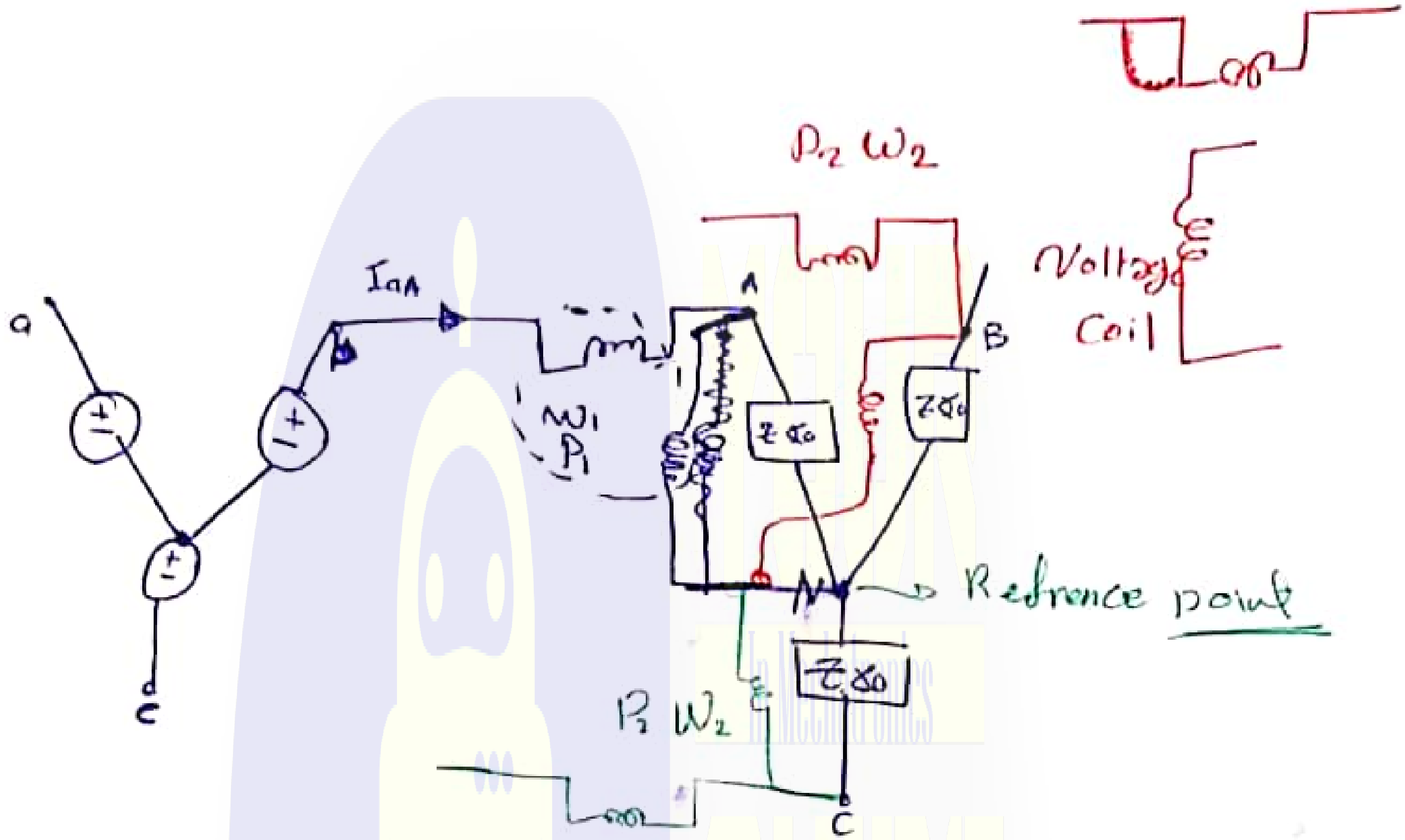
$I_3 - I_2 = I_{BC}$

CH11 +Y→Y & Y→Δ | exam 7/7 63

Tuesday 2/7/2014

Watt meter (Average Power)

Current coil



$$P_T = P_1 + P_2 + P_3$$

$$P_1 = P_2 = P_3 = V_p I_p \cos(\theta_v - \theta_i)$$

$$= \frac{V_L}{\sqrt{3}} I_p \cos(\theta_v - \theta_i)$$

$$= 3 I_p \frac{V_L}{\sqrt{3}} \cos \underbrace{(\theta_v - \theta_i)}_{\theta_z}$$

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

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

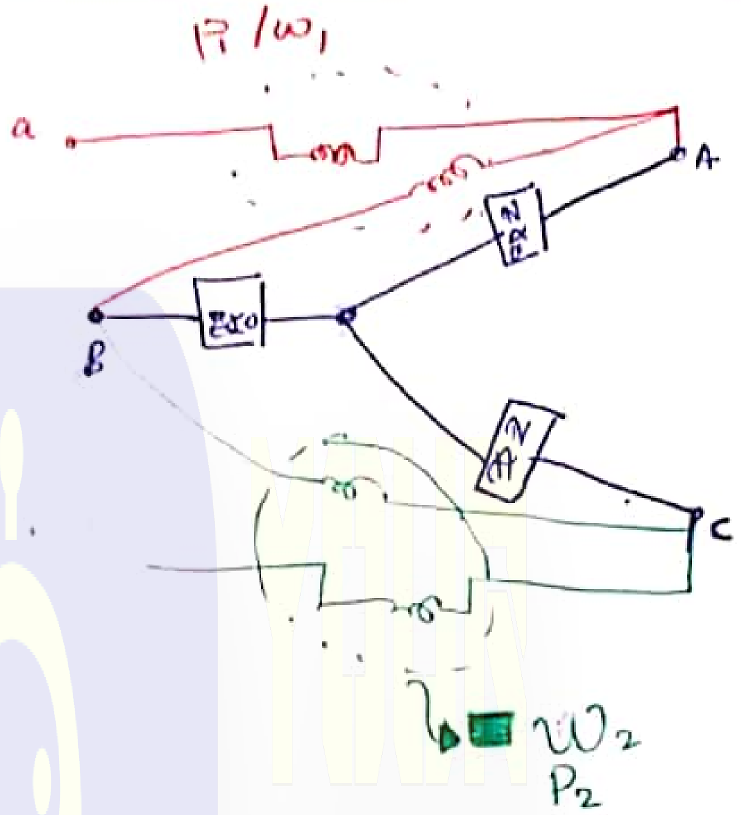
If we use 2 Wattmeters

الواطاتين

180

BC / CB

180 shifted



$P_T = P_1 + P_2$

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

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

$V_{ab} = V_L \angle 30$

$V_{bc} = V_L \angle -90$

$V_{ca} = V_L \angle -210$

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

$P_T = V_L I_L (2 \underbrace{\cos 30}_{\sqrt{3}/2} \cos\theta)$

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

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

$P_T = V_L I_L \cos\theta$

رح تساوي نفس الـ ٣

Wattmeter3

N Ref. 1Ø

For Two Wattmeter

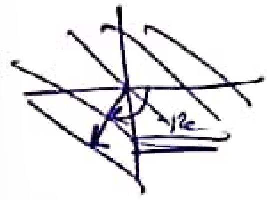
1. $P_T = P_1 + P_2$
2. $Q = \sqrt{3}(P_2 - P_1)$
3. $S_T = \sqrt{P_T^2 + Q_T^2}$
4. $\tan\theta = \frac{Q_T}{P_T} = \sqrt{3}\,\frac{P_2 - P_1}{P_2 + P}$

$Z_\theta = \frac{V_{ab}}{I_{aA}}$

$I = \frac{V_{ab}}{Z\theta}$

[illegible] $(30 - \theta)$

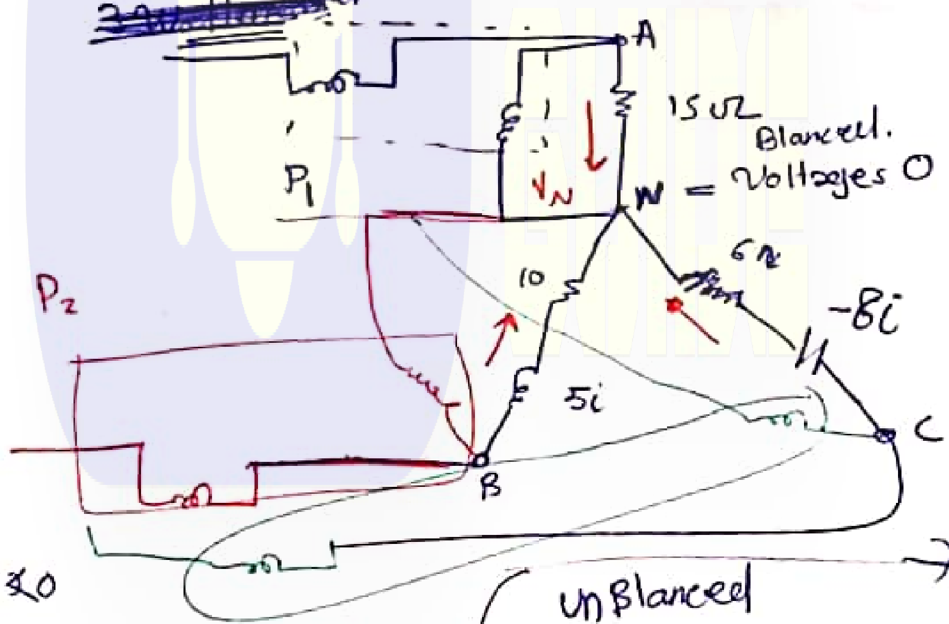
if	$P_1 = P_2$	~~Res~~ Resistive load
	$P_2 > P_1$	Inductive load
	$P_2 < P_1$	Capacitive load



3 Wattmeter

~~3 Wattmeter~~

exg 12.13



Balanced. Voltages 0

$V_{AN} = 100 \angle 0$

$V_{BN} = 100 \angle 120$

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

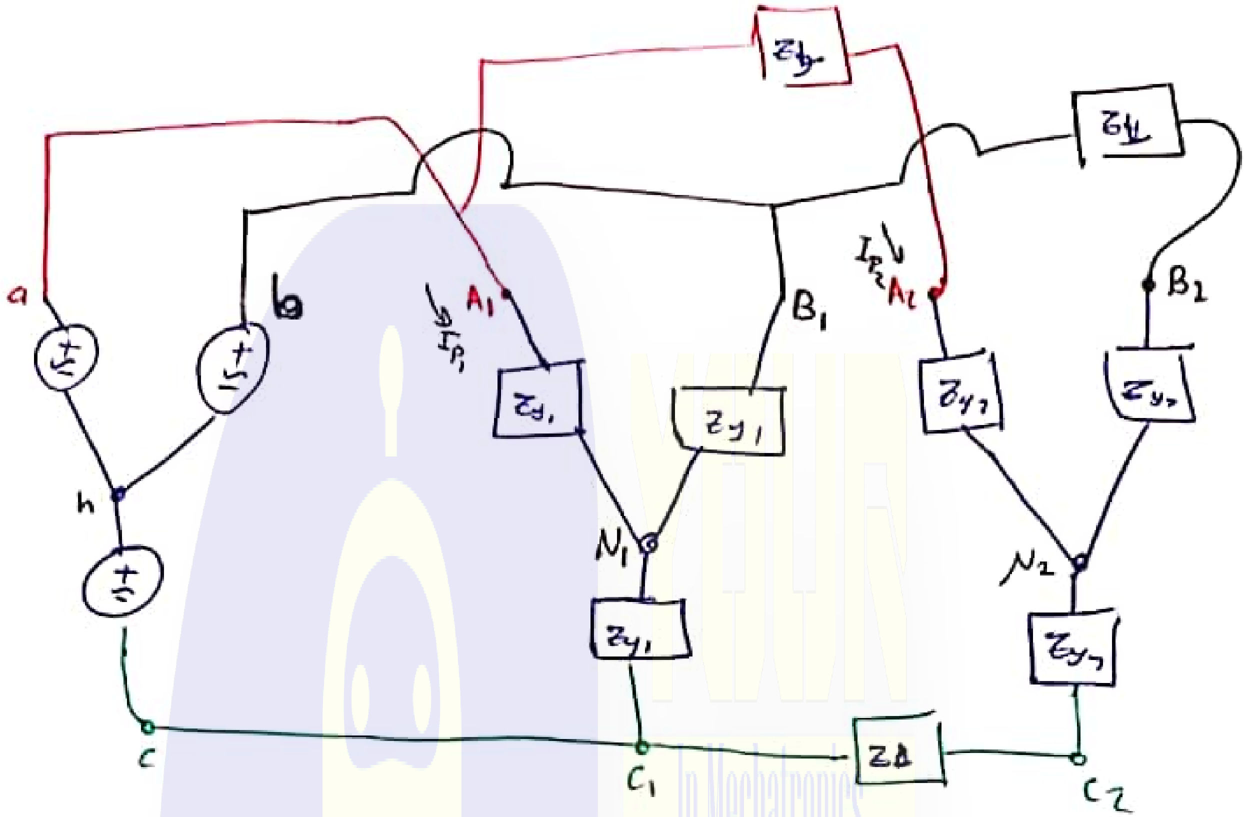
$I_{aA} = 6.67 \angle 0$

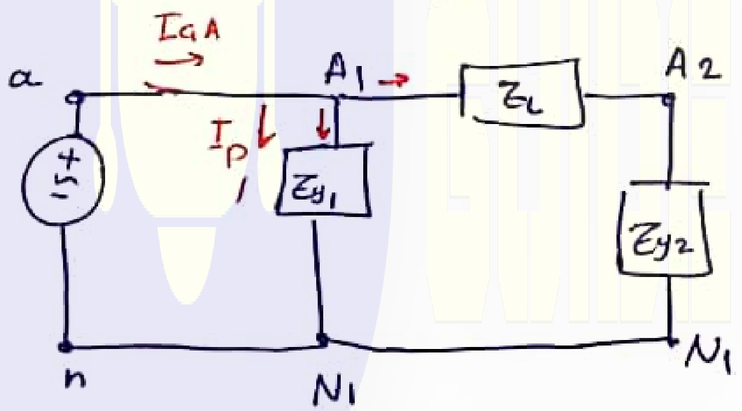
$I_{bB} = 8.94 \angle 93.44$

$I_{cC} = 10 \angle -60.84$

Unbalanced

$$\frac{V_{AN} - V_N}{Z_a} + \frac{V_B - V_N}{Z_B} + \frac{V_c - V_N}{Z_c} = 0$$





$$I_{P_1} = \frac{V_{an}}{Z_{y_1}}$$

$$I_{P_2} = \frac{V_{an}}{Z_L + Z_{y_2}}$$

$$I_{aA} = I_{P_1} + I_{P_2}$$

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wednesday
3/7/2019

$P_T = P_1 + P_2$

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

$S_T = P_T \pm j\,Q_T = \sqrt{P_T^2 + Q_T^2}$ load ال Power بنقيس

$\tan\theta = \sqrt{3}\ \dfrac{P_2 - P_1}{P_1 + P_2}$

Load لل

$\boxed{12.70}$ $P_1 = 1200\,W$ $V_L = 240\,V$ Find P.F & Z_y?

$P_2 = -400\,W$ $I_L = 6\,A$

Sol $P_T = 1200 - 400 = 800\,W$

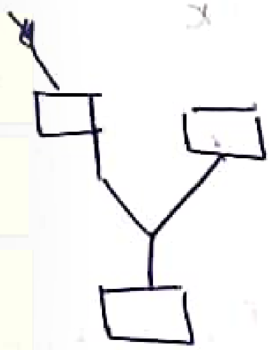
$Q = \sqrt{3}\ (-400 - 1200) = -2771.28\ VAR$

$\tan\theta = \dfrac{Q_T}{P_T} = \dfrac{-2771.28}{800}$

$\theta = -73.89$

$Z = \dfrac{(240/\sqrt{3})}{6} \angle -73.89^\circ$

$\dfrac{V_P}{I_L}$



$P_T = P_1 + P_2 = 7394.5\ W$

$Q = \sqrt{3}\,(4803.5 - 2591) = 3832.5\ VAR$

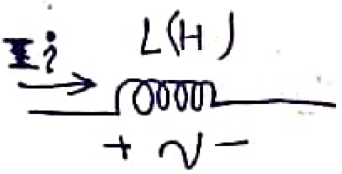
$|S| = \sqrt{Q_T^2 + P_T^2} = 8328.5$

$\tan\theta = \frac{Q_T}{P_T} = \quad \theta = 27.8$

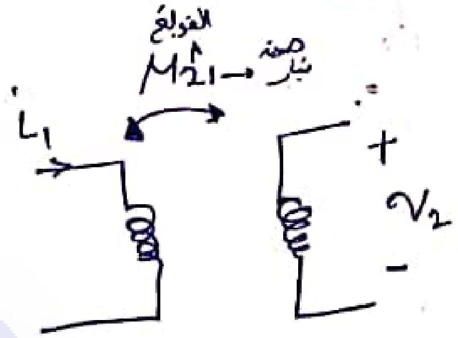
$\cos(27.8) = 0.88$

Monday 8/7/2019

CH 13
Magnatic Coupling CKts

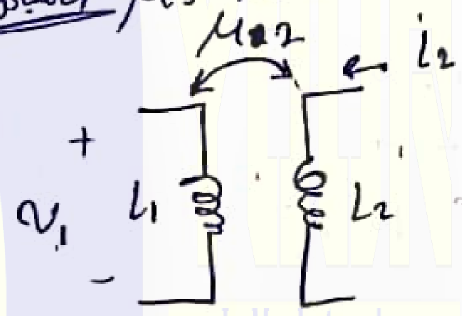


$$v(t) = L\frac{di(t)}{dt}$$



$$v_2 = M_{21}\frac{di_1}{dt}$$

حث متبادل M: Mutual inductance

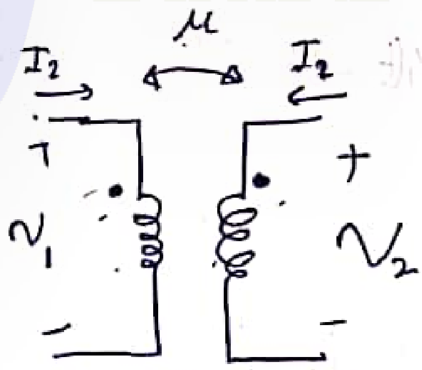


$$M_{12} = M_{21} = M$$

$$v_1 = M_{12}\frac{di_2}{dt}$$

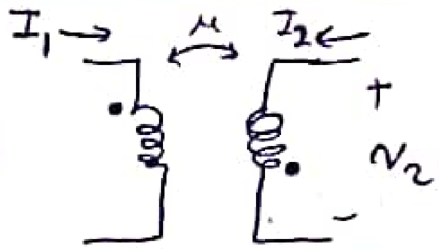
M: Mutual Inductance:- ~~The ck coil~~
↳ The ability of a coil to induce a voltage in other coils

* $\boxed{\text{Dot convention}}$:- (1)



$$v_2 = M\frac{di_1}{dt}$$

(2)



$v_2 = -M \frac{di_1}{dt}$

تيار داخل في • يعتبر عندها (+)

(3)

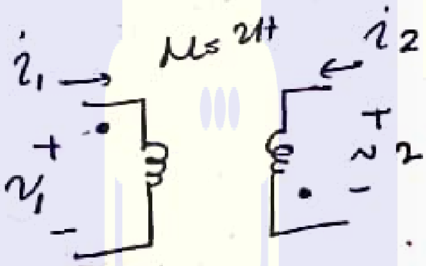
$v_2 = -M \frac{di_1}{dt}$

(4)

$v_2 = M \frac{di_1}{dt}$

اذا صار عنا تغيير نفل (+)

~~H.W~~
ex8



بوزن عند current source 1

$i_2(t) = 5\sin 45t$

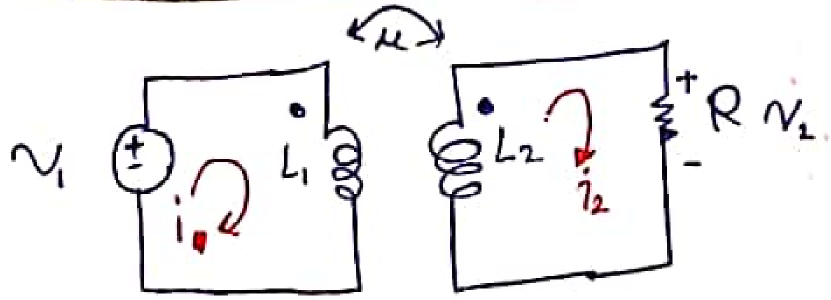
$v_1(t) = -M \frac{di_2}{dt} = (-2(5(45)\cos 45t))$

$= -450 \cos 45t \ V$

Let $i_1 = 4e^{-6t}$ find v_2

$v_2 = -M \frac{di_1}{dt} = -2(4(-6)e^{-6t})$

$= 48 e^{-6t} \ V$



Mesh 1:

$$-v_1 + L_1\frac{di_1}{dt} - M\frac{di_2}{dt} = 0$$

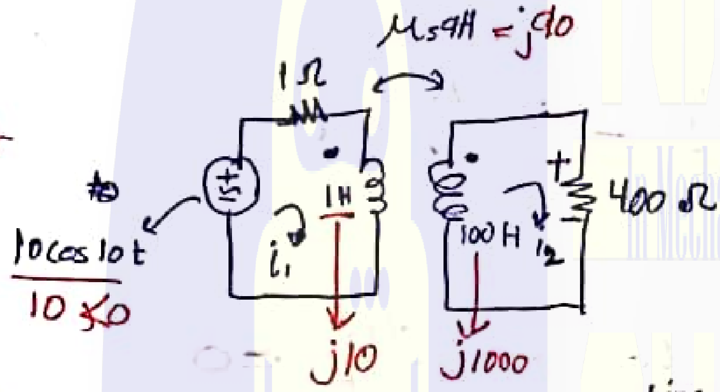
$$v_1 = L_1\frac{di_1}{dt} - M\frac{di_2}{dt}$$

Mesh 2

$$-v_2 + L_2\frac{di_2}{dt} - M\frac{di_1}{dt} = 0$$

$$v_2 = L_2\frac{di_2}{dt} - M\frac{di_1}{dt}$$

ex:



Sol:-

time domain) $i \rightarrow d/dt \rightarrow \frac{di}{dt}$

Freq $i_1 \rightarrow j\omega \rightarrow I_1 j\omega$

Mesh 1

$$v_{1(t)} = i_1(1) + L_1\frac{di_1}{dt} - M\frac{di_2}{dt}$$

$$V_1 = I_1(1) + j10 I_1 - j90 I_2$$

$$10\angle 0 = I_1 + j10 I_1 - j90 I_2$$

$$\boxed{(1+10j)I_1 - j90 I_2 = 10\angle 0} \rightarrow (1)$$

Mesh 2

$$\boxed{400 I_2 + 100j I_2 - 90j I_1 = 0}$$

solving by Cramer rule

$$\boxed{-90j I_1 + (400+100i) I_2 = 0} \rightarrow (2)$$

$\Delta = [\quad]$

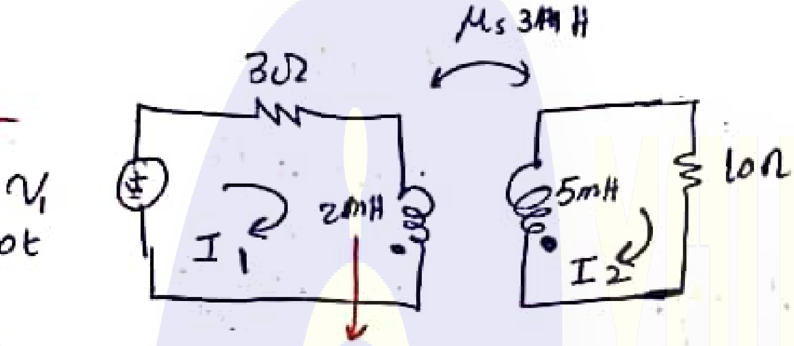
$\Delta_1 = [\quad]$

$\Delta_2 = [\quad]$

$I_1 = \frac{\Delta_1}{\Delta}$

$I_2 = \frac{\Delta_2}{\Delta}$

ex:-



هون عنا 3 تغيرات

ماهونا لايف لو مش لينو

Sola

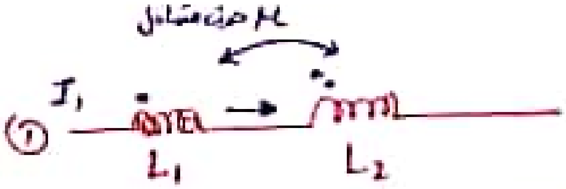
Mesh 1

$$-V_0 + 3i_1 + 2\frac{di_1}{dt} - 3\frac{di_2}{dt} = 0$$

Mesh 2

$$10i_2 + 5\frac{di_2}{dt} - 3\frac{di_1}{dt} = 0$$

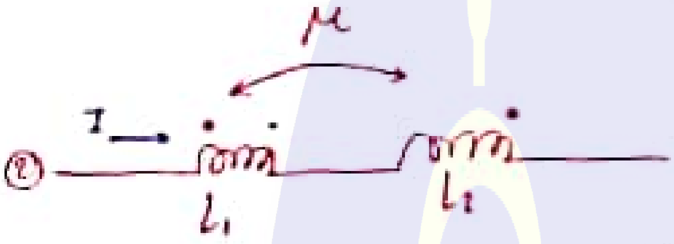
Wednesday
10/7/2019

① 

$L_{T_1} = L_1 + M$

$T_2 = L_2 + M$

$$\boxed{L_T = L_1 + L_2 + 2M}$$

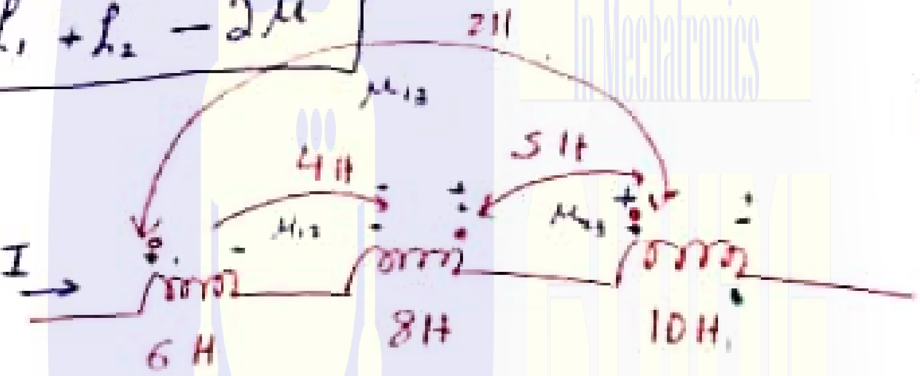
② 

$L_T = L_1 - M + L_2 - M$

$$\boxed{L_T = L_1 + L_2 - 2M}$$

حطي عند •(+)

③ Ex:-



لنشوف منه
دخل داخل
ونحط +
مثلا L_2
دخل من المكان إلي فيه نقطة
فنقدر عند إي علامة نقطة (+)
ونكمل الحل

Find L_T ?

Sol:-

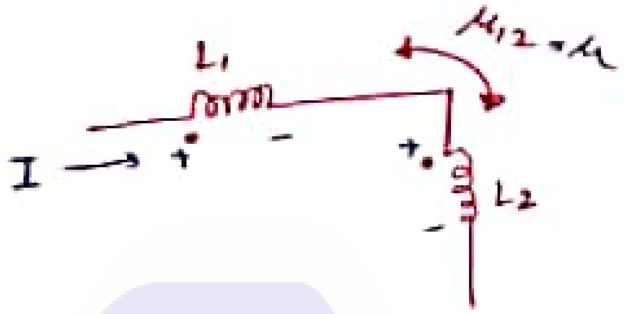
$L_{T_1} = 6 - 4 + 2 = 4$

$L_{T_2} = 8 - 4 - 5 = -1$

$L_{T_3} = 10 + 2 - 5 = 7$

$L_T = 10\ H$

exo-



$$L_T = L_1 + M + L_2 + M$$

$$\boxed{L_T = L_1 + L_2 + 2M}$$

exo- find L_{eq}

$$\underset{total}{Z_s} = \frac{V_s}{I_s} = j\omega L_T$$

$$I_s = I_1 + I_2$$

$\rightarrow V_s = j\omega L_1 I_1 + j\omega M I_2$

$\rightarrow V_s = j\omega L_2 I_2 + j\omega M I_1$

$$\begin{bmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_s \\ V_s \end{bmatrix}$$

$$\Delta = \begin{bmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{bmatrix} \qquad \Delta_1 = \begin{bmatrix} V_s & j\omega M \\ V_s & j\omega L_2 \end{bmatrix}$$

$$\Delta_2 = \begin{bmatrix} j\omega L_2 & V_s \\ j\omega M & V_s \end{bmatrix}$$

Solve for I_1, I_2

$$\Delta = \begin{bmatrix} j\omega L_1 & j\mathcal{M}\omega \\ j\mathcal{M}\omega & j\omega L_2 \end{bmatrix} = -\omega^2 L_1 L_2 + \omega^2 \mathcal{M}^2$$

$$\Delta_1 = \begin{bmatrix} V_s & j\mathcal{M}\omega \\ V_s & j\omega L_1 \end{bmatrix} = j V_s \omega L_2 - j V_s \omega \mathcal{M}$$

$$\Delta_2 = \begin{bmatrix} j\omega L_1 & V_s \\ j\mathcal{M}\omega & V_s \end{bmatrix} = j V_s \omega L_1 - j V_s \omega \mathcal{M}$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{j V_s \omega [L_2 - \mathcal{M}]}{\omega^2 [\mathcal{M}^2 - L_1 L_2]}$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{j V_s \omega [L_1 - \mathcal{M}]}{\omega^2 [\mathcal{M}^2 - L_1 L_2]}$$

$$I_s = I_1 + I_2 \rightarrow \frac{j V_s \omega [L_2 - \mathcal{M}] + j V_s \omega [L_1 - \mathcal{M}]}{\omega^2 [\mathcal{M}^2 - L_1 L_2]}$$

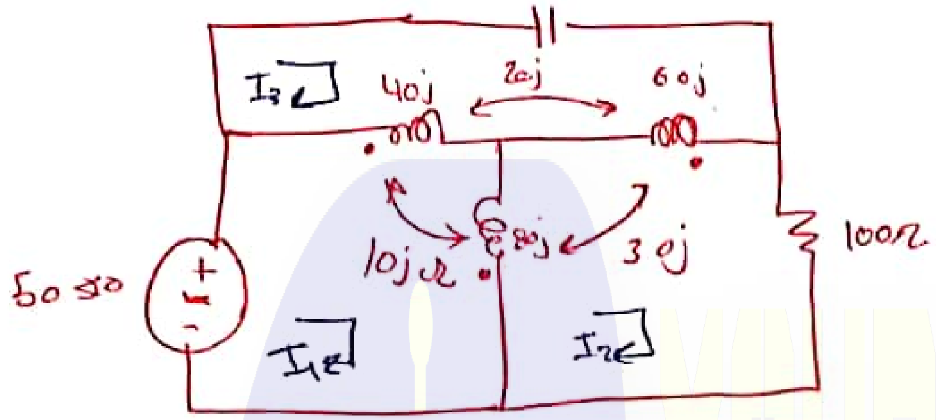
$$\frac{j V_s \omega [(L_1 - \mathcal{M}) + (L_2 - \mathcal{M})]}{\omega^2 [\mathcal{M}^2 - L_1 L_2]}$$

$$Z_{total_s} = \frac{V_s}{I_s} = \cancel{V_s} * \frac{\omega^2 [\mathcal{M}^2 - L_1 L_2]}{j \cancel{V_s} \cancel{\omega} [(L_2 - \mathcal{M}) + (L_1 - \mathcal{M})]}$$

$$Z_s = \frac{-j\omega [\mathcal{M}^2 - L_1 L_2]}{(L_2 - \mathcal{M}) + (L_1 - \mathcal{M})}$$

$$L_T = \frac{Z_s}{j\omega} = \frac{L_1 L_2 - \mathcal{M}^2}{L_1 + L_2 - 2\mathcal{M}}$$

ex:- write the mesh eqs



Mesh 1

$$-50\angle 0 + j40(I_1 - I_3) + 80j(I_1 - I_2) + j20(I_3 - I_2) +$$
$$j10(I_2 - I_1) + 30j(I_2 - I_3) + 10j(I_3 - I_1) = 0$$

Mesh 2

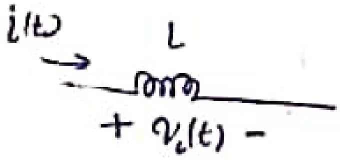
$$100I_2 + j80(I_2 - I_1) + j60(I_2 - I_3) + 10j(I_1 - I_3) + 30j(I_3 - I_2)$$
$$+ j20(I_3 - I_1) + 30j(I_1 - I_2) = 0$$

Mesh 3

$$-j50I_3 + j60(I_3 - I_2) + j40(I_3 - I_1) + 30j(I_2 - I_1)$$
$$+ 20j(I_1 - I_3) + j20(I_2 - I_3) + \cancel{j10}\ j10(I_1 - I_2) = 0$$

Energy in a coupled ckts

Sunday
14/7/2019



$$p(t) = i(t)\, v(t)$$
$$= i(t) L \frac{di}{dt}$$

$$w = E = \int p(t)\, dt = \int i(t)\, L \frac{di}{dt}\, dt$$

$$\boxed{= \frac{1}{2} L i^2} \Rightarrow J$$

For Mutual Coupling ckts

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

~~energy should be~~

$\boxed{\text{energy should} \geq 0}$

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

* coupling coefficient

← دايمًا مابين
٠ و ١

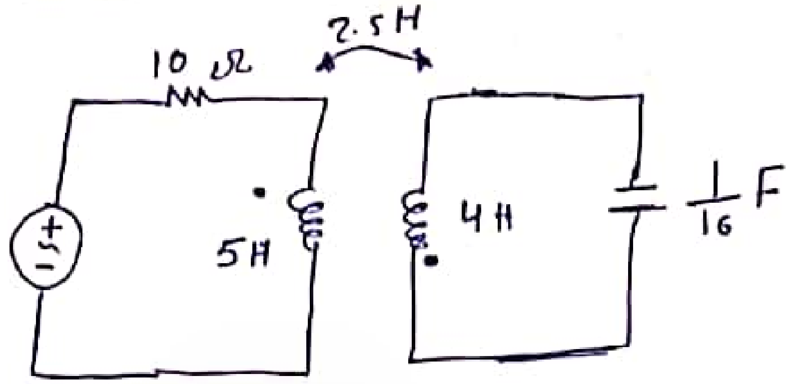
$$K = \frac{M}{\sqrt{L_1 L_2}}$$

$$\boxed{0 \leq K \leq 1}$$

1

ex:-

$v(t) = 60\cos(4t+30^\circ)$ V



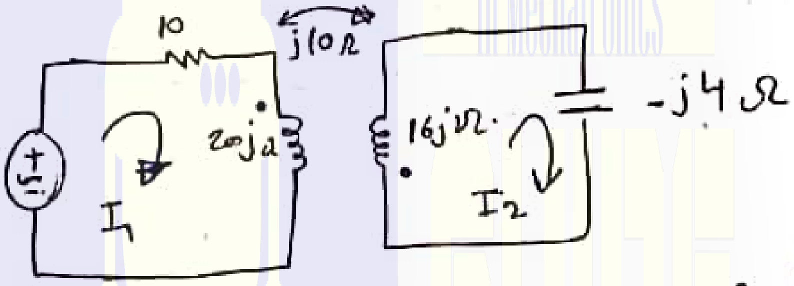
find K & W$|_{t=1\,sec}$?

Sol:-

$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{2.5}{\sqrt{(4)(5)}} = \frac{2.5}{\sqrt{20}} = 0.56$$

$$E = \frac{1}{2} L_1 i_1^2(t) + \frac{1}{2} L_2 i_2^2(t) \pm M\, i_1(t) \cdot i_2(t)$$

$V = 60\angle 30$



حبارنا تعريض
لأنهم في دخلو :

① $(10+j20) I_1 + j10 I_2 = 60\angle 30$

② $(j16 - j4) I_2 + j10 I_1 = 0$

Solve for I_1 & I_2

$I_1 = 3.9\angle -19.4^\circ$ A $\rightarrow$ $i_1(t) = 3.9\cos(4t - 19.4)$

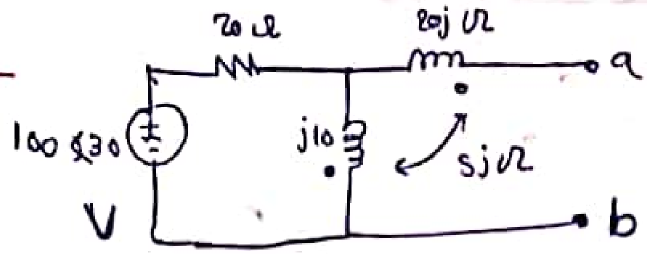
$I_2 = 3.254\angle 160.6$ A $\rightarrow$ $i_2(t) = 3.254\cos(4t + 160.6)$

$i_1(t=1) = -3.3.89$ A

$i_2(t=1) = 2.824$ A

$E = 0.5(5)(-3.389)^2 + 0.5(4)(2.824)^2 + (2.5)(-3.389)(2.824) -$

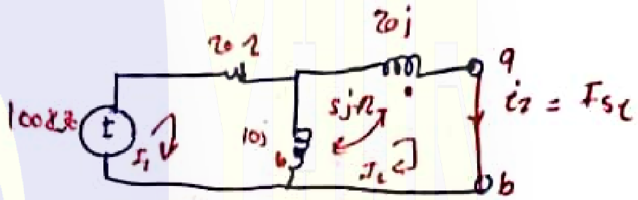
ex:-



Find Z_{eq}?

Solve:-

$$Z_{eq} = \frac{V_{oc}}{I_{S.C}}$$



$\boxed{\text{mesh 1}}$

$$(20+j10)I_1 - j10\, I_2 + j5\, I_2 = 100\angle 30$$

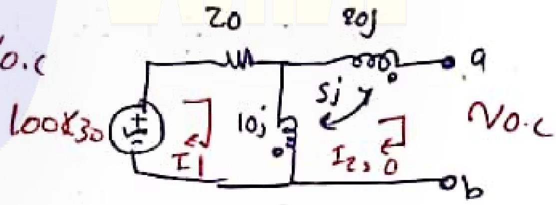
$\boxed{\text{mesh 2}}$

$$(j20+j10)I_2 - j10\, I_1 + j5\, I_1 = 0$$

solve for I_2

$$I_2 = 1.145 \angle 6.37^\circ \text{ A}$$

* Now we have to find $V_{o.c}$



$$(20+j10)I_1 = 100\angle 30$$

$$I_1 = 4.47\angle 3.43^\circ \text{ A}$$

$$V_{o.c} = 10j\, I_1 + 5j\, I_1$$

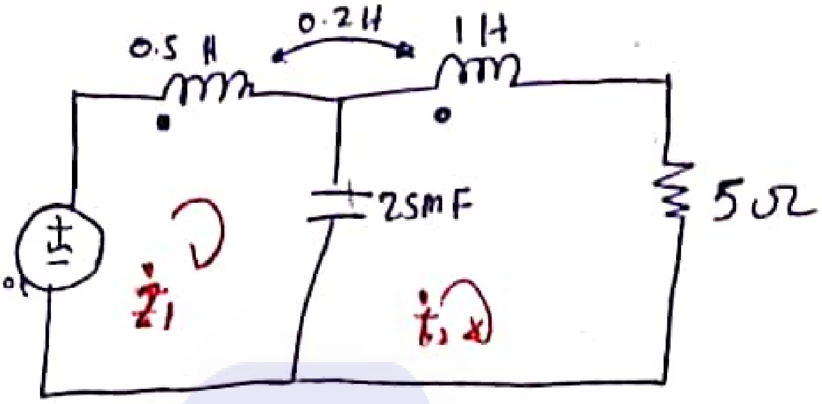
coupling

coupling

$$Z_{eq} = \frac{V_{o.c}}{I_{s.c}}$$

$$V_{o.c} = j10 I_1 + 5j I_1$$

ex2



$i_1(t)$?

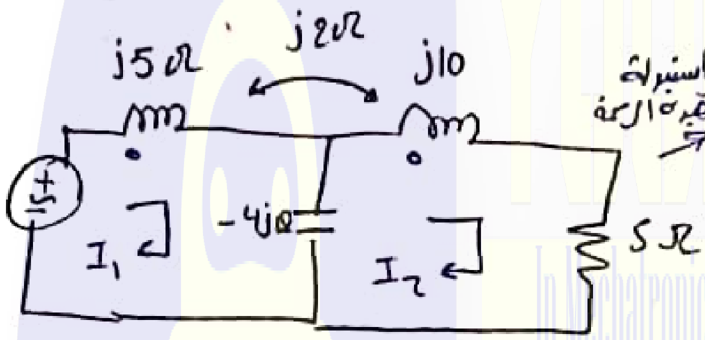
$i_2(t)$?

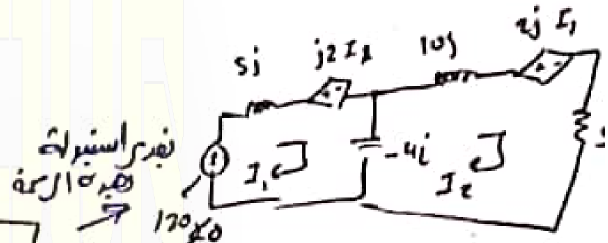
$W|_{t=15ms} = ?!$

Sol

$V = 120 \angle 0$

$\underline{w = 10}$





<u>mesh 1</u>

$$(j5 - 4j)\, I_1 + 4j\, I_2 + 2j\, I_2 = 120 \angle 0$$

mesh 2

$$(5 + 10j - 4j)\, I_2 + j4\, I_1 + j2\, I_1 = 0$$

solve for I_1, I_2

$I_1 = 3.081 \angle 40.74 A \sim i_1(t) = 3.081 \cos(10t + 40.74°)$

$I_2 = 2.367 \angle -49.46 A$ $i_2(t) = 2.367 \cos(10t - 49.46°)$

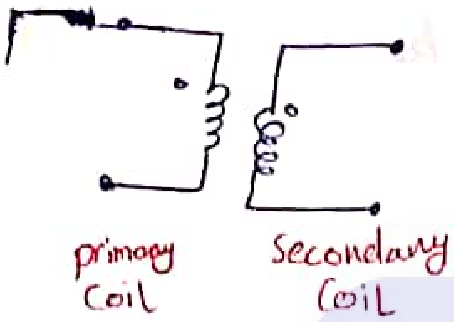
$i_1(t)$ ———

$i_2(t)$ ———

W_s ———

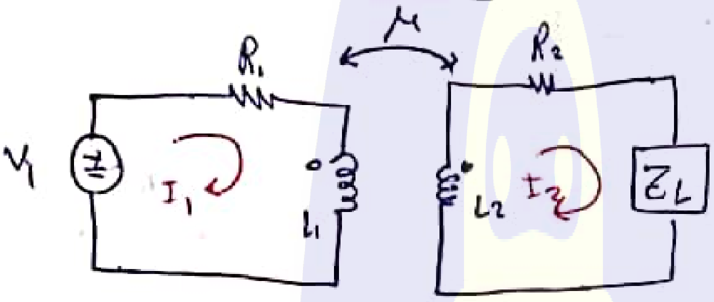
Linear Transformers

Monday
15/7/2019



used with high frequencies Ckts. (RF) Radoi frequency

has 4 terminals.



mesh 1

$$v_1 = I_1 (R_1 + j\omega L_1) - j\omega M I_2 \quad \dots (1)$$

mesh 2

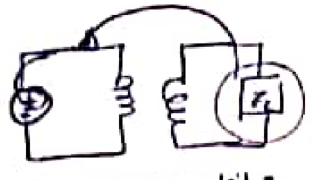
$$0 = -j\omega M I_1 + (R_2 + Z_L + j\omega L_2) I_2 \quad \dots (2) \qquad I_2 = \frac{j\omega M I_1}{R_2 + Z_L + j\omega L_2}$$

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

$$\boxed{Z_{in} = R_1 + j\omega L_1 + \frac{\omega^2 M^2}{R_2 + Z_L + j\omega L_2}}$$

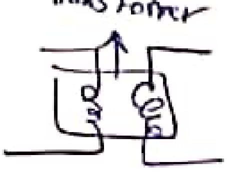
Reflected Impedance:

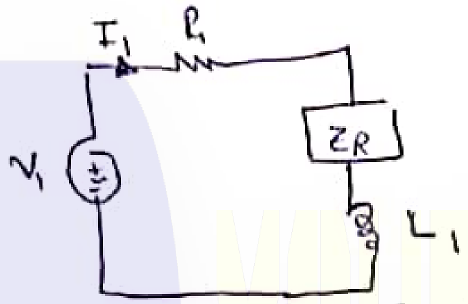
$$Z_R = \frac{\omega^2 M^2}{R_2 + Z_L + j\omega L_2}$$



دمج الحمل Z_L للدارة الثانية

كيف شكل الدارة



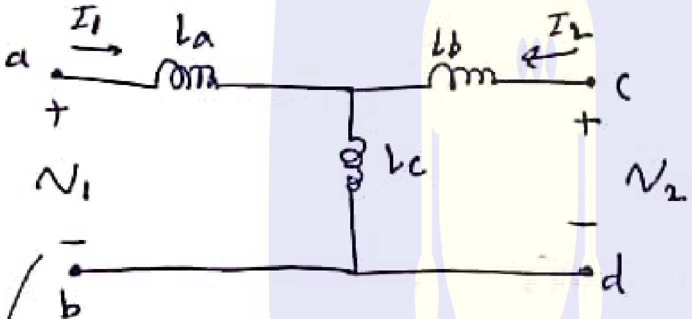


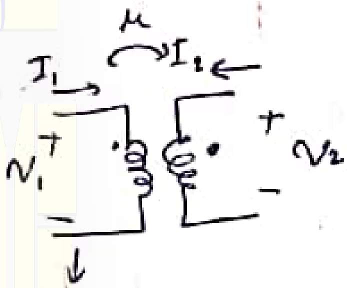
$$Z_{in} = \frac{V_1}{I_1} = R_1 + j\omega L + Z_R$$

هي نفسها

$$\frac{\omega^2 M^2}{R_2 + Z_L + j\omega L_2}$$

T: equivalent CKT.





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

$$L_a = L_1 - M$$
$$L_b = L_2 - M$$
$$L_c = M$$

اذا عكسنا دوت بنعوض عن M بالسالب

$+$ للسيروا

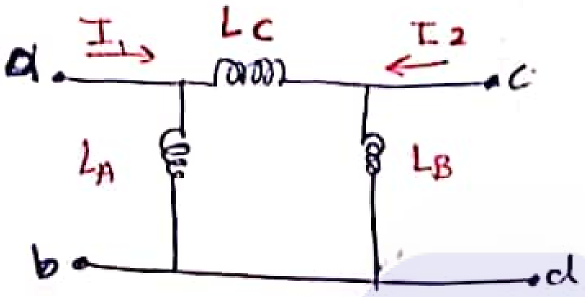
وآخر وحدة $-$

$$V_1 = j\omega L_a I_1 + j\omega L_c (I_1 + I_2)$$

$$V_1 = j\omega I_1 (L_1 - \cancel{M}) + \cancel{j\omega M I_1} + j\omega M I_2$$

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

π equivalent :-



نحول من $\Delta \leftarrow Y$

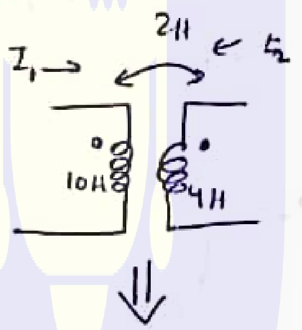
$Y \rightarrow \Delta$ conversion

$$L_A = \frac{L_1 L_2 - M^2}{L_2 - M}$$

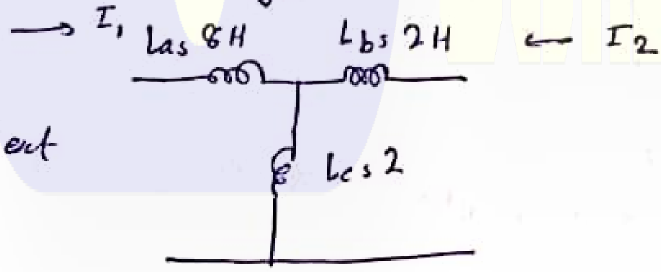
$$L_B = \frac{L_1 L_2 - M^2}{L_1 - M}$$

$$L_C = \frac{L_1 L_2 - M^2}{M}$$

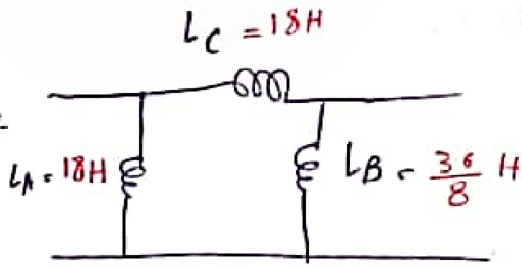
ex:-



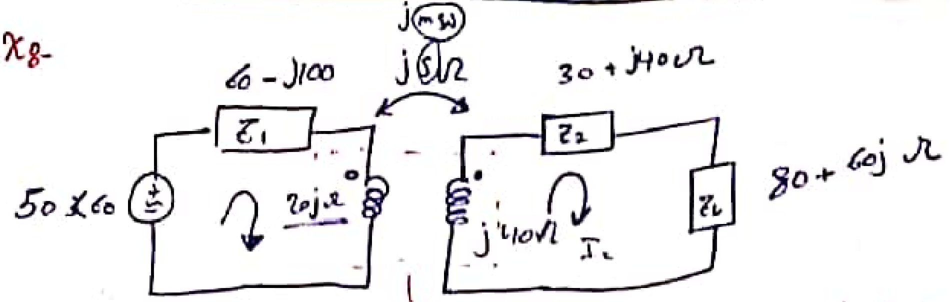
T equivalent



π equivalent



ex 8-



find Z_{in} & I_1 ?

ممكن يطلب انزوكل لـ I
بس يحول الـ DOL الجزء الي عليه بعكس
ونجمع عادي رياضي

Sol 8-

$$Z_{in} = Z_1 + \underbrace{j\omega L_1} + Z_R \rightsquigarrow \frac{(\omega M)^2}{Z_2 + Z_L + j\omega L_2}$$

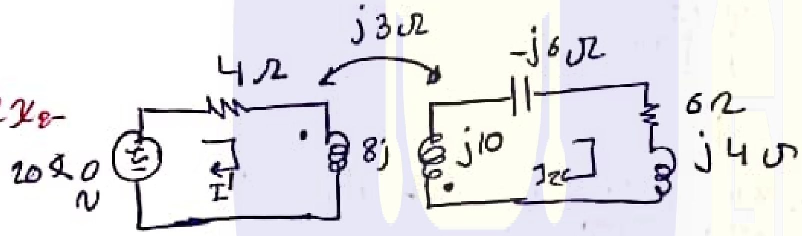
$$= 60 - j100 + 20j + \frac{5^2}{30 + 40j} + 80 + 60j + 40j$$

~~Z_{in} 100∠53.1~~

$$Z_{in} = 100.14 \angle -53.1^\circ \ \Omega$$

$$I_1 = \frac{V}{Z_{in}} = \frac{50 \angle 60}{100.14 \angle -53.1} = 0.5 \angle 113.1^\circ \ A$$

ex 8-

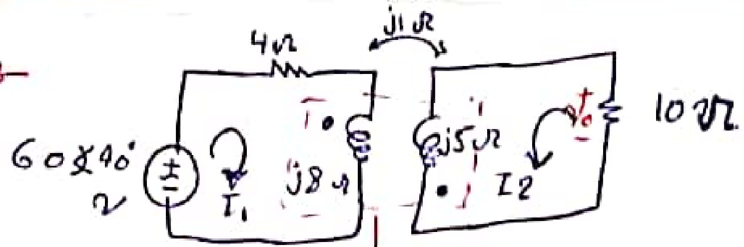


sol

$$Z_{in} = 4 + j8 + \frac{3^2}{-j6 + 6 + j4 + j10} \Rightarrow Z_{in} = 8.57 \angle 58.05^\circ \ \Omega$$

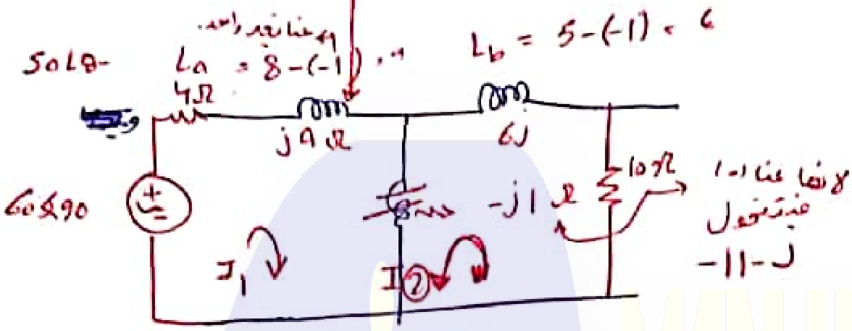
$$I_1 = \frac{V}{Z_{in}} = \frac{20 \angle 0}{8.57 \angle 58.05} = 2.3 \angle -58.05 \ \Omega$$

ex8



الحالة الاصلية اللي اتخدناها اول المحاضرة

Sol



ويرجع كرشي زي ماكان

mesh 1

$$60\angle 90 = (4+j9-j)I_2 + -j1\, I_2$$

نقدر أحل عادة زي كلفنا دارة عادية بطلع Z_{eq} بعين بطلع I_1 بعد current divion

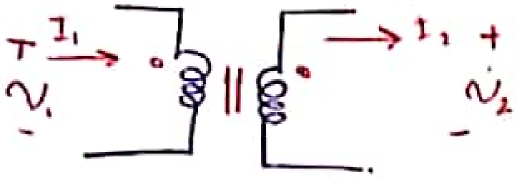
mesh 2

$$0 = (10+j6)\, I_2 + -j1\, I_1$$

Ideal Transformer:-

$n_1 : n_2 \longrightarrow$ نسميها n $= 1 : n$

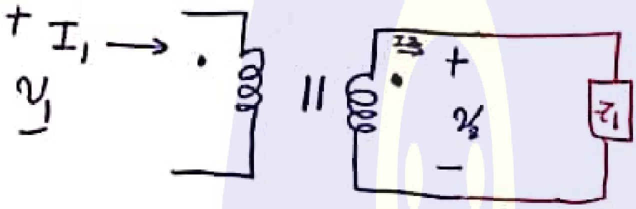
Tuesday
16/7/2019

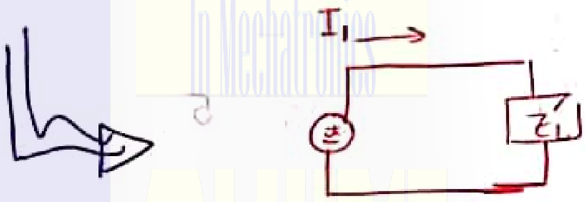


اعطنا عدد لفات
البرايمري مع عدد لفات سكندري

N_1 : number of turns of primary coil
N_2 : number of turns of secondary coil

$\frac{N_2}{N_1} = n$ turns radio





we have

① stepup Transformer

② step down transformer.

complex power

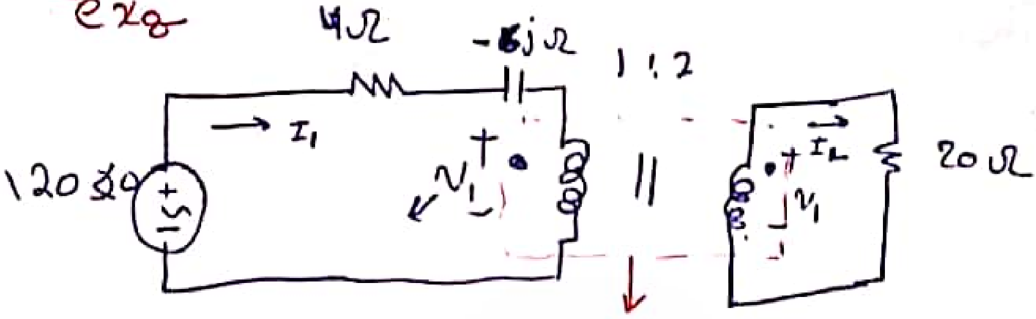
$$\boxed{\begin{aligned} S_1 &= S_2 \\ I_1^* V_1 &= I_2^* V_2 \end{aligned}}$$

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

if we reflect the [secondary impedance] to the primary

$$Z_L' = \frac{Z_L}{n^2}$$

مثال ex 8



$\frac{2}{2} : \frac{4}{2}$

1 : ② → n

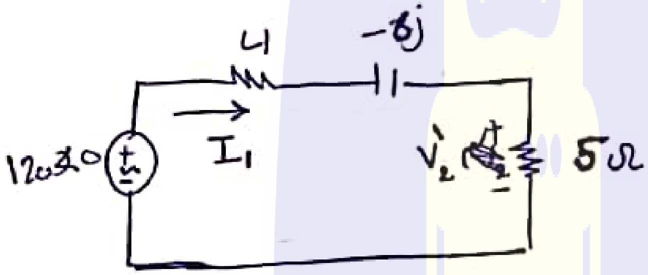
لما يعطوني 1:1 لازم نكون

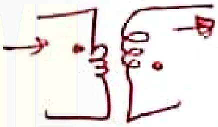
V_1 , V_2 على كويل كدا

Sol:

$$Z_L' = \frac{Z_L}{n^2} = \frac{20}{4} = 5\,\Omega$$

Coil الـ احول يروحوا





رح تكون

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

$$I_1 = \frac{120\angle 0}{4-6i+5} = 11.09\angle 33.69^\circ\ A$$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2} = n \rightarrow I_2 = \frac{I_1}{n} = \frac{I_1}{2} = 5.5\angle 33.69\ A$$

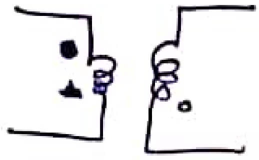
$$V_2 = I_2(20) = 110.9\angle 33.69^\circ\ V$$

$$V_2' = 5 I_1 = 55.45\angle 33.69^\circ\ A$$

$$\frac{V_2}{V_2'} = n \rightarrow \boxed{V_2' = \frac{V_2}{n}} \rightarrow \boxed{I_2' = I_2 n}$$

$$P_{20} = |I_2^2|\, R = 5.54^2 \times 20 = 613.8\ W$$

اذا غيرنا



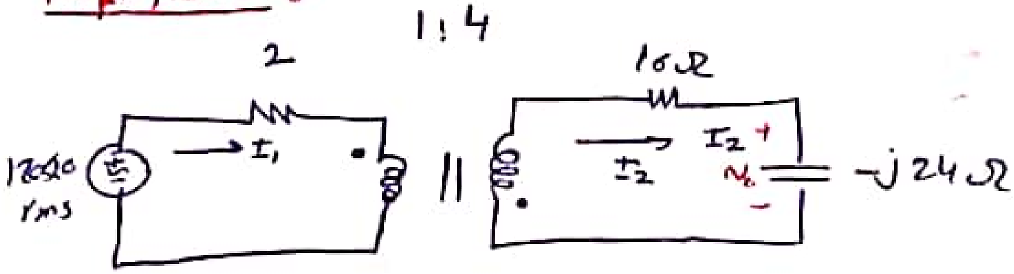
$I_2 = \frac{-I_2}{2} = 5.54 \angle -146.31$ $= I_2$ رح يختلف عنا

$V_2 = I_2 (20) = 110.9 \angle -146.31$

$\frac{V_2}{V_1} = n \longrightarrow V_1 = \frac{V_2}{n} = 55.45 \angle -146.31$

$S_1 = V_1 I_1^* = 615.9 \angle -179.9$

Prac problem



16 - 24j ~~Reflect~~ Reflect نعكس

Sol.

$$Z_L' = \frac{16-24j}{4} = 1-1.5j \ \Omega$$

$$I_1 = \frac{120\angle 0}{2+1-1.5j} = 35.77\angle 26.5 A$$

$V_2 < V_1$ لل step up

$$I_2 = \frac{-I_1}{n} = 8.9\angle -153.5^\circ A$$

$$V_o = I_2(-j24) = 214.66\angle 116.56 V$$

$$S_{source} = V_{source} I_1^* = 120\angle 0 (35.77\angle -26.5)$$

$$= 4292.4\angle -26.5 \ VA$$

CH 14: Freq. Responces

21/7/2019
sunday

Linear system:

$x(t) \rightarrow \boxed{h(t)} \rightarrow y(t)$

$x(t)$ = input
$y(t)$ = output
$h(t)$ = Impules responce
ردة فعل

time invariant system: -

غير متغير مع الزمن

1. $x(t) \rightarrow \boxed{} \xrightarrow{y(t)} \boxed{\text{delay}} \rightarrow y(t-t_0)$
2. $\rightarrow \boxed{\text{delay}} \rightarrow x(t-t_0) \rightarrow \boxed{\text{system}} \rightarrow$

(convolution) output , input العلاقة بين ← linear time invariant

$*$

linear time invariant:

$$y(t) = x(t) * h(t)$$

$$\downarrow$$

$$Y(\omega) = X(\omega) \times H(\omega)$$

$$Y(\omega) = \int_{-\infty}^{\infty} y(t)\, e^{-j\omega t}\, dt$$

Fourier

$$\boxed{H(\omega) = \frac{Y(\omega)}{X(\omega)}} \rightarrow \boxed{\text{transfer function}}$$

$\frac{\text{output}}{\text{input}}$ → in freq domain

$H(\omega) = \frac{I_o(\omega)}{I_{in}(\omega)}$ → current gain

$H(\omega) = \frac{V_o(\omega)}{V_{in}(\omega)}$ → Voltage gain

$H(\omega) = \frac{y(\omega)}{x(\omega)}$ → [redacted] transfer function

$$H(\omega) = \frac{\omega - 4}{\omega - 6}$$

$\omega - 4 = 0$

$\omega = 4$ (zero) (x) (اصفار البسط)

$\omega - 6 = 0$

$\omega = 6$ (poles) (o) (اصفار مقام)

ex:

$$H(\omega) = \frac{4\omega - 8}{\omega^2 + 7\omega + 12}$$

find zero, poles:-

zero: $4\omega - 8$

$\omega = \frac{8}{4} = 2$ $\omega = 2$ rad/sec

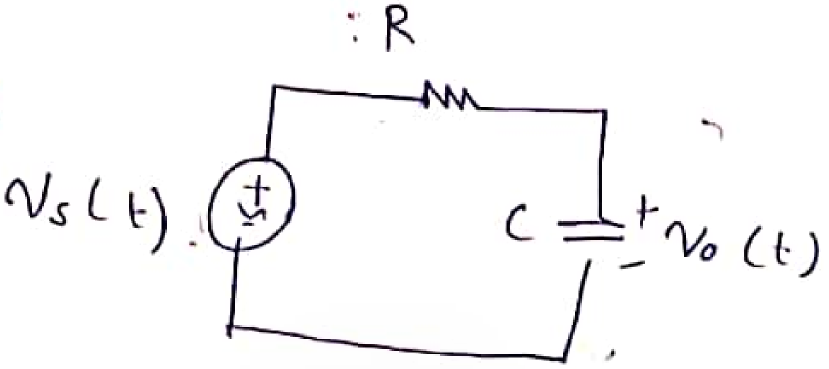
poles: $\omega^2 + 7\omega + 12$

$(\omega + 3)(\omega + 4)$

$\omega = -4$

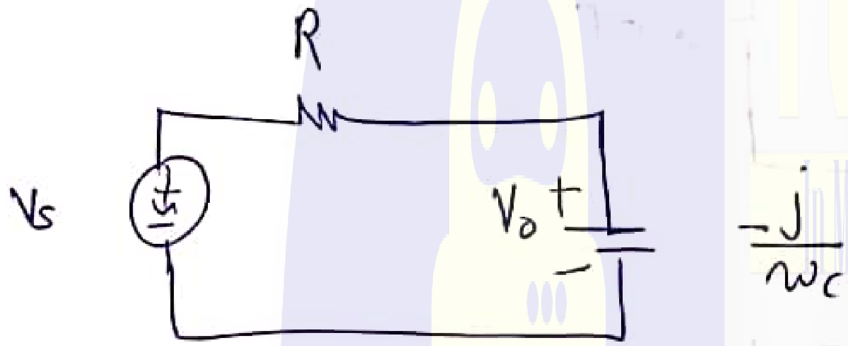
$\omega = -3$

exa



find $\frac{v_o(t)}{v_{in}(t)} = H(\omega)$

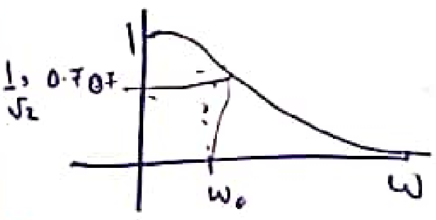
$\Downarrow$



$$v_o = \frac{v_s\left(\frac{+1}{j\omega c}\right)}{R + \frac{1}{j\omega c}}$$

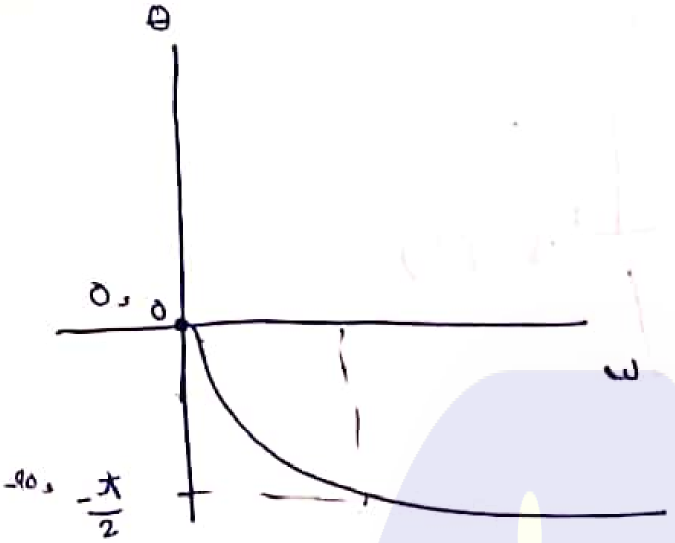
$$\frac{v_o}{v_s} = \frac{\frac{1}{j\omega c}}{R + \frac{1}{j\omega c}} \longrightarrow \frac{1}{1 + j\omega c R} = \frac{1}{1 + j\frac{\omega}{\omega_0}}$$

$$\omega_0 = \frac{1}{RC} \implies |H| = \frac{1}{\sqrt{1 + \left(\frac{\omega}{\omega_c}\right)^2}}$$

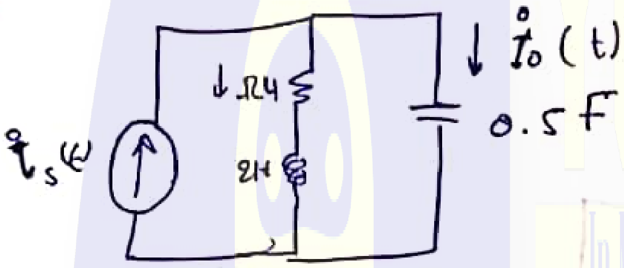


$$\phi = -\tan^{-1}\left(\frac{\omega}{\omega_0}\right)$$

3

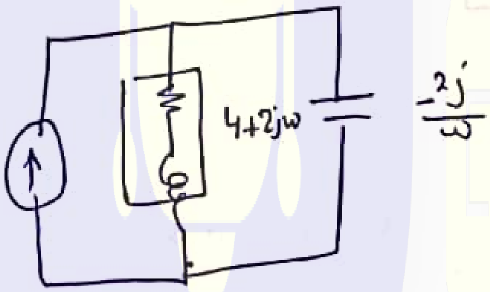


ex8



find $\frac{I_o(\omega)}{I_s(\omega)} = H(\omega)$

⇓



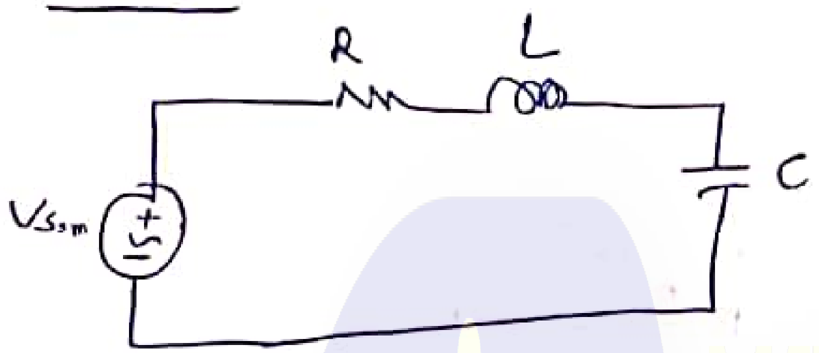
$$I_o = \frac{I_s\,(4 + j2\omega)}{4 + 2j\omega - \frac{2j}{\omega}}$$

$$H(\omega) = \frac{I_o}{I_s} = \frac{(4 + j2\omega)}{4 + 2j\omega - \frac{2j}{\omega}}$$

* Series Resonance

Monday
22/7/2019

RLC



Resonance occurs in RLC CKTs

$\Rightarrow \boxed{X_L = X_C}$

$\Rightarrow \boxed{Z_T = R}$ $\Rightarrow$ Imag $= 0 \rightarrow$ Z_T

$\rightarrow$ R + j(Imag) = 0

$X_L = X_C$

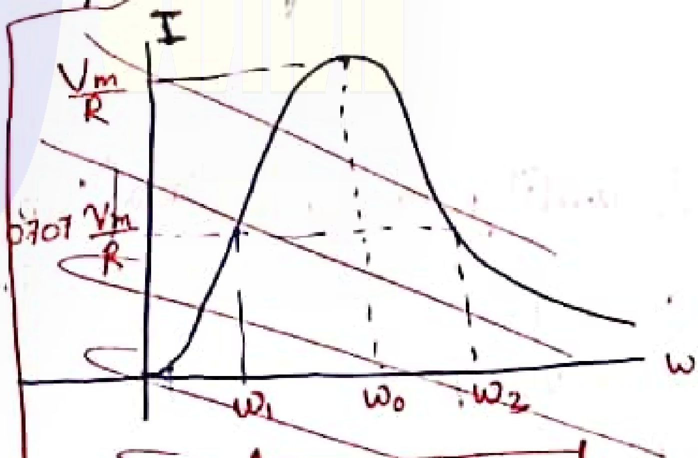
$$\omega_0 L = \frac{1}{\omega_0 C}$$

$$\omega_0^2 = \frac{1}{LC}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

Resonance freq

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



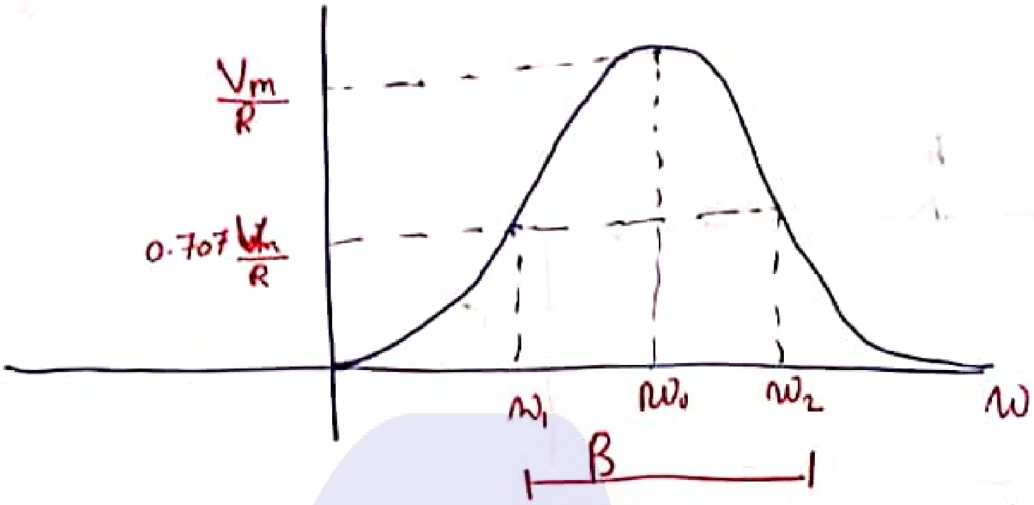
Half power Bandwith (BW)

At Resonance

① $Z_T = R$ (Imag = 0)

② V, I are in phase

③ $V_L, V_C > V_s$



Half power Band with (BW)

ω_1 , ω_2 : Half power freq

عند ω_0
بيحصل Max

① $P_{max} = 0.5\ I^2 R$

② $\omega_1 = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$

③ $\omega_2 = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$

④ $\omega_0 = \sqrt{\omega_1 \omega_2}$

⑤ $\beta = \omega_2 - \omega_1$

Quality factor $Q = 2\pi\left(\frac{\text{Total energy stored ckt}}{\text{The energy loss by cycles}}\right)$

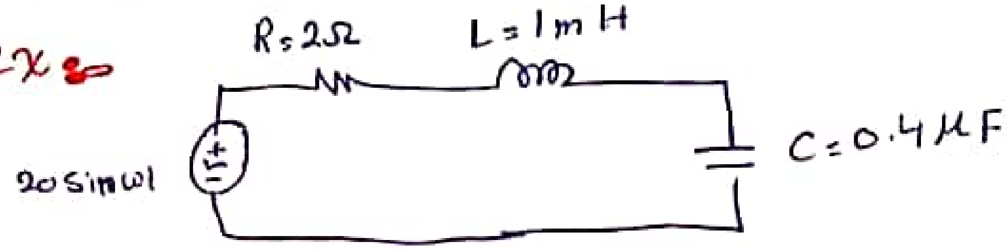
$Q = \frac{1}{\omega_0 CR}$

$Q = \frac{\omega_0}{B}$

$\omega_1 = \omega_0 - \frac{B}{2}$

$\omega_2 = \omega_0 + \frac{B}{2}$

ex 8



Sol -

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(1\times10^{-3})\times(0.4\times10^{-6})}} = 50 \text{ krad/sec}$$

$\omega_1 = 49$ k rad/sec

$\omega_2 = 51$ k rad/sec

$B = \omega_2 - \omega_1$

$51 - 49 = 2$ K rad/sec

$P_{max} = \frac{1}{2} I^2 R$

$$I_{max} = \frac{V_{m}}{R} = \frac{20}{2} = 10 \text{ A}$$

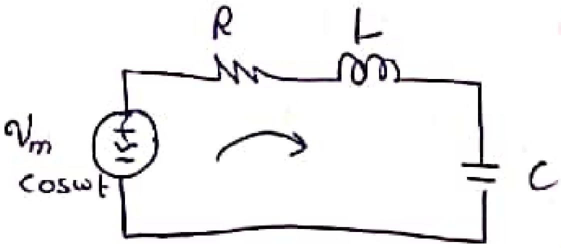
$Q = 25$ → No Unit

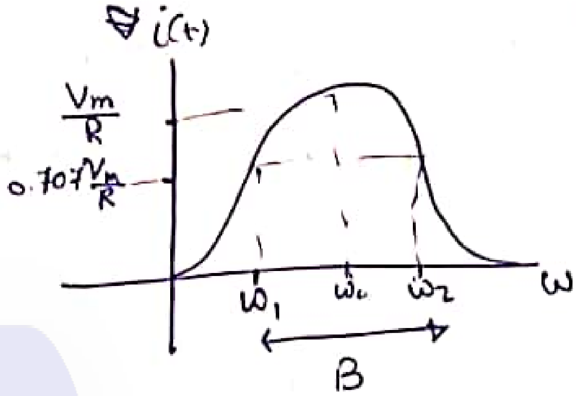
ex 9

Series Resonant

Tuesday

23/7/2019





$\omega_0 = \frac{1}{\sqrt{LC}}$

$Q = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 RC}$

$\omega_1 = \omega_0 - B/2$

$\omega_2 = \omega_0 + B/2$

$B = \frac{R}{L} = \frac{\omega_0}{Q}$

$Q \geq 10$

$Z = R + j\omega_0 L - \frac{1}{j\omega_0 C}$

$= R + j[\omega_0 L - \frac{1}{\omega_0 C}]$

$\downarrow$

$= 0$

~~...~~ UNLL Respond

$\omega_0 L - \frac{1}{\omega_0 C} = 0$

$\omega_0 L = \frac{1}{\omega_0 C}$

$\omega_0^2 = \frac{1}{LC}$

$\omega_0 = \frac{1}{\sqrt{LC}}$

$Q \leq 10$

$\omega_1 = -\frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$

$\omega_2 = \frac{R}{2L} + \ldots$

$\omega_1, \omega_2 = \omega_0 \sqrt{1 + \left(\frac{1}{2Q}\right)^2} \pm \frac{\omega_0}{2Q}$

ex: $R = 4\Omega$, $L = 25mH$, $C = ??$, $Q = 50$

sol:

$Q = \frac{\omega_0 L}{R} = 50 = \omega_0 \frac{25\times10^{-3}}{4} = \omega_0 = \frac{200}{25\times10^{-3}}$

$\omega_0 = 8K \, rad/s$

$\omega_0^2 = \frac{1}{LC} \longrightarrow C = \frac{1}{L\omega_0^2} \rightarrow C = \frac{1}{25\times10^{-3}\times(8\times10^3)^2}$

$V_m = 100$

$I_{max} = \frac{100}{4} = 25 \longrightarrow P_{w_c} = \frac{1}{2} * 25^2 * 4$

$I_{w_1, w_2} = 25 * .707$ $\quad P_{w_1, w_2} = \frac{1}{2}(17.6)^2 * 4$

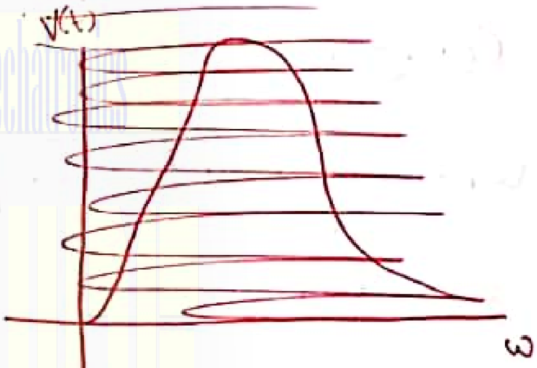
(*) Parallel Resonance

$Y = \frac{1}{R} + \frac{1}{j\omega L} + j\omega C$

$\frac{1}{R} + j(\omega C - \omega L)$

$\omega C - \frac{1}{\omega L} = 0$

$\omega_0 = \frac{1}{\sqrt{LC}}$



① $\omega_1 = \frac{-1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$

② $\omega_2 = \frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$

$\omega_1, \omega_2 = \omega_0 \sqrt{1 + \left(\frac{1}{2Q}\right)^2} \pm \frac{\omega_0}{2Q}$

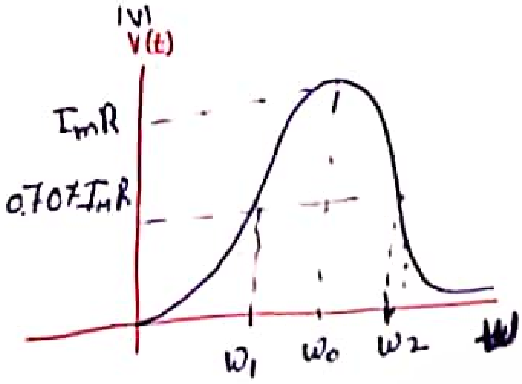
③ $B = \omega_2 - \omega_1 = \frac{1}{RC}$

④ $Q = \frac{\omega_0}{B} = \omega_0 RC = \frac{R}{\omega_0 L}$

if $Q \geq 10$

① $\omega_1 = \omega_0 - B/2$

② $\omega_2 = \omega_0 + B/2$

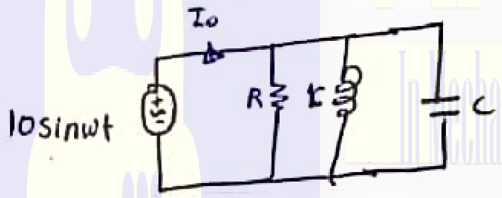


$$I_L = - I_C$$

$$I_L = \frac{I_m R}{w_0 L} = Q I_m$$

$$I_C = w_0 C I_m R = Q I_m$$

ex:



$R = 8 k\Omega \qquad L = 0.2\ mH \qquad C = 8 \mu F$

find w_0, Q & B ?

$$I_o = \frac{10 \angle -90}{8 \times 10^3} = 1.25 \angle -90 A$$

$$P_{max} = 0.5 \times (1.25 \times 10^{-3})^2 \times (8 \times 10^3)$$

sol:

$$w_0 = \frac{1}{\sqrt{LC}} = 25k\ rad/s$$

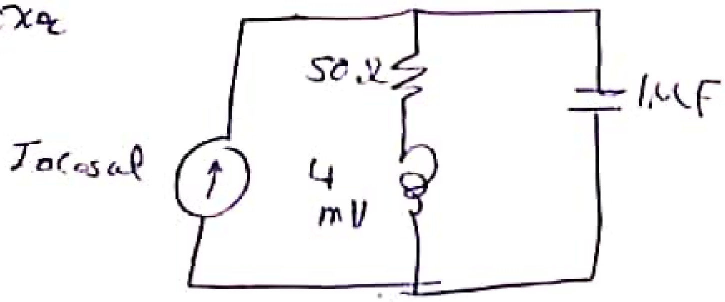
$$Q = \frac{R}{w_0 L} = \frac{8 \times 10^{+3}}{25 \times 10^3 (0.2 \times 10^{-3})} = 16000$$

$$B = \frac{w_0}{Q} = \frac{25 \times 10^3}{16000} = 15.625\ rad/s$$

$$w_1 = w_0 - B/2 = 25000 - \frac{15.625}{2} = 24992\ rad/s$$

$$w_2 = w_0 + B/2 = 25000 + \frac{15.625}{2} = 25008\ rad/s$$

$\frac{\lambda}{2}$ exa



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

$$Z_{total} = \frac{(50+j40)\cdot\frac{1}{j\omega C}}{(50+40j)+\frac{1}{j\omega C}} = \frac{\frac{-jR}{\omega L}}{R+j\left(\omega L-\frac{1}{\omega C}\right)}$$

$$= \frac{\frac{-jR^2}{\omega L} - \frac{R}{\omega 2}\left(\omega L-\frac{1}{\omega C}\right) + \frac{RL}{C} - j\left[\frac{\omega L^2}{C} - \frac{L}{\omega C^2}\right)}{R^2+\left(\omega L-\frac{L}{\omega C}\right)^2}$$

$$= \frac{-j\left[\frac{R^2}{\omega L}+\frac{\omega L^2}{C}-\frac{L}{\omega C^2}\right]+\frac{RL}{C}-\frac{R}{\omega L}\left(\omega L-\frac{1}{\omega C}\right]}{R^2+(\omega L-L\omega)}$$

$$\omega_0 = \sqrt{\frac{1}{LC}+\frac{R^2C}{L^3}}$$

passive filters

Monday
29/7/2019

R, L, C

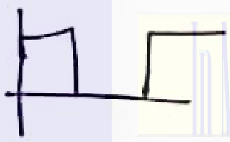
Many freq — signal → Filter → desired frequency

① Low pass filter [LPF)
Low frequency to pass.

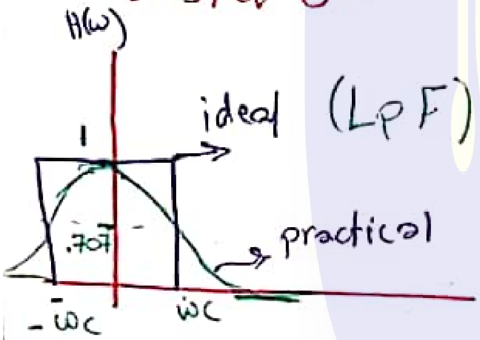
② Band pass filter Modrate (BPF]

③ High pass filter [HPF)
high freq to pass

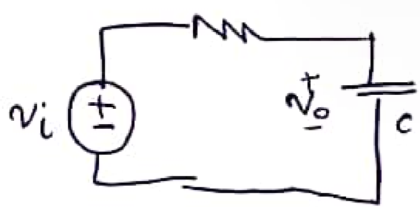
④ Band. stop filter....



Transfer f^n



ωc: corner / cutoff freq



$\frac{1}{j\omega c}$

$$v_o = \frac{v_i \frac{1}{j\omega c}}{R + \frac{1}{j\omega}}$$

$$\frac{v_o}{v_i} = H(\omega) = \frac{\frac{1}{j\omega c}}{R + \frac{1}{j\omega c}} = \boxed{\frac{1}{1 + j\omega cR}}$$

$\omega_c = \frac{1}{Rc}$

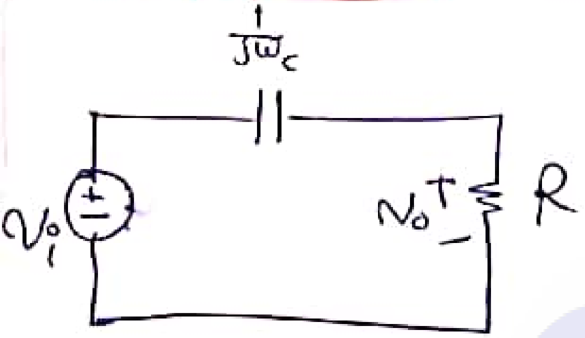
$H(\omega_c) = \frac{1}{\sqrt{2}}$

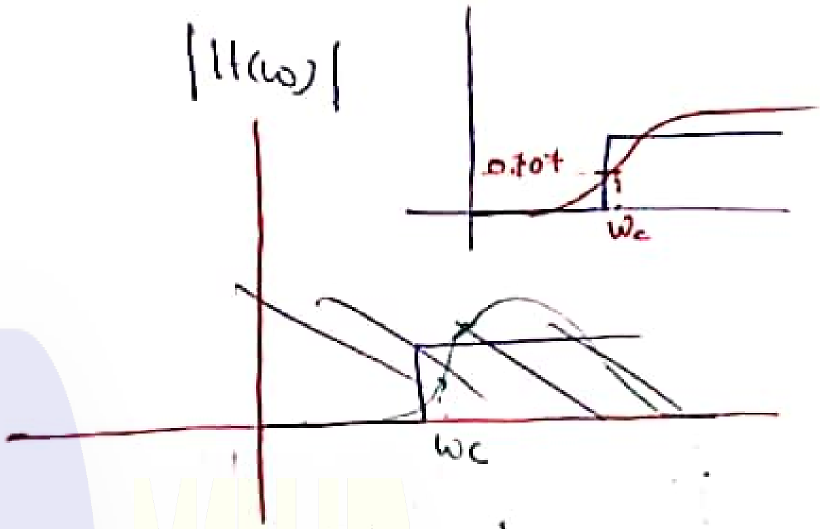
$H(0) = 1$

$H(\infty) = 0$

①

- high pass filter (HPF)





$$V_o = \frac{V_i \quad R}{R + \frac{1}{j\omega C}}$$

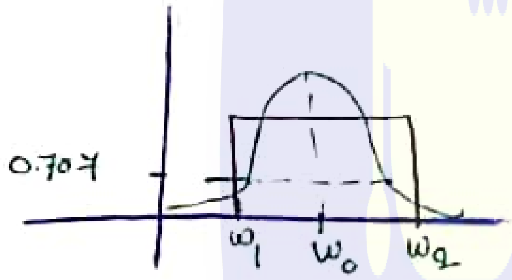
$$\frac{V_o}{V_i} = H(\omega) = \frac{R}{R + \frac{1}{j\omega c}} = \frac{j\omega c R}{1 + j\omega RC}$$

$$\omega_c = \frac{1}{RC}$$

$H(0) = 0$

$H(\infty) = 1$

- Band Pass filter (BPF)



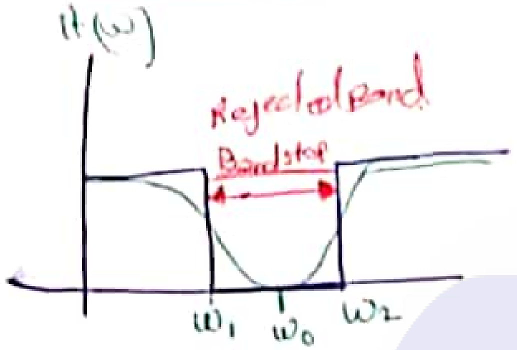
$$\frac{V_o}{V_i} = H(\omega) = \frac{R}{R + j\omega L + \frac{1}{j\omega c}}$$

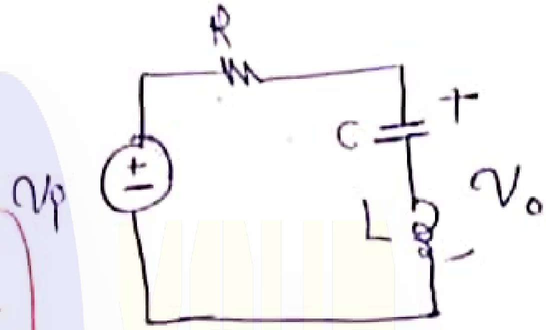
$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$H(0) = 0$

$H(\infty) = 0$

Band stop filter (Notch Filter)

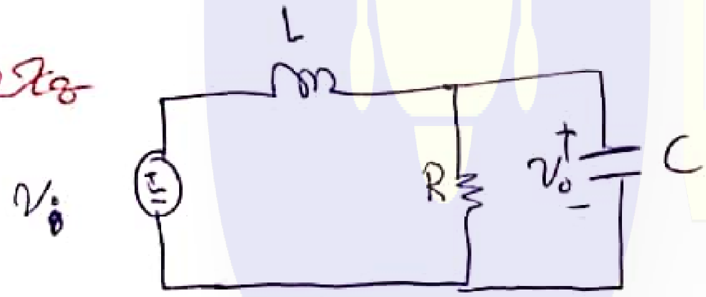




$$\frac{v_o}{v_i} = H(\omega) = \frac{\frac{1}{j\omega C} + j\omega L}{R + \frac{1}{j\omega C} + j\omega L}$$

	H(0)	H(∞)
LPF	1	0
HPF	0	1
BPF	0	0
BSF	1	1

ex:



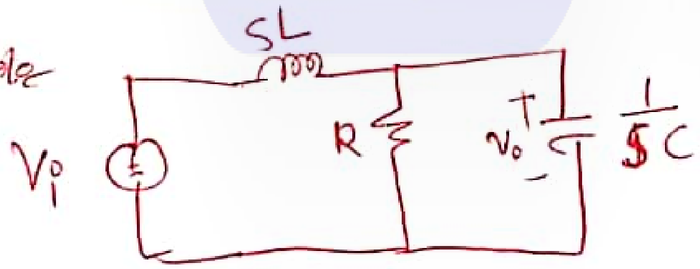
Note $\boxed{s = j\omega}$

$R = 2k\Omega$

$L = 2H$

$C = 2\mu F$

sol:



$$v_o = \frac{(R \parallel \frac{1}{sC})\, v_i}{sL + (R \parallel \frac{1}{sC})} \rightarrow \frac{v_o}{v_i} \overset{H(s)}{=} \frac{R}{s^2 RLC + sL + R}$$

$$H(\omega) = \frac{R}{-\omega^2 RLC + j\omega C + R}$$

$H(0) = 1$

$(\omega = \frac{1}{\infty})$ $H(\infty) = 0$ LPF

$$|H| = \sqrt{\frac{R^2}{(R - w^2 RLC)^2 + w^2 L^2}}$$

$$H = \frac{R}{\sqrt{(R - w^2 RLC)^2 + w^2 L^2}}$$

at $\omega = \omega_c$ $\qquad |H(\omega)| = \frac{1}{\sqrt{2}}$ [illegible]

$$\frac{1}{2} = \frac{2 * 10^3}{(2*10^3 - \omega_c^2 (2*10^3 * 2 * 2*10^{-6})^2 + \omega_c^2 \, 2^2}$$

Slove for ω_c

$$\omega_c = 742 \, rad/s$$

4/8/2019
Sunday

- Decible Scale

$$G = 10 \log_{10} \frac{P_2}{P_1}$$

$$G = 20 \log_{10} \frac{V_2}{V_1}$$

- Bode - plots

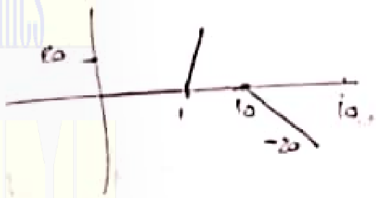
poles , zeroes. → slope (+)

$$H(\omega) = \frac{V_o \text{ (output)}}{V_i \text{ (input)}}$$

slope (-)

exa $H(s) = \frac{5000 s + 50000}{s^2 + 501 s + 500}$

sol, $\frac{5000 s + (50000)}{(s+1)(s+500)}$



$$= \frac{50000\left(\frac{s}{10} + 1\right)}{500\left(\frac{s}{1}+1\right)\left(\frac{s}{500} + 1\right)}$$

$\log(AB) = \log A + \log B$

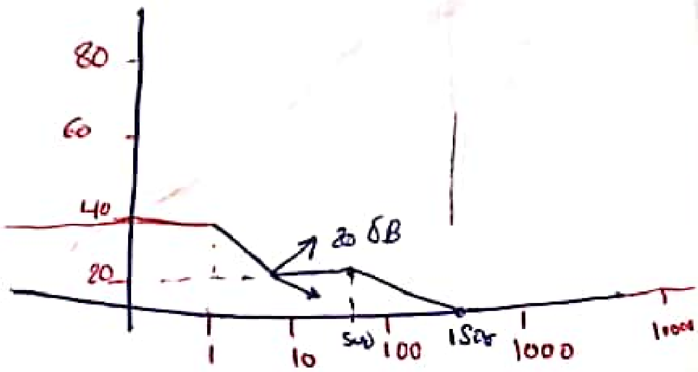
$\log\left(\frac{A}{B}\right) = \log A - \log B$

$$= \frac{100\left(\frac{s}{10} + 1\right)}{\left(\frac{s}{1}+1\right)\left(\frac{s}{500} + 1\right)}$$

40 dB

$\underline{20 \log 100} + 20 \log\left(\frac{s}{10} + 1\right) - 20 \log\left(\frac{s}{1} + 1\right) - 20 \log\left(\frac{s}{500} + 1\right)$

$$\frac{\left(\frac{s}{z_1} + 1\right)\left(\frac{s}{z_2} + 1\right) \cdots}{\left(\frac{s}{p_1} + 1\right)\left(\frac{s}{p_2} + 1\right) \cdots}$$



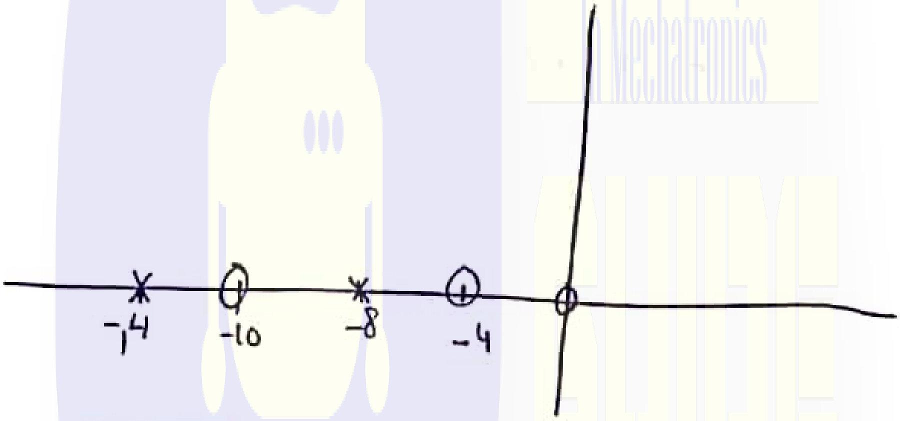
exe

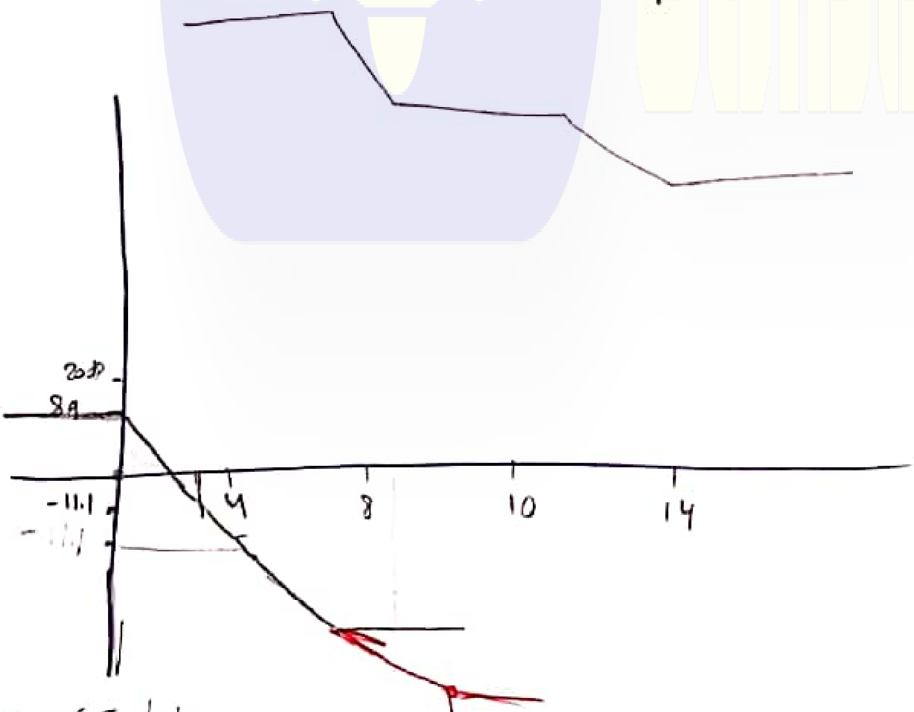
$$H(s) = \frac{(S+8)(S+14)}{s(s+4)(s+10)} \quad j\omega$$

$$\frac{\overset{2}{\cancel{8}}\left(\frac{s}{8}+1\right)\cdot \overset{1.4}{\cancel{14}}\left(\frac{s}{14}+1\right)}{\cancel{4}s\left(\frac{s}{4}+1\right)\cancel{10}\left(\frac{s}{10}+1\right)}$$

$$= \frac{2.8\left(\frac{s}{8}+1\right)\left(\frac{s}{14}+1\right)}{s\left(\frac{s}{4}+1\right)\left(\frac{s}{10}+1\right)}$$

(4)



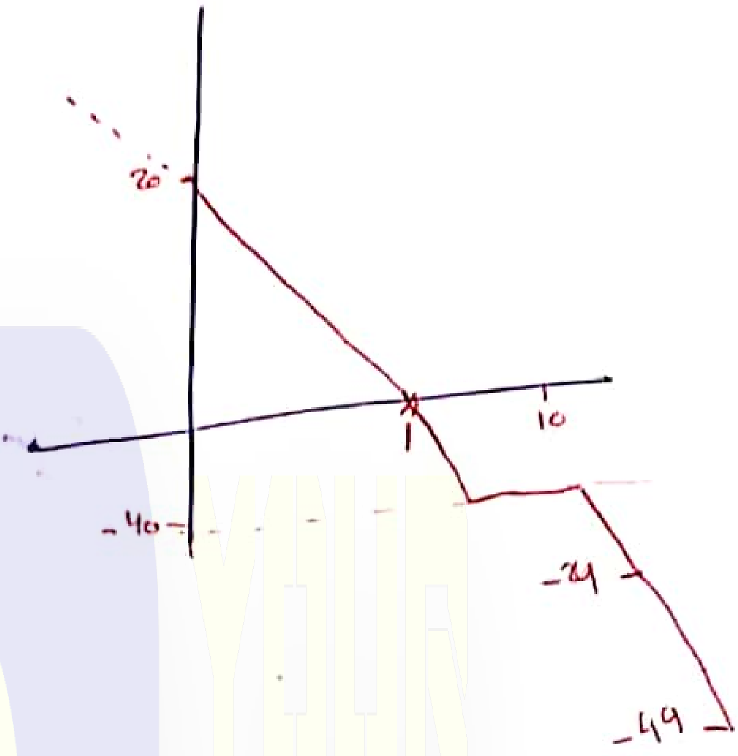


14.3(5 $\frac{1.1}{5}$

exa

$$H(\omega) = \frac{5(j\omega+2)}{j\omega(j\omega+10)}$$

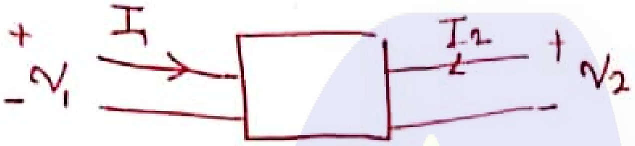
$$= \frac{5(2)(\frac{s}{2}+1)}{10\, s(\frac{s}{10}+1)}$$



Two Ports Networks :-

Monday
5/8/2019

Impedance parameters (Z)



$V_1 = I_1 Z_{11} + I_2 Z_{12} \rightarrow (1)$

$V_2 = I_1 Z_{21} + I_2 Z_{22} \rightarrow (2)$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$Z_{11} = \frac{V_1}{I_1} \Big|_{I_2=0}$

$Z_{12} = \frac{V_1}{I_2} \Big|_{I_1=0}$

$Z_{21} = \frac{V_2}{I_1} \Big|_{I_2=0}$

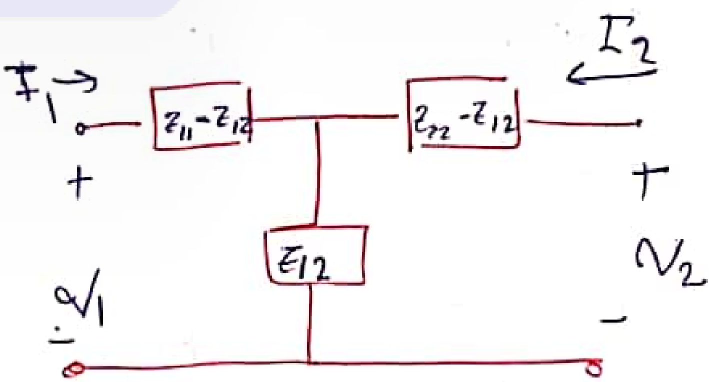
$Z_{22} = \frac{V_2}{I_2} \Big|_{I_1=0}$

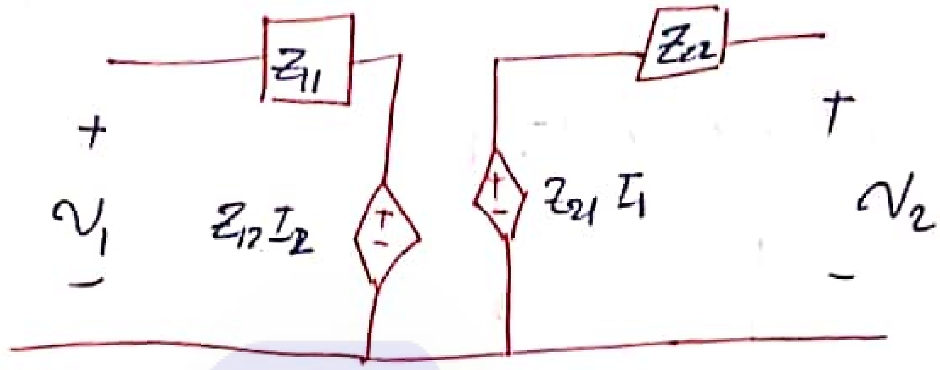
if $\boxed{Z_{11} = Z_{22}}$ symmetrical Network

if the network is Linear [No dependent source]

$\boxed{Z_{21} = Z_{12}}$ $\boxed{\text{receprical network}}$

(1)





exa-

Sol:-

$Z_{12} = 40\,\Omega = Z_{21}$

$Z_{11} = 40 + 20 = 60\,\Omega$

$Z_{22} = 30 + 40 = 70\,\Omega$

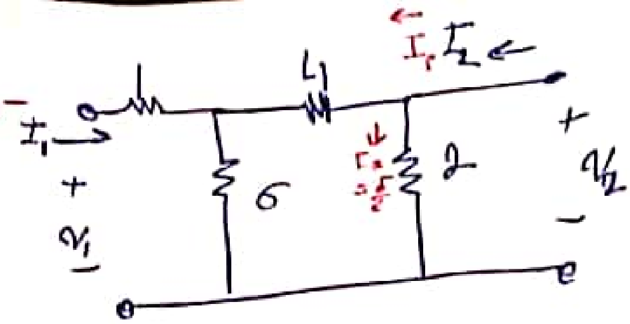
$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = \frac{(20+40)\cancel{I_1}}{\cancel{I_1}}\Big|_{I_2=0} = 60\,\Omega$

$Z_{21} = \frac{40\cancel{I_1}}{\cancel{I_1}}\Big|_{I_2=0} = 40\,\Omega$

$Z_{12} = \frac{40\cancel{I_2}}{\cancel{I_2}}\Big|_{I_1=0} = 40\,\Omega$

$Z_{22} = \frac{(30+40) I_2}{I_2}\Big|_{I_1=0} = 70\,\Omega$

exg-



Sol

to find Z_{21}

$V_2 = 2\frac{I_1}{2} = I_1$

$Z_{21} = \frac{I_1}{I_1}\Big|_{I_2=0} = 1\Omega$

to find Z_{22}

$V_2 = \frac{5}{6} I_2 (2) = \frac{10}{6} I_2$

$Z_{22} = \frac{10}{6}\frac{\times I_2}{I_2}\Big|_{I_1=0} = \frac{10}{6}\Omega = \frac{5}{3}\Omega$

$I_x = \frac{I_2 \times 2}{12} = \frac{I_2}{6}$

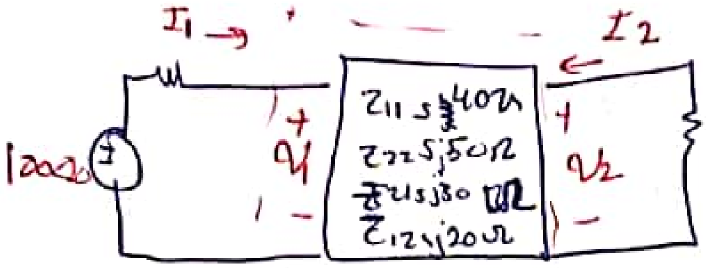
$V_1 = \frac{I_2}{6}\times 6 = I_2$

$Z_{12} = \frac{I_2}{I_2} = 1\Omega$

$V_1 = I_1(1) + \overset{3}{\cancel{\frac{6}{2}}}(I_1)$

$V_1 = 4I_1$

$Z_{11} = \frac{4I_1}{I_1}\Big|_{I_2=0} = 4\Omega.$



Sol

$V_1 = 100 + 5 I_1$

$V_1 = I_1 Z_{11} + I_2 Z_{12}$

$V_2 = I_1 Z_{21} + I_2 Z_{22}$

$100\angle 0 = 40 I_1 + j20 I_2$

$-10 I_2 = 30j I_1 + j50 I_2$

$0 = 30j\, I_1 + (10 + 50j) I_2$

$V_2 = -10 I_2$

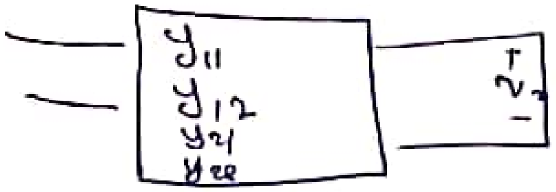
$\Delta = \begin{bmatrix} 40 & 20j \\ -30j & 10+j50 \end{bmatrix}$ $\quad I_1 = \frac{D_1}{\Delta}$

$D_1 = \begin{bmatrix} 100\angle 0 & 20j \\ 0 & 10+50j \end{bmatrix}$ $\quad I_2 = \frac{\Delta_2}{\Delta}$

$D_2 = \begin{bmatrix} 40 & 100\angle 0 \\ -j30 & 0 \end{bmatrix}$

Admittance parameter

Tuesday
6/8/2019



$$\boxed{\begin{aligned} I_1 &= y_{11} V_1 + y_{12} V_2 \\ I_2 &= y_{21} V_1 + y_{22} V_2 \end{aligned}}$$

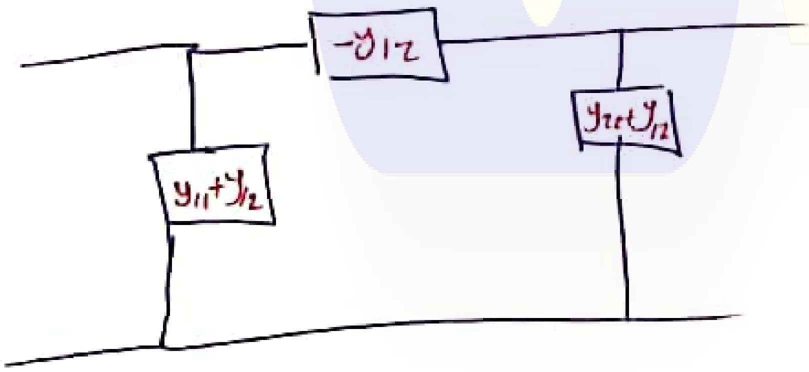
$y_{11} = \frac{I_1}{V_1} \Big|_{V_2 = 0}$ S.C input impedance.

$y_{12} = \frac{I_1}{V_2} \Big|_{V_1 = 0}$
$y_{21} = \frac{I_2}{V_1} \Big|_{V_2 = 0}$ } S.C transfer admittance.

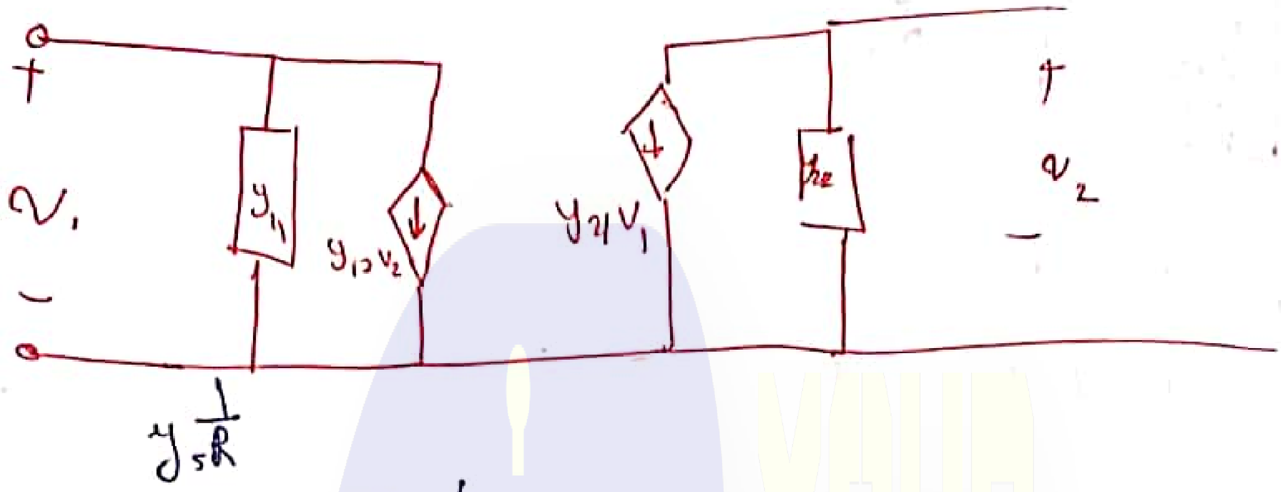
$y_{22} = \frac{I_2}{V_2} \Big|_{V_1 = 0}$ } S.C O/P admittance
output

~~Linear~~

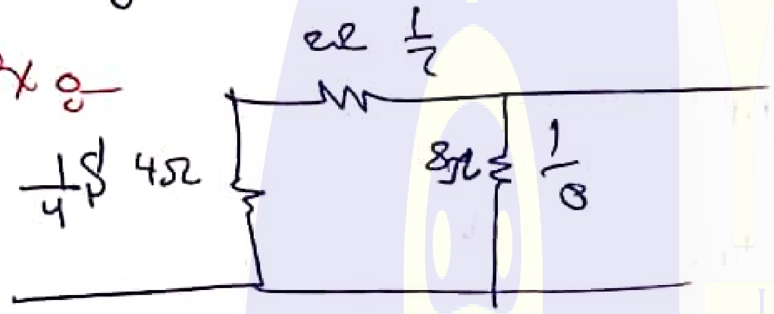
Linear network (No dependent source)



If the network is Not recepurcal



Ex:



$y_{21} = y_{12} = -\frac{1}{2}$ S

$y_{11} + y_{12} = \frac{1}{4}$

$y_{11} = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$ S

→ $y_{22} + y_{12} = \frac{1}{8}$

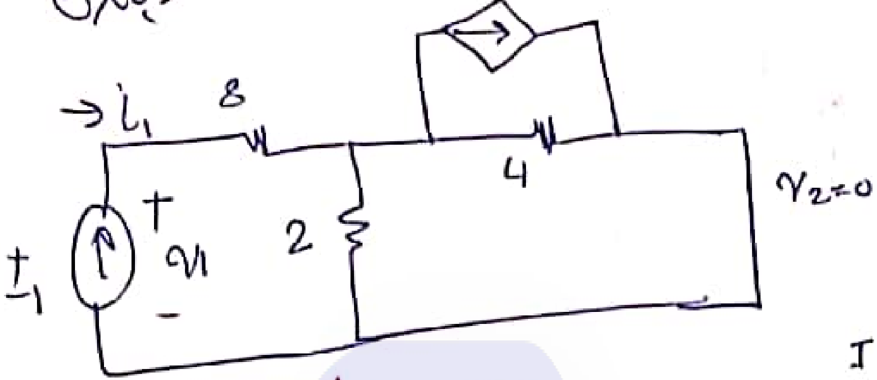
→ $y_{22} = \frac{5}{8}$

or
$y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$

⋮

2

ex:-



$I_1 = y_{11} V_1 + y_{12} V_2$

$I_2 = y_{21} V_1 + y_{22} V_2$

$y_{21} = \frac{I_2}{V_1}\Big|_{V_2 = 0}$

$y_{11} = \frac{I_1}{V_1}\Big|_{V_2 = 0}$

Mesh 2

$4I_x - 8I_1 + 2(I_x - I_1) = 0$

$6I_2 - 10I_1 = 0$

$I_x = \frac{10}{6} I_1$

$I_1 = \frac{6}{10} I_x$

$v_1 = 8I_1 + 2(I_1 - \frac{10}{6} I_1)$

$v_1 = 8I_1 + 4I_2 - 8I_1$

$v_1 = 8I_1 + 2I_1 - \frac{10}{3} I_1$

$v_1 = (\frac{30}{3} - \frac{10}{3}) I_1$

$v_1 = \frac{20}{3} I_1$

$y_{11} = \frac{I_1}{v_1} = \frac{2}{30} = 0.15$ S

$v_1 = 8I_1 + 2(I_1 - I_x)$

$= 8(\frac{-3}{5} I_2) + 2(\frac{-3}{5} I_2 - 2(\frac{-I_2}{3}$

$v_1 = \frac{-\frac{4}{2}}{5} I_2 + \frac{6}{5} I_2 + 2I_2$

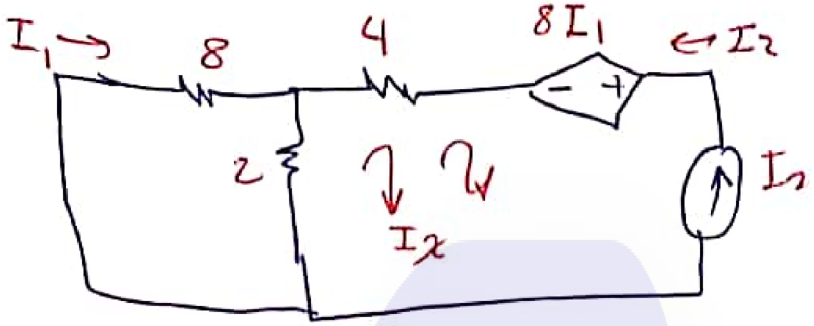
$v_1 = I_2\left(\frac{-\frac{4}{2} - 6 + 10}{5}\right)$

$v_1 = I_2\left(\frac{-20}{5}\right)$

$v_1 = -4 I_2$

$y_{21} = \frac{I_2}{v_1} = \frac{-1}{4}$ S

تكملة سؤال



$I_x = -I_2$

$y_{12} = \frac{I_1}{V_1}\Big|_{V_1=0}$

$y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$

$I_1 = -I_2 \frac{2}{10} = -\frac{1}{5} I_2$

$\boxed{I_2 = -5 I_1}$

$V_2 = 8I_1 + 4I_2 - 8I_1$

$= \cancel{8I_1} + 4(-5I_1) \cancel{- 8I_1}$

$V_2 = -20 I_1$

$y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = -\frac{1}{20}\ S$

$V_2 = -20 I_1$

$V_2 = -20 I_1$

$V_2 = -20 \left(-\frac{1}{5} I_2\right)$

$V_2 = +4 I_1$

$y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{4}\ S$