Electrical Circuit (B)

Section (1)

15 feb 2015 → 17 feb (2015)

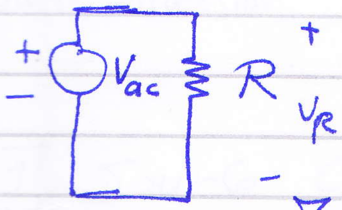
Revision

Sheet (1)

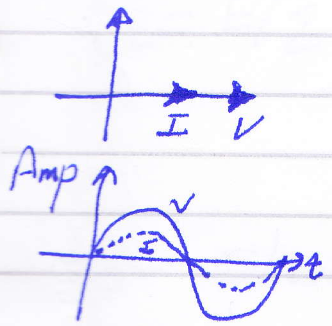
Dr Basem El Halawany

بسم الله الرحمن الرحيم

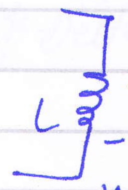
Revision
Section (1)



$v = IR$, $Z = \frac{V_R}{I}$



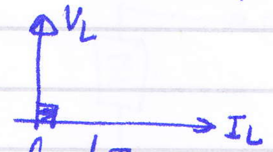
in phase



$V_L = L\frac{di}{dt}$

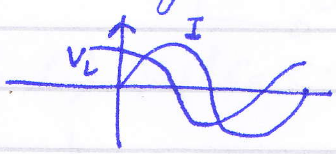
$= I(j\omega L)$

$V_L = (\omega L)(I)\angle 90^\circ$

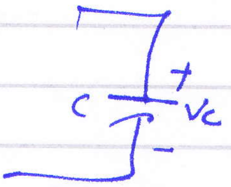


V lead I

I lag V

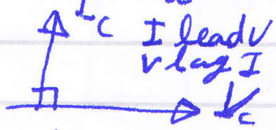


$Z_L = j\omega L = \omega L\angle 90$



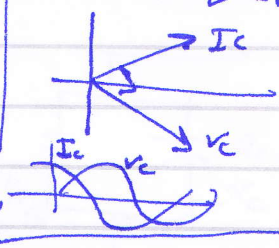
$V_c = \frac{1}{j\omega c} I_c$

$= -\frac{j}{\omega c} I_c = \left(\frac{I_c}{\omega c}\right)\angle -90$

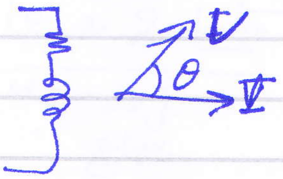


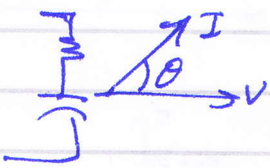
I lead V

V lag I



$\omega \rightarrow$ rate at which coil rotates in one second





% $Z = A + jB = \sqrt{A^2+B^2}\angle \tan^{-1}\left(\frac{B}{A}\right)$

% $Z = A\angle\theta = A\cos\theta + jA\sin\theta$

% $Z_1 = A_1\angle\theta_1$, $Z_2 = A_2\angle\theta_2$

$Z_1 Z_2 = A_1 A_2 \angle\theta_1+\theta_2$

$Z_1/Z_2 = A_1/A_2 \angle\theta_1-\theta_2$

$1/Z_1 = \frac{1}{A_1}\angle -\theta_1$

$\sqrt{Z_1} = \sqrt{A_1}\angle\theta_1/2$

% $\rightarrow e^{j\phi} = \cos\phi + j\sin\phi$

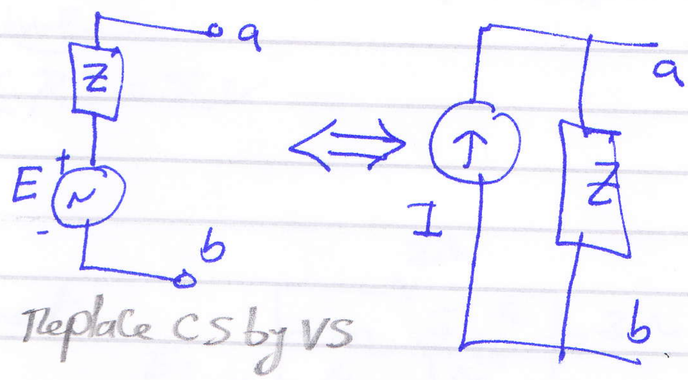
$\frac{1}{j} = -j$

② ac Analysis Theories

1. Source Conversion
2. Mesh (loop)
3. Nodal
4. Delta-wye / wye-Delta
5. Super Position
6. Thevinin
7. Norton

1 Source Conversion

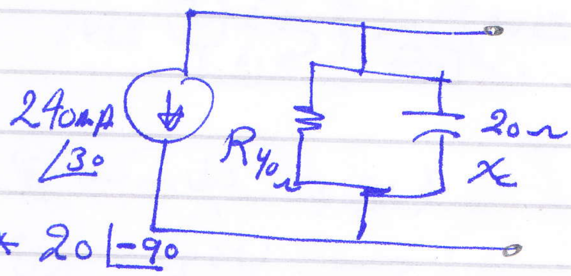
$I = E/Z$



ex Sheet 1 (Prob. 1) Replace CS by VS

$Z = R // X_c$ $\quad \left(20 = \frac{1}{\omega C}\right)$

$X_c = \frac{-j}{\omega_c} = -20j$



$= \frac{40 * (-20j)}{40 - 20j} = \frac{40\angle 0 * 20\angle -90}{40 - 20j}$

مرافق

$= \frac{800\angle -90}{\sqrt{(40)^2 + (20)^2}\ \angle \tan^{-1}\left(\frac{-20}{40}\right)}$

يفضل حساب الزاوية $\tan^{-1}\left(\frac{20}{40}\right)$ بالموجب
وإضافة إشارة (-) في الآخر

$= \frac{800\angle -90}{44.22\angle -26.57}$

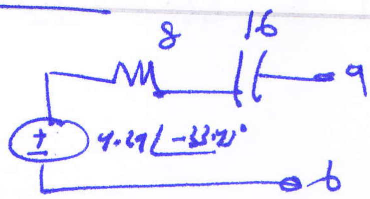
$= 17.89 \angle -90 - (-26.57) = 17.89 \angle -63.43^\circ$

$= 17.89 \cos(-63.43) + j \sin 17.89 \sin(-63.43)$

$Z = 8 - j16\ \Omega$

$E = IZ = 240mA\angle 30 * 17.89\angle -63.43$

$= 4.29 \angle -33.43^\circ$



③

[2] Mesh (loop)

الخطوات (الاعتماد على VS فقط)

ⓐ Convert Current Source → voltage Source.

ⓑ Redraw & simplify circuit, table Respects

$R_1, R_2, - L_1, L_2 -$

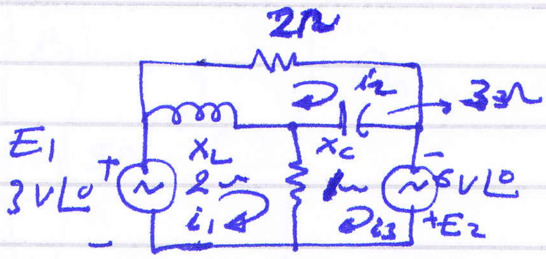
ⓒ choose loops & directions -

ⓓ Apply KVL $\Sigma RI = \Sigma V$

ⓔ Solve equations

ex (2) ... Sheet (1)

Solve by loop → loop current



Sol//

loop 1 → $\Sigma IR = \Sigma V$

(لو قابلت ـ ليطارىم كتب صحيحا + ●)

$3\angle 0 = i_1 (\overset{R}{1} + \overset{X_L}{j2}) - i_2 (2j) - i_3 (1) \longrightarrow (1)$

$0 = i_2 (2 + j2 - j3) - i_1 (j2) - i_3 (-j3) \longrightarrow (2)$

$+6\angle 0 = i_3 (1 - j3) - (1) i_1 - (-j3) i_2 \longrightarrow (3)$

$$\Delta = \begin{bmatrix} 1+j2 & -2j & -1 \\ -j2 & 2-j1 & +j3 \\ -1 & +j3 & 1-j3 \end{bmatrix}, \quad \Delta_1 = \begin{bmatrix} 3 & -2j & -1 \\ 0 & 2-j1 & j3 \\ 6 & +j3 & 1-j3 \end{bmatrix}$$

$$\Delta_2 = \begin{bmatrix} 1+j2 & 3 & -1 \\ -2j & 0 & +j3 \\ -1 & 6 & 1-j3 \end{bmatrix} \quad \Delta_3 = \begin{bmatrix} 1+j2 & -2j & 3 \\ -2j & 2-j1 & 6 \\ -1 & +j3 & 6 \end{bmatrix}$$

$i_1 = \Delta_1/\Delta = 5.26 \angle -41.25$

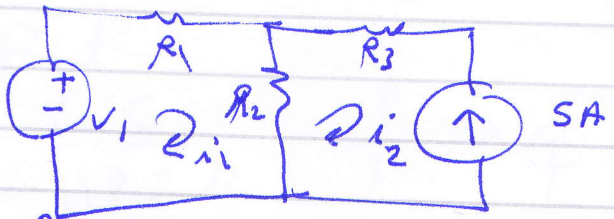
$i_2 = \Delta_2/\Delta = 3.18 A \angle -45$

$i_3 = \Delta_3/\Delta = 3.39 \angle -1.03^\circ$

Current Source لما يكون فيه

Notes ملاحظة

$i_2 = \cancel{5A} - 5A$



loop 1

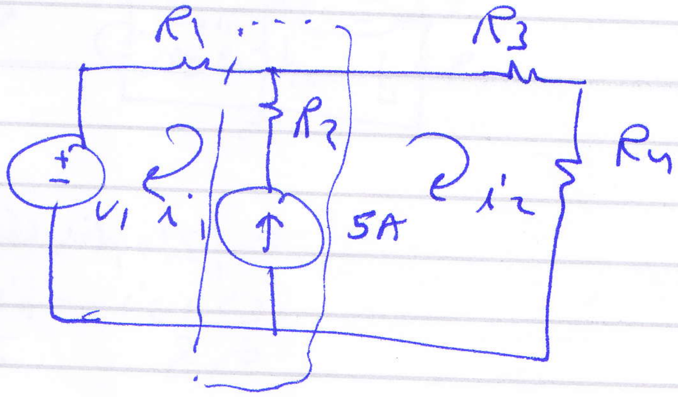
$i_1(R_1+R_2) - i_2 R_2 = +V_1$

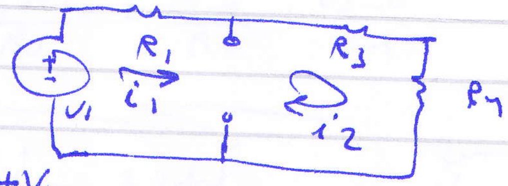
وتطلع صح

OR

① $5A = i_2 - i_1$

نحذف الفرع ده ونعمل loop كبيرة





$\cancel{i(R_1+R_2+R_3)}$

② $i_1(R_1) + i_2(R_3+R_4) = +V_1$

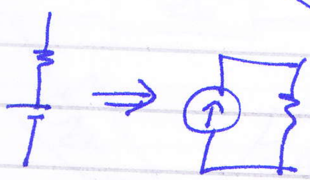
$\boxed{3}$ Nodal Analysis

الأهم هو $\boxed{C.S}$ ؟

a- Select Ref Point

b- Convert V.S to C.S

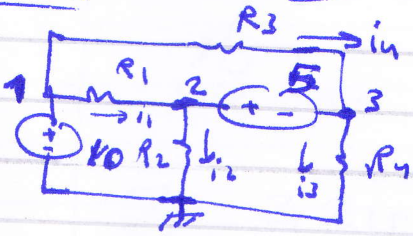
لا تحل



Notes ملاحظة

2,3 $\Rightarrow$ نعتبرهم نقطة واحدة

V_2 فرق جهد



1- $\boxed{V_2 - V_3 = V_2}$

2- $\boxed{V_1 - 0 = 10}$

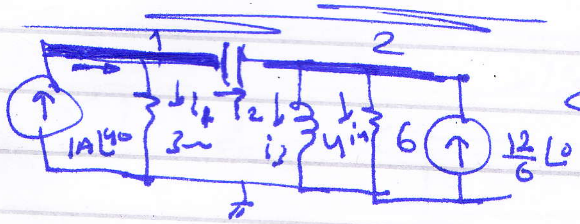
3- مجموع التيارات الداخلة للنقطة = مجموع التيارات الخارجة

at (2,3)

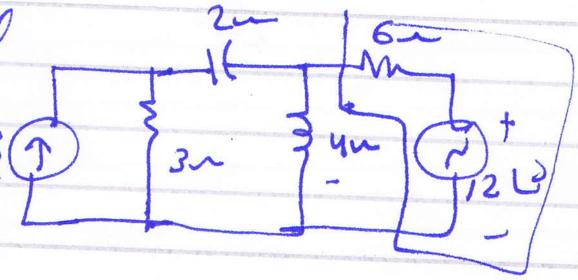
$$\underbrace{i_1 + i_4}_{\text{داخل}} = \underbrace{i_2 + i_3}_{\text{خ}}$$

$$\frac{V_1 - V_2}{R_1} + \frac{V_1 - V_3}{R_3} = \frac{V_2 - 0}{R_2} + \frac{V_3 - 0}{R_4}$$

ex (3) ... sheet(1) Nodal



$\Leftarrow$



at 1 $\quad 1\angle 40° = i_1 + i_2$

at 2 $\quad 2\angle 0 + i_2 = i_3 + i_4$

$Y_c = \frac{1}{2}j \,,\; Y_L = -j\frac{1}{4}$

$i_1 = \frac{V_1 - 0}{3} \longrightarrow (1)$

$i_2 = V_1 - V_2 / X_c = (V_1 - V_2) Y_c$

$i_2 = (V_1 - V_2) / (\frac{\cancel{1}}{j2}) = \frac{V_1 - V_2}{-j/2} = (V_1 - V_2)(j\frac{1}{2})$

$i_3 = \frac{V_2 - 0}{X_L} = V_2 Y_L = V_2(-j\frac{1}{4})$

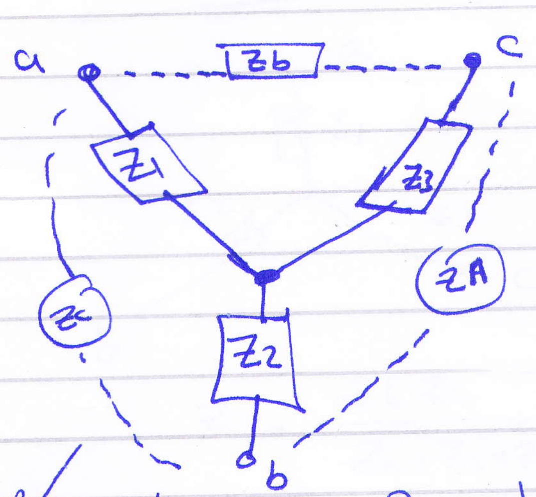
$i_4 = V_2 - 0/6$

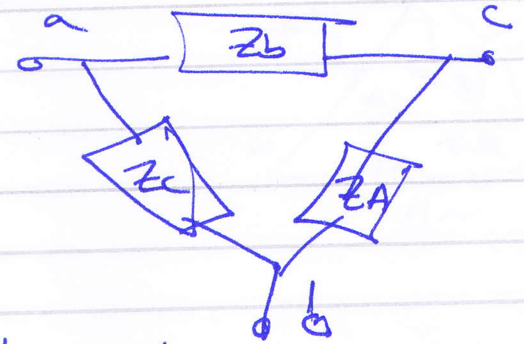
$V_1 = 5.29\angle 48.75°$

$V_2 = 5.8\angle 33.27$

وعلى ما يحل

4- $(\Delta - Y)$ & $(Y - \Delta)$





If we have $\Delta \rightarrow$ Req. Y

$$Z_1 = \frac{Z_b Z_c}{Z_a + Z_b + Z_c}$$

$$Z_2 = \frac{Z_a Z_c}{Z_a + Z_b + Z_c}$$

$$Z_3 = \frac{Z_a Z_b}{Z_a + Z_b + Z_c}$$

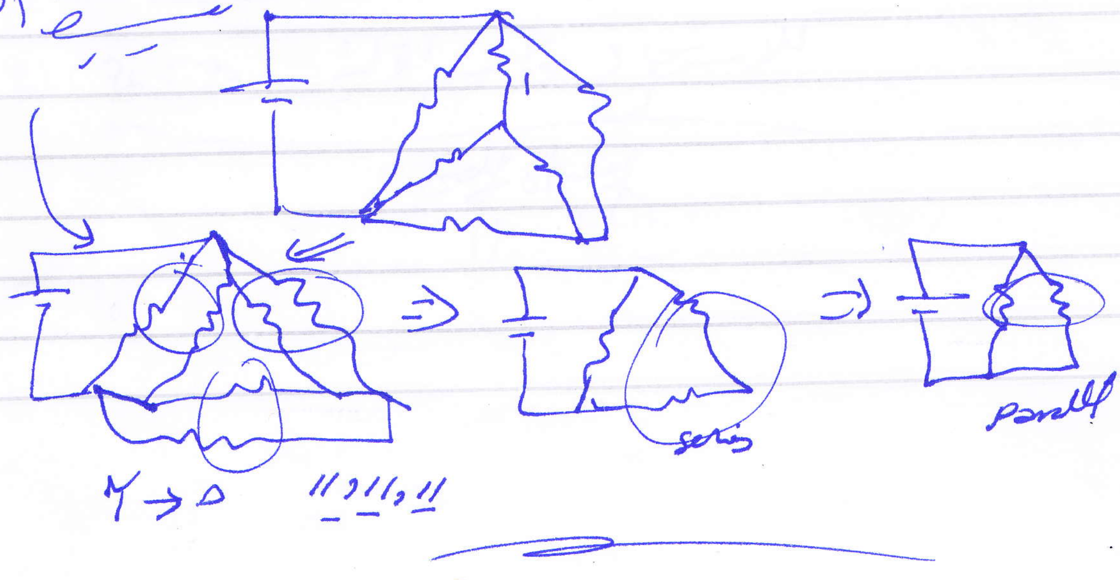
If we have $Y \rightarrow$ Req. Δ

$$Z_a = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_1}$$

$$Z_b = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_2}$$

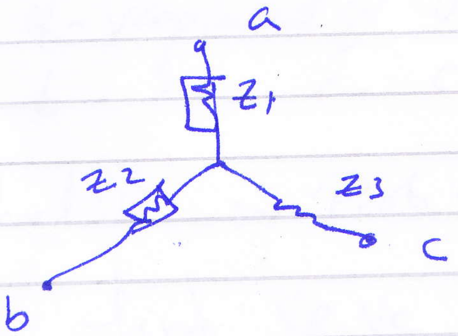
$$Z_c = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_3}$$

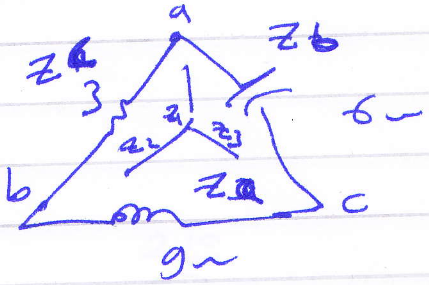
طريقة لاستخدام
تبسيط الدائرة



⑦

ex (4) sheet (1)





$$Z_1 = \frac{Z_b Z_c}{Z_a + Z_b + Z_c} = \frac{-j6 \times 3}{3 - j6 + j9} = \frac{-j18}{3 + j3} = \frac{18\angle -90}{4.2\angle 45}$$

$$Z_2 = \frac{Z_c Z_a}{Z_a + Z_b + Z_c} = \frac{j27}{3 + j3}$$

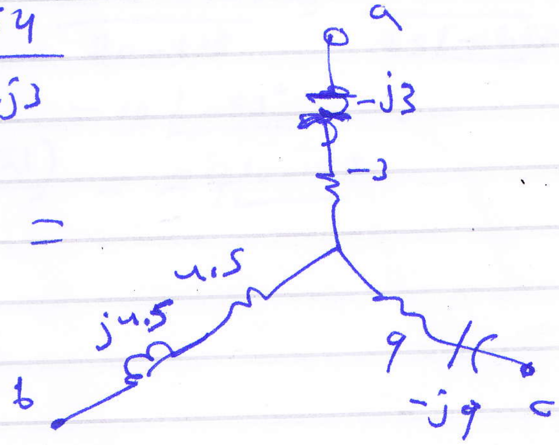
$$Z_3 = \frac{Z_b Z_a}{Z_a + Z_b + Z_c} = \frac{54}{3 + j3}$$

$Z_1 = -3 - j3$

$Z_2 = 4.5 + j4.5$

$Z_3 = 9 - j9$

=



للاستنتاج كيف بس القوانين Z_2 ، Z_b ، Z_a

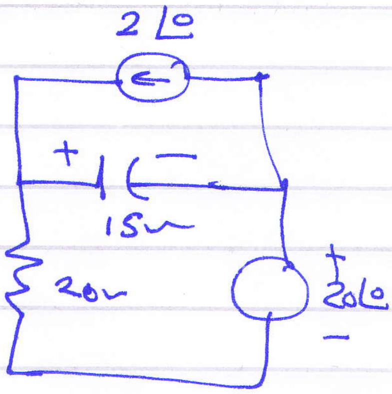
self study

8

5- Super Position

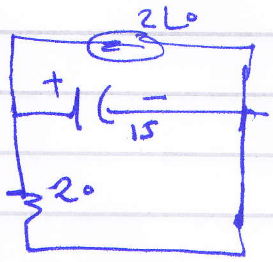
a- Replacement of V.S by S.C
b- // // C.S by O.C

Sheet (1) $\rightarrow$ Prob (5)



find V_R, V_C

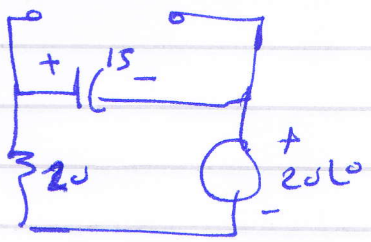
[a]



$Z_1 = R // X_C = 20 // -j15 = \dfrac{20 \times 15\angle -90}{20 - j15} = \dfrac{300\angle -90}{25\angle -36.87}$
$= 12\angle -53^\circ$

here
$V_{R_1} = V_{C_1} = I \times Z = (2\angle 0)(12\angle -53) = 24\angle -53$

[b]



$V_{R_2} = \dfrac{20\angle 0 \times 20\angle 0}{20 - j15} = 16\angle 36.87^\circ$

$V_{total} = 20 \therefore V_{C2} = \cancel{20 - 16\angle 36.87} \quad \dfrac{-15\angle 90 \times 20}{20 - j15}$
$= 12\angle 126$

$V_{R total} = V_{R1} + V_{R2} = 24\angle -53 + 16\angle 36.87 = 28.8\angle -19.44$

$V_{C total} = V_{C1} + V_{C2} = 12\angle -53^\circ$