Electrical Circuits (B)

Section (2)

(22-2) → (24-2) /2015

مطبعة جامعة بنها

اسئلة هنا تشمل حسابات V, I في branch معين (مش كل القيم الادارية)

* Sheet (1) , Problems (5-7) + extra.

## [5] SuperPosition Theorem.

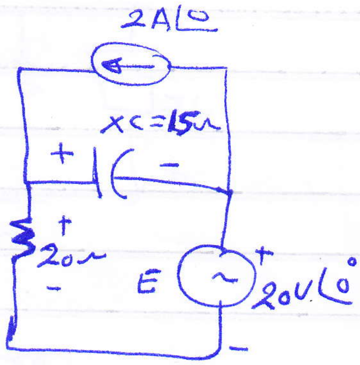
(الغي كل الـ sources ما عدا واحد فقط ثم كرر العمليات مع كل source آخر لو فيه ٣ ⟸ اعمل ٣ مرات)

(1) Replace each CS with O.C and Vs with SC

(2) calc. I, V for Branches Required in both separated Cases (CS, VS) Then $V_T = V_{oc} + V_{sc}$

يعني مرة نلغي الـ CS ونحسب التيار والجهد ومرة تانية نلغي الـ VS ونعيد الحسابات ونجمع الـ تيارات والجهود الكلية

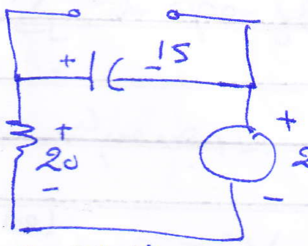
**example** Calc $V_R, V_C$




[1] let current source open circuit

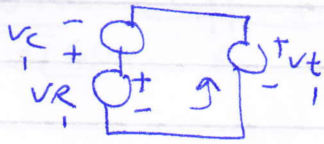
Required $V_{R_1}, V_{C_1}$

Use voltage divider




1- $V_{R_1} = \dfrac{20\angle 0 \times 20}{20 - j15} = 16\angle 36.8^\circ$

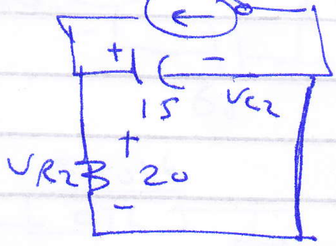
~~$V_t$ = 20 * ∠-15 $V_t$~~




$\Sigma V = 0 \quad + V_{t_1} + V_{c_1} - V_{R_1} = 0 \qquad V_R = V_{c_1} + V_{t_1}$

2. $V_{c_1} = V_{R_1} - V_{t_1} = 24\angle -53 - 20\angle 0$

[2] Now let VS → SC




$\therefore V_{c_2} = V_{R_2} = I_t \times Z_t$

$= 2\angle 0 \times \left(\dfrac{20 \times -j15}{20 - j15}\right)$

$V_c = V_{R_2}$

~~$= 2\angle 0 \times 12\angle -53$~~ $= 24\angle -53^\circ$

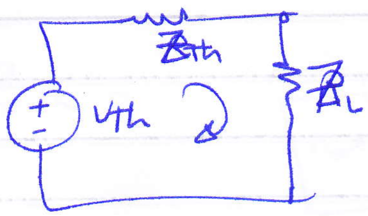
$\therefore V_{ct} = V_{c_1} + V_{c_2} = $ ——

$V_{Rt} = V_{R_1} + V_{R_2} = 16\angle 36.8 + 24\angle -53$

②

# 6_ Thevenin's

اختصار الدائرة لتصبح مكافئة للشكل التالي

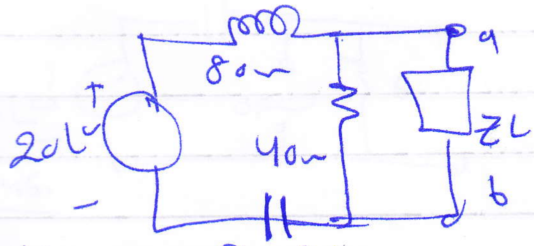



تستخدم لما الكورنتات I، V، $Z_L$
في دائرة كبيرة جداً او انا بدور branch والمطلوب
اذا نختصر الدائرة للشكل :.

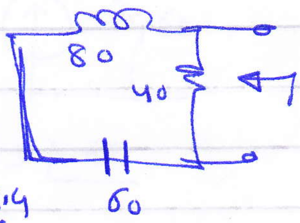
$I_{Z_L} = \frac{V}{Z_L + Z_{th}}$
$V_{Z_L} = I \times Z_L$

$V_{Th}$ → o.c voltage at load Terminals
$Z_{Th}$ → equivalent circuit of loads at terminals (when sources off)

ex [6] Sheet
find thevenin equivalent at $Z_L$

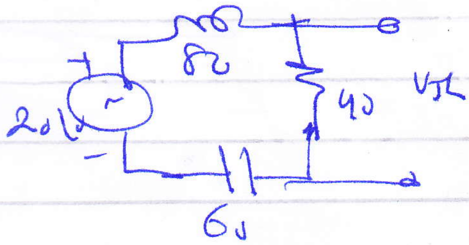



[1] Zth
اعتبر $Z_L$ is open واستبدل كل vs بـ short
CS بـ open
$(X_c + X_L) // R$ الان بحسب الجمع الموازي

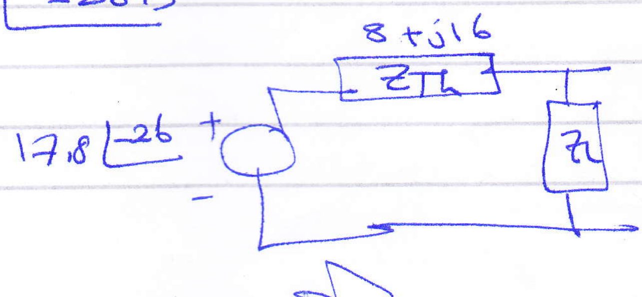



$\therefore Z_{Th} = \frac{40 \times (j80 - j60)}{40 + (j80 - j60)} = 8 + j16 = 17.8 \angle 63.4$

② $E_{th} = V_{th} = V_{Load} = V_{40\Omega}$

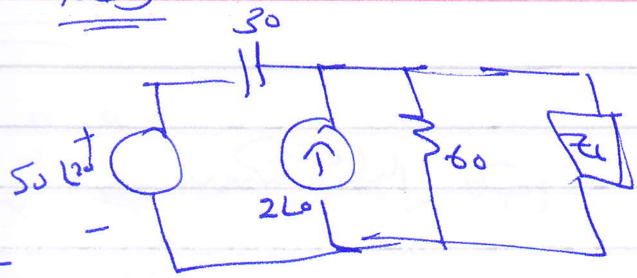



$= \frac{20\angle 0 \times 40 \angle 0}{j80 - j60 + 40}$
$= 17.8 \angle -26.5$



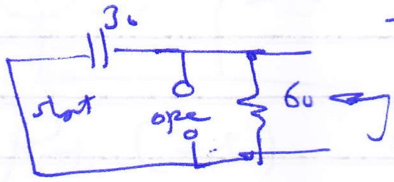
③

ملاحظة



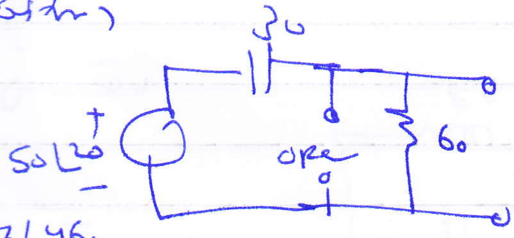

الحل ايضا

① $Z_{Th} =$




$60 \,//\, (-j30)$

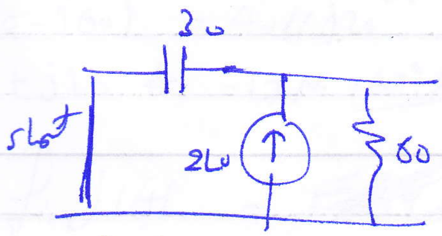
② $V_{th}$ ?! (superposition)




$V_{L1} = \frac{50\angle 20° \times 60}{60 - j30} = 44.7\angle 46.$

$V_{L2} =$ current divider

~~$\frac{20 \times (-j30)}{60 - j30}$~~



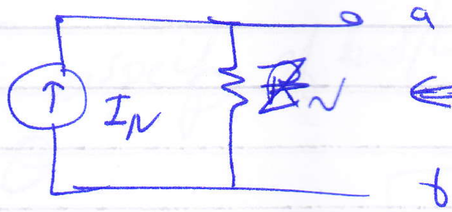

$i \times Z_t = 20 \times \left(\frac{60 \times -j30}{60 - j30}\right) = 53\angle -63$

$V_{L\,total} = V_{th} = V_{L1} + V_{L2} = 56.9\angle -15$

(4)

## 7- Norton's

ex

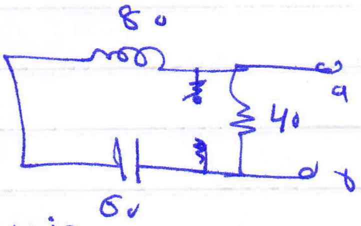



[illegible Arabic note]

[1] $Z_N = R_{Th}\ (Z_{Th})$ [illegible Arabic note]

[2] $I_N = \dfrac{V_{Th}}{Z_{Th}}$

[illegible Arabic note]




[1] $Z_N = Z_{Th} =$

$40 // (j80 - j60) = 40 // j20$

$= 8 + j16 = 17.89 \angle 63.5$

[2] $I_N = \dfrac{V_{Th}}{Z_{Th}}$ , so find $V_{Th}$ = ~~56.9∠45~~ $17.89 \angle -26.5$

$= \dfrac{\sout{56.89 \angle 45}}{\sout{17.89 \angle 63}}$ $\dfrac{17.89 \angle -26.5}{17.89 \angle 63.5} = 1 \angle 63 + 26.5$

$= 1 \angle 90$

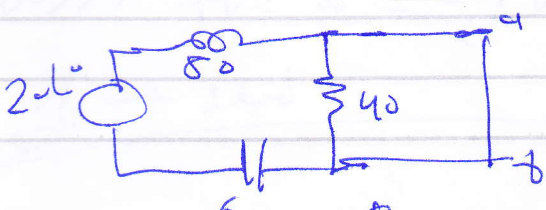
[illegible]

$I_N$ [illegible Arabic note]

SC [illegible Arabic note]

$I_{ab} = I_{40\Omega}$

$= \dfrac{20 \angle 0}{j80 - j60} = 1 \angle -90$

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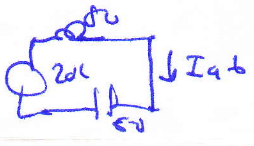

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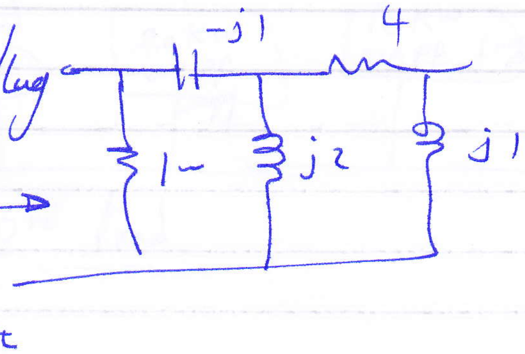
# lead / lag Power factor

① find Pf , specify if lead/lag




sol/ $Pf = \cos\theta$

$Z_t =$

$= \left[ (4+j1) \,//\, j2 + (-j1) \right] // 1$

$= \left[ \frac{(4+j)(2j)}{4+j+2j} - j \right] // 1$

$= \left( \frac{8j-2}{4+3j} - j \right) // 1$

$= \left( \frac{8j - 2 - 4j + 3}{4+3j} \right) // 1$

$= \frac{4j+1}{4+3j} // 1 = \left( \frac{4j+1}{4+3j} \times \frac{4-3j}{4-3j} \right) // 1$

$= \frac{16j + 4 + 12 - 3j}{16+9} // 1 = \left( \frac{13j}{25} + \frac{16}{25} \right) // 1$

$= \frac{\left( \frac{13j}{25} + \frac{16}{25} \right)(1)}{\frac{13j}{25} + \frac{16}{25} + 1} = \frac{(0.52j + 0.64)}{0.5j + 1.64}$

$= 0.479 \angle 21.4°$

$Pf = \cos\theta = \cos 21.4 = 0.9309$

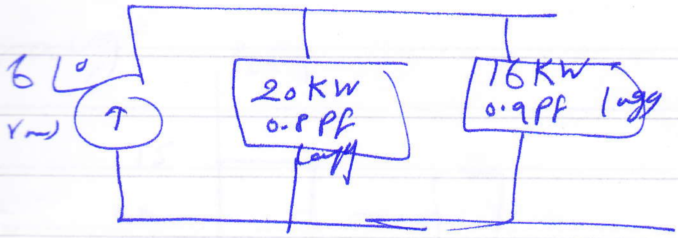
(زرنكوليو) +ve so I lag $V_{source}$

if -ve I lead

(6)

For ~~it~~ calc. $V_o$, i/p Pf

Sol




**1st load**

$P_1 = 16\ KW$

$Pf = 0.9$ (+ve = lag)

$i_1$ lag $v_1$ by $\theta_1$

$\theta = \cos^{-1}(0.9) = 25.84^\circ$

$= \theta v - \theta i$

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

$Q = P\tan\theta$

$= (16\times10^3)\tan 25.84$

$= 7749.15\ VAR$

$S_1 = P\cos\theta = 17KVA$

**2nd load**

$P_2 = 20kw$

$Pf = 0.8$ Lag, ∴ $i_2$ lag $v_2$ by $\theta_2$

∴ $\theta_2 = \cos^{-1}(0.8) = 36.87^\circ$

$= \theta v_2 - \theta i_2$

$Q_2 = P_2\tan\theta_2 = 20\times10^3 \tan 36.87$

$= 15000\ VAR$

$S_2 = P\cos\theta = 25KVA$

$S_t = 17 + 25 = 42\ KV = IV$ ~~X~~

$P_{tot} = 16k + 20k = 36K$

$Q_t = 7749.15 + 15000 = 22.749\ KVAR$

$\theta_t = \tan^{-1}\left(\frac{Q_t}{P_t}\right) = \tan^{-1}\left(\frac{22.7491}{36}\right) = 32.29^\circ$

∴ $Pf = \cos\theta_t = \cos(32.29) = 0.845$ (+ve = lagg)

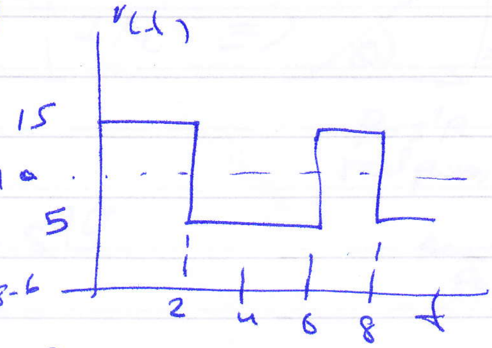
$|S_t| = \sqrt{Q_t^2 + P_t^2} = 42.585\ KVA$

$|S_t| = |I||V_o| = 6|V_o|$

∴ $V_o = 7097\ volt$

$\theta_t = \theta v - \theta i$ ∴ $\theta v = 32.29$

3. find RMS of signal, avg



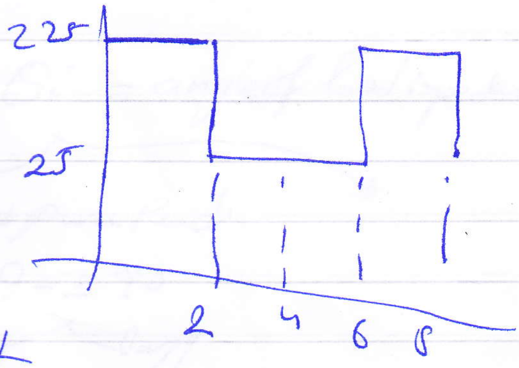

$$Avg = \frac{\text{area under curve}}{T\,(\text{base})}$$

$$= \frac{2\times 15 + (4\times 5) + 2\times 15}{8} = \frac{80}{8} = 10$$

(6-2, 8-6)

$$RMS = \sqrt{\frac{(\text{area under curve})^2}{T\,(\text{base})}} = \sqrt{\frac{?!}{8}}$$

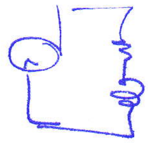
[illegible]



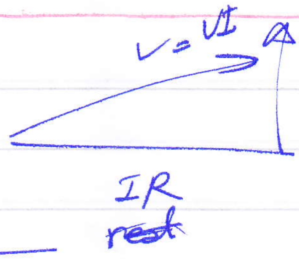

$$= \sqrt{\frac{2\times 225 + 4\times 25 + 2\times 225}{8}}$$

(8-6, 6-2)

$$= \sqrt{125} = 11.18 \text{ volt}$$



Notes:-

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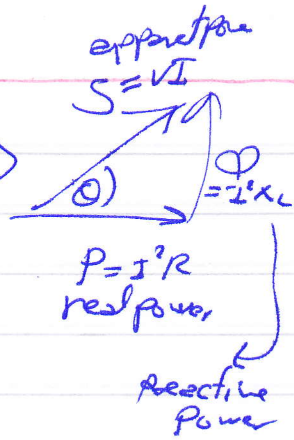


$$S = \sqrt{P^2 + Q^2} = VI = S\angle\theta$$

$$P = VI\cos\theta = S\cos\theta$$

$$Q = VI\sin\theta = S\sin\theta$$

→ If $Q = 0$ → resistive load

$Q < 0$ ⊖ → capacitive leading pf i lead v

$Q > 0$ ⊕ → inductive lagging pf i lag v

→ Power factor $\theta = \theta_v - \theta_i$ = angle of load impedance

pure Resistive load $\theta = 0$

pure Reactive $\theta = \pm 90$ lead / lagg