ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

تلخيص فيرست وسكند لمادة:

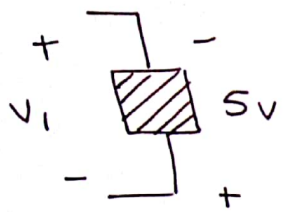
دوائر كهربائية (١)

جزيل الشكر للطالب:

موسى النجار

* تلخيص سيرت ١

* polarity:



$V_1 = -(5)v$

لما عكس الاقطاب.

* ohm's low:

① $I \rightarrow \overset{+}{\bigcirc} V_R \overset{-}{\bigcirc}$ — R

$V_R = IR$

(التيار داخل في الموجب)

② $I \rightarrow \overset{-}{\bigcirc} V_x \overset{+}{\bigcirc}$ — R

$V_x = -IR$

(التيار داخل في السالب).

* Example:

$I = ?$ $\rightarrow$ $\overset{+}{\bigcirc} V_x \overset{-}{\bigcirc}$ — $-12v+$ $\quad R = 1k.$

$I = \frac{V}{R} \rightarrow I = \overset{+}{\bigcirc} \frac{-V_x}{R}$: العبرة بالعطاء

لأنه داخل في الموجب

$= \frac{-12}{1} = -12A$ ✓

ملاحظة:

$-V_x = -12$

عكس القطبية

$V_x = 12.$

OR

$I = \frac{V}{R} = \overset{-}{\bigcirc} \frac{12}{1} = -12A$ ✓

داخل في السالب و 12 الي عطت

* Power:

$P_{abs} = \pm IV$ (For any element).

For R: على فرض التيار داخل في الموجب

$IV = \frac{V}{R} * V = \frac{V^2}{R}$.

$IV = I(IR) = I^2R$.

only For R

$P_{gen} = -P_{abs}$ لعنصر السالب.

* Power in real Life:

1. absorbed / dissipated / deliverd by.
   - + For R
   - − For S

2. Supplied / generated / deliverd into.
   - + For S
   - − For R.

* Resistors:

1. $R = 0$ ↓ Short cct (S.C). $V = 0$, $I = ?$

2. $R = \infty$ ↓ open cct (O.C) $I = 0$, $V = ?$

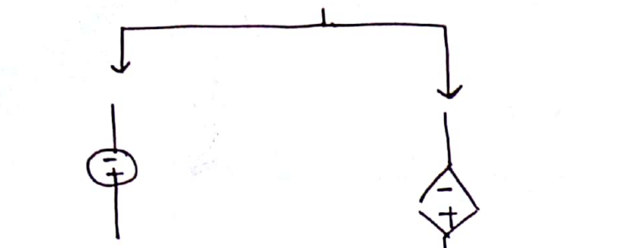
3. $0 < R < \infty$ ↓ —∿— V, I ohm's low.

* $G = \frac{1}{R}$ Ω^{-1}, Simens (conductance).

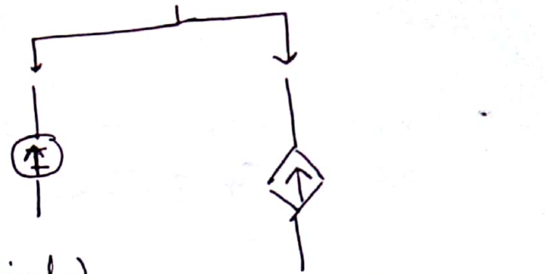
مقلوب المقاومة.

2.3 Voltage and current sources:

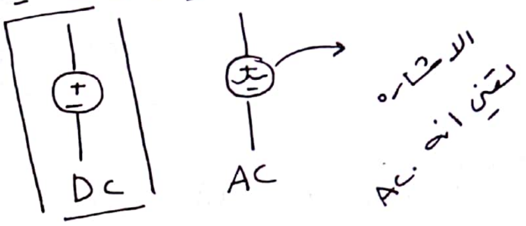
1. voltage source: (DC)



2. current source (DC)



* كل واحدة من الـ ٤ اللي فوق في منه AC و DC :

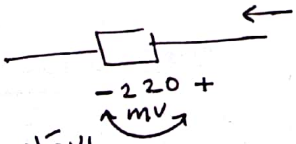


عادة الفيزكس فقط DC.

* The default power for: (إذا السؤال طلب الـ power بدون ما يحدد نوعها بستخدم الـ Default)
  - R → dissipated.
  - S → generated.

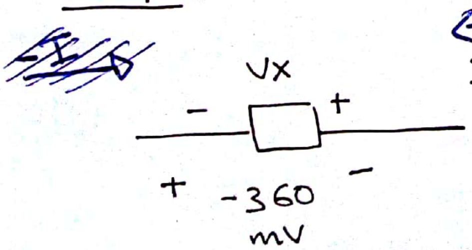
* P_{abs} :
  - $(+)$ → * اذا كان التيار داخل في الموجب سواء كانت مقاومة او سورس
  - $(-)$ → * اذا كان التيار داخل في السالب سواء كانت مقاومة او سورس.

* Practice 2.6:



$P_{abs} = +220 * 4 = 880\ mV.$

* Example:



$V_x = ?$

$P_{abs} = ?$

$P_{gen} = ?$

الحل في الخلف

* $V_X = -(-360) = 360$ mV.

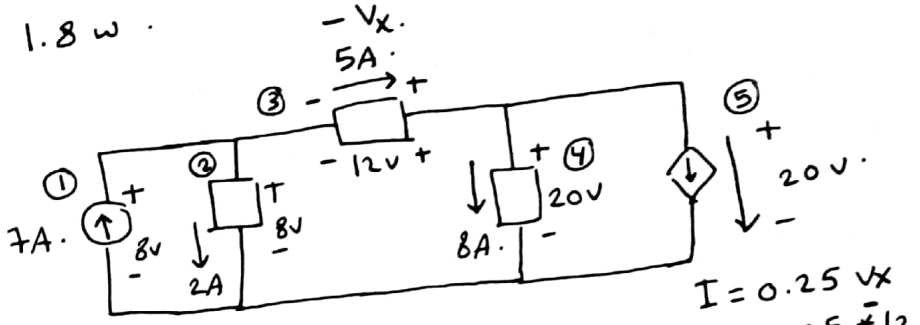
↳ عكس القطبية

* $P_{abs} = +IV_X = 5 * 360 = 1800$ mw $= 1.8$ w.

OR. $= -I(-360) = 5 * 360 = 1800$ mw $= 1.8$ W.

* $P_{gen} = -P_{abs} = -1.8$ w.

* Practice 2.9:



$I = 0.25\,V_X$

$= 0.25 * 12$

$= -3A$

Find V_X, P_{abs} For all elements.....

* Solution:

* رقم العناصر بداية عشان ما تخربط:

For ①: $P_{abs} = -IV = -7 * 8 = \underline{-56\ W}$.

For ②: $P_{abs} = +8 * 2 = \underline{16\ W}$.

For ③: $P_{abs} = -12 * 5 = \underline{-60\ W}$.

OR $= -I(-V_X) = IV_X = 5 * -12 = \underline{-60\ W}$.

* تذكر: $-V_X = 12$.

$V_X = -12$.

For ④: $P_{abs} = +20 * 8 = \underline{160\ W}$.

For ⑤: $P_{abs} = +20(0.25 * V_X)$

$= +20\ (0.25 * -12)$

$= \underline{-60\ Watt}$.

3: Voltage and current laws:

3:1 Nodes, Paths, loops and branches:

- node: نقطة مشتركة بين عنصرين او اكثر.
- Path: أي مسار (طويت) بدك اياه في الدائرة الكهربائية.
- loop: نفس الـ path ولكن نقطة البداية لازم تكون نفس نقطة النهاية
- branch: اي path تتكون من عنصر واحد مع الاطراف تبعتو.

3.2 KirchoFF's current low:

$\sum I = 0$ node.

* المجموع الجبري للتيارات الداخلة على اي node = صفر (على فرض ان جميع التيارات داخلة او خارجة).

* مجموع التيارات الداخلة = الخارجة.

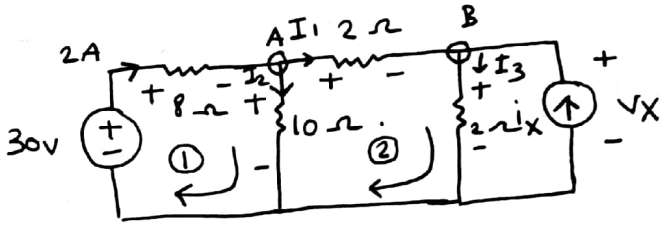
$$\sum I_{in} = \sum I_{out}$$

3.3 KirchoFF's voltage low:

* المجموع الجبري للجهود ضمن اي مسار مغلق (loop) = صفر.

* practice 3.4:

Find V_x? i_x??



*Solution:

KvL at loop 1:

$$-30 + 2(8) + I_2(10) = 0 \rightarrow I_2 = \frac{30 - 16}{10} = 1.4A.$$

KCL at node A:

$$I_{in} = I_{out} \rightarrow 2 = I_1 + I_2 \rightarrow I_1 = 2 - I_2 = 2 - 1.4 = 0.6A.$$

KvL at loop 2:

$V_x = 2 * I_3$

$$-10(I_2) + 2(I_1) + \boxed{I_3(2)} = 0$$

$$-14 + 1.2 + V_x = 0 \rightarrow V_x = 12.8\ V \checkmark$$

$$V_x = 2I_3 \Rightarrow I_3 = 6.4A$$

KCL at node B

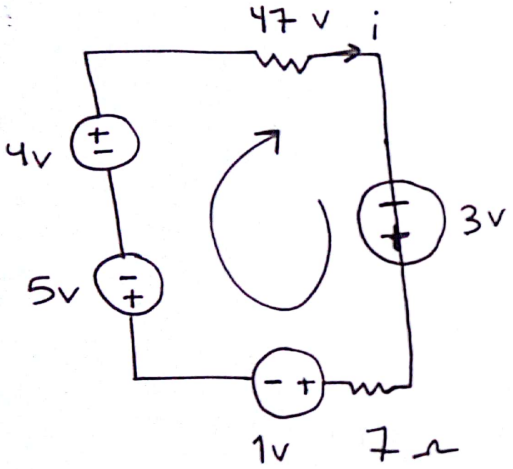
$$I_1 + I_x = I_3$$

$$0.6 + I_x = 6.4$$

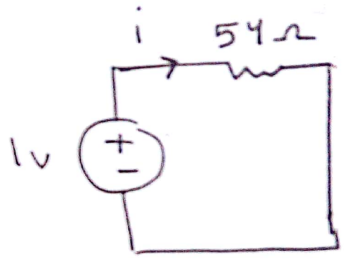
$$i_x = 5.8A$$

series voltage sources:

كمانون KVL



Find i?



- سيفل إلى هذا، تذكر -

KVL :

$$-3 + 7i + 1 + 5 - 4 + 47i = 0$$

$$54i - 1 = 0$$

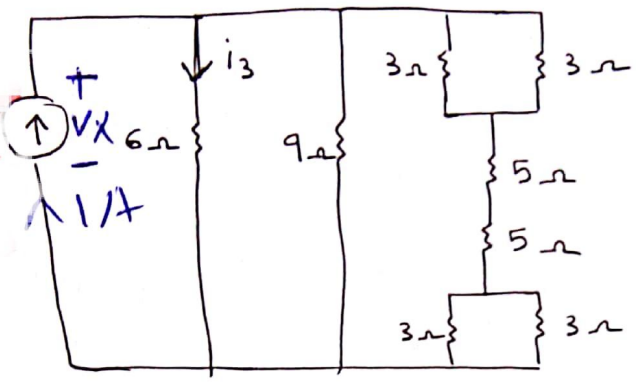
$$i = \frac{1}{54}\ A \longrightarrow i = \frac{V \to 1v}{R \to 54\ \Omega}$$

→ Series: $R_{eq} = R_1 + R_2 + \dots R_N$

→ parallel: $R_{eq}^{-1} = R_1^{-1} + R_2^{-1} + \dots R_N^{-1}$

$$R_{eq} = \left[R_1^{-1} + R_2^{-1} + \dots R_N^{-1}\right]^{-1}$$

* Practice 3.14:



Find V_x?

Sol:

$$R_{eq} = \left[(3 /\!/ 3) + 10 + (3 /\!/ 3)\right] /\!/ 9 /\!/ 6$$

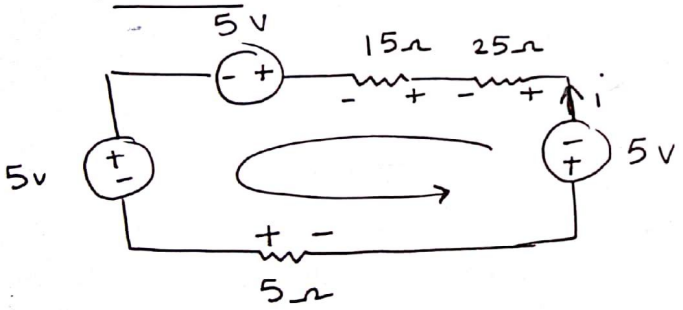
(1.5 and 1.5)

$$R_{eq} = 13 /\!/ 9 /\!/ 6$$

$$= \left(13^{-1} + 9^{-1} + 6^{-1}\right)^{-1} = 2.8192\ \Omega.$$

$$V_x = I R_{eq} = 1 * 2.8192 = 2.892\ V.$$

* Practice 3.12 :



Find i?

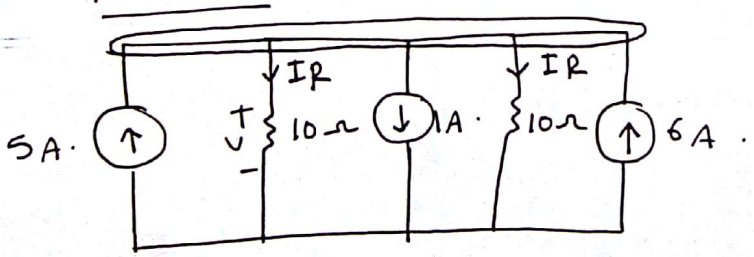
KVL:

$5 + i(45) + 5 + 5 = 0$

$45i = -15$

$i = -\frac{1}{3}\ A$ ✓

* Practice 3.13:



Find V?

$V = I_R * 10$

↓

?

KCL:

$5 + 6 = 2 I_R + 1$

$I_R = 5\ V \longrightarrow V = 50\ V.$

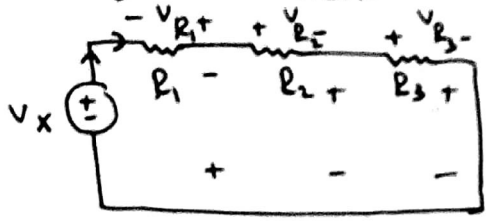
ال السابق: لو كانت المقاومات لستي متساوية مثلاً 5 ≠ 10:

$$5 + 6 = I_{R_{10}} + I_{R_5} + 1$$

$$10 = \frac{V}{10} + \frac{V}{5}$$ (نضع التيارات بدلالة الجهود والمقاومات (أوم))

$$10 = \frac{3V}{10} \rightarrow 3V = 100 \rightarrow \boxed{V = 33.33V}$$

* Voltage devision:



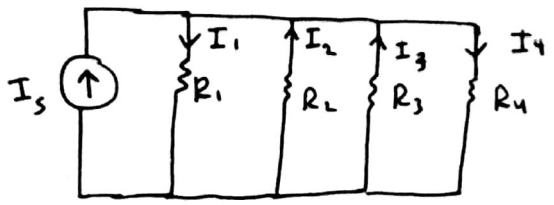
* شرط كلهم توالي Series.

$$V_{R_1} = -V_x \left(\frac{R_1}{R_1 + R_2 + R} \right)$$ لأنه عكس القطبية

$$V_{R_2} = +V_x \left(\frac{R_2}{Req} \right)$$

$$V_{R_3} = +V_x \left(\frac{R_3}{Req} \right)$$

* Current devider rule:



$$I_1 = +I_s \left(\frac{R_2 // R_3 // R_4}{R_1 + (R_2 // R_3 // R_4)} \right)$$ I_s مع

$$I_2 = -I_s \left(\frac{R_1 // R_3 // R_4}{R_2 + (R_1 // R_3 // R_4)} \right)$$ I_s عكس

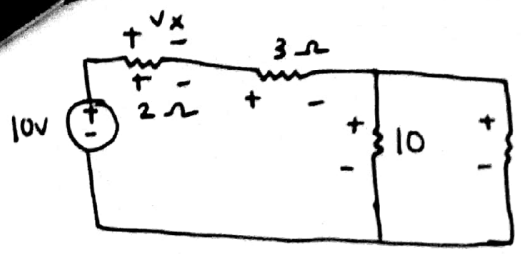
$$I_3 = -I_s \left(\frac{R_1 // R_2 // R_4}{R_3 + (R_1 // R_2 // R_4)} \right)$$

$$I_4 = +I_s \left(\frac{R_1 // R_2 // R_3}{R_4 + (R_1 // R_2 // R_3)} \right)$$

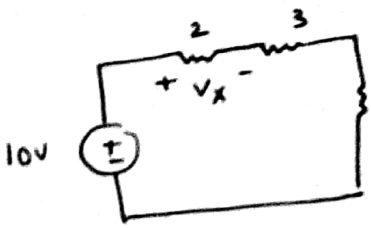
* البسط ← محصلة المقاومة اللي لا يمر فيها التيار المطلوب.

* المقام ← حاصل الجمع بين المقاومة المطلوبة عندها التيار ومحصلة المقاومة التي لا يمر فيها التيار المطلوب.

Practice 3.15:



Find Vx?



Series - لانهم كلهم بكون

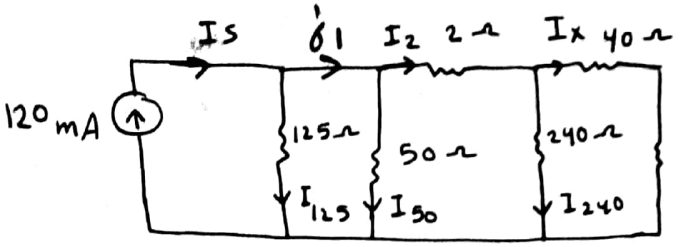
$$V_x = +10 * \left(\frac{2}{2+3+5}\right)$$

$$= 2V.$$

* Practice 3.16:

Find Vx?

$V_x = 20\, I_x$.



* عشان اطلع I_x لازم اطلع i_2 وعشان اطلع i_2 بدي i_1.

* $i = +\, i_s \left(\frac{125}{125 + R_x}\right)$ ماجبرنا = 100 mA ✓

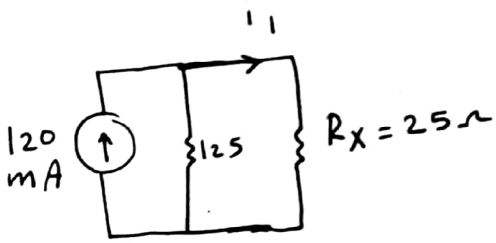
R_s.

* $R_s = R_x + 125$.

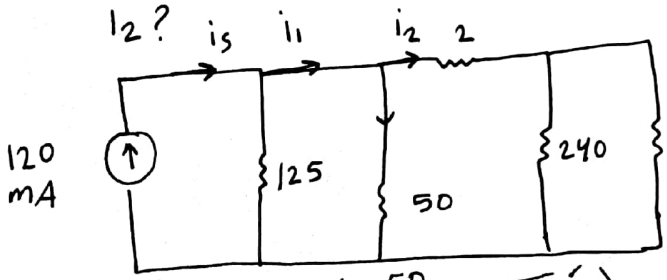
$$\left[\left[(20+40) \,//\, 240\right] + 2\right] \,//\, 50$$

$(60 \,//\, 240 = 48) + 2$

$= 50 \,//\, 50 = 25\,\Omega$.



عشان لازم Parallel



$$i_2 = i_1 \left(\frac{50}{50 + R_x'}\right)$$

$$= i_1 \left(\frac{50}{100}\right)$$

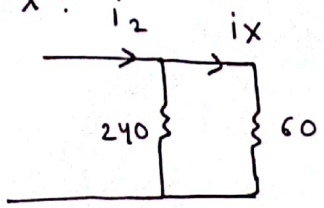
$= 50\,mA$.

$R_x' = [60 \,//\, 240] + 2$

$= 48 + 2 = 50$

- كملة الحل في الملف

i_x ?



$$i_x = \left(\frac{240}{240+60}\right) i_2 = 40\,mA$$

$$V_x = i_x * 20 = 40 * 20 = 800\,mV = 0.8\,V$$

* CH. 4: Nodal and mesh analysis:

* nodal (KCL):

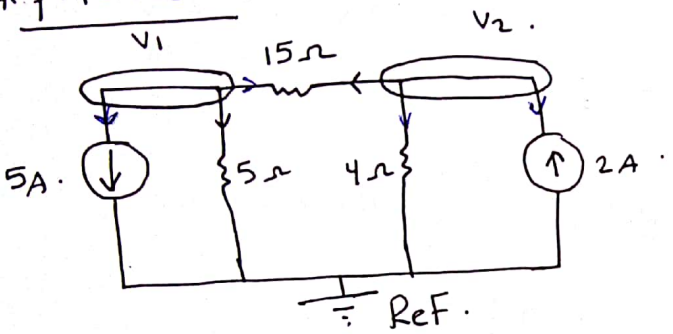
١. نحدد النقطة المرجعية (ref).

٢. نحدد الـ $V_1, V_2, V_3, \ldots$

٣. نستخدم قانون آدم للتعبير عن التيارات بدلالة الجهود.

٤. نحل المعادلات على الآلة الحاسبة.

* practice 4.1:



KCL.

① apply KCL at node V_1:

$$5 + \frac{V_1}{5} + \frac{V_1 - V_2}{15} = 0$$

$$V_1\left(\frac{1}{5} + \frac{1}{15}\right) + V_2\left(\frac{-1}{15}\right) = -5$$

$$\boxed{0.267\,V_1 - 0.067\,V_2 = -5} \rightarrow ①$$

② apply KCL at node V_2:

$$-2 + \frac{V_2}{4} + \frac{V_2 - V_1}{15} = 0$$

$$V_2\left(\frac{1}{4} + \frac{1}{15}\right) + V_1\left(\frac{-1}{15}\right) = 2$$

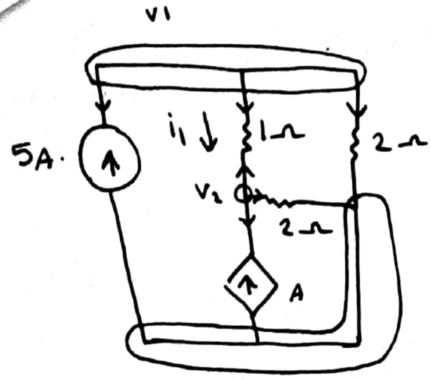
$$0.317\,V_2 - 0.067\,V_1 = 2$$

$$\boxed{-0.067\,V_1 + 0.317\,V_2 = 2} \rightarrow ②$$

$$V_1 = -18.1\,V$$

$$V_2 = 2.482\,V$$

...tice 4.3 :



لس Ref = 0V.

Find V_1 : ① if $A = 2i_1$ and if ② $A = 2V_1$?

: SoL :

* KCL at V_1: $-5 + \frac{V_1 - V_2}{1} + \frac{V_1 - 0}{2} = 0 \rightarrow \boxed{3V_1 - 2V_2 = 10} \rightarrow$ ①

* KCL at V_2: $\frac{V_2 - V_1}{1} + \frac{V_2 - 0}{2} - A = 0$ ↳ *② → ②a, ②b

$\rightarrow 2V_2 - 2V_1 + V_2 - 2A = 0.$

$\rightarrow \boxed{-2V_1 + 3V_2 - 2A = 0}$

if $A = 2i_1 = 2(i_1) = 2\left(\frac{V_1 - V_3}{1}\right) = 2V_1 - 2V_2.$

$\Rightarrow -2V_1 + 3V_2 - 4V_1 + 4V_2 = 0$

$\boxed{-6V_1 + 7V_2 = 0} \rightarrow$ ②a

$V_1 = 70/9\ V$, $V_2 = 20/3\ V$ ✓

$7.78\ V$ $= 6.67\ V$

②b $\rightarrow A = 2V_1$.

$\Rightarrow -2V_1 + 3V_2 - 2(2V_1) = 0$

$-2V_1 + 3V_2 - 4V_1 = 0$

$-6V_1 + 3V_2 = 0$

① and ②b $\rightarrow$ $V_1 = -10\,V$, $V_2 = -20\,V$ ✓

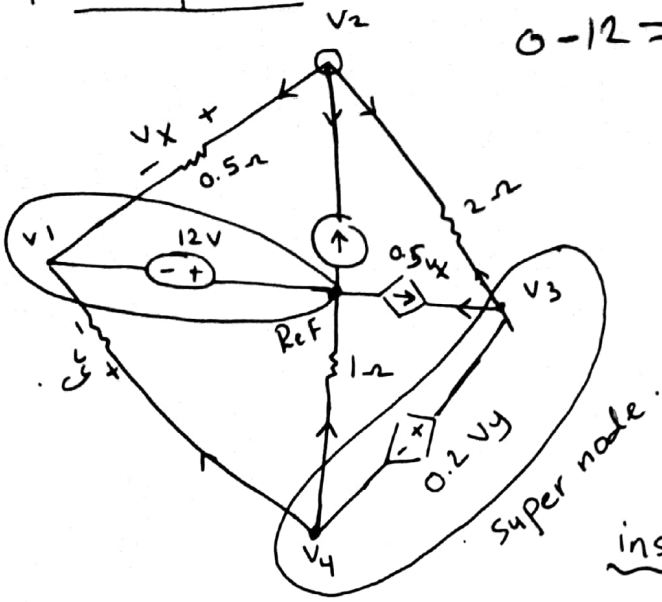
* Super node:

$V_B - V_A = X_v$ → شو ما كانت القيمة

V_B ↓ الي عند الطرف الموجب للسورس.

V_A ↓ الي عند الطرف السالب للسورس

* Example 4.6:



$0 - 12 = V_1$ ← $V_1 = -12$ volt

* KCL at node V_2:

$$\frac{V_2 - V_1}{0.5} - 14 + \frac{V_2 - V_3}{2} = 0$$

$$4V_2 - 4V_1 + V_2 - V_3 = 28.$$

$$-4V_1 + 5V_2 - V_3 = 28 \rightarrow (1)$$

$$\boxed{5V_2 - V_3 = -20}$$

* at Super node:

inside → $V_3 - V_4 = 0.2V_y$.

$$V_3 - V_4 = 0.2V_4 - 0.2V_1$$

$$5V_3 - 5V_4 = V_4 - V_1$$

$$V_1 + 5V_3 - 6V_4 = 0 \rightarrow (2)$$

$$\boxed{5V_3 - 6V_4 = 12} \rightarrow (2)$$

$V_y = V_4 - V_1 = V_4 + 12$ * بسيط

* KCL: (outside)

V_x ↱

$$\frac{V_3 - V_2}{2} - 0.5(V_2 - V_1) + \frac{V_4}{1} + \frac{V_4 - (-12)}{2.5} = 0 \quad *10$$

($V_2 - V_1 = -12$)

$$5V_3 - 5V_2 - 5(V_2 + 12) + 10V_4 + 4V_4 + 4(12) = 0$$

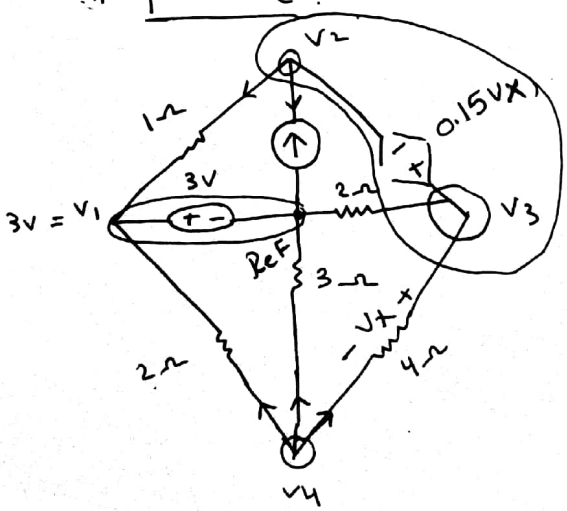
$$5V_3 - 5V_2 - 5V_2 - 60 + 10V_4 + 4V_4 + 48 = 0$$

$$V_2(-5-5) + V_3(5) + V_4(10+4) = 12.$$

$$-10V_2 + 5V_3 + 14V_4 = 12 \rightarrow (3)$$

$$\boxed{V_2 = -4,\ V_3 = 0,\ V_4 = -2}$$

* practice:



$\boxed{V_1 = 3V}$

kcl at nod V_4:

$$\frac{V_4 - V_3}{4} + \frac{V_4}{3} + \frac{V_4 - 3}{2} = 0$$

$$3V_4 - 3V_3 + 4V_4 + 6V_4 - 18 = 0$$

$$-3V_3 + V_4(3+4+6) = 18$$

$$\boxed{-3V_3 + 13V_4 = 18} \ (1)$$

. أكمل الحل في الدفتر

Super node:

inside → $V_3 - V_2 = 0.15(V_3 - V_4)$ $\times 100$

$100V_3 - 100V_2 = 15V_3 - 15V_4$.

$V_2(-100) + V_3(100-15) + V_4(15) = 0$.

$-100V_2 + 85V_3 + 15V_4 = 0$ ②

* KCL:

$\frac{V_2 - 3}{1} - 4 + \frac{V_3}{2} + \frac{V_3 - V_4}{4} = 0$ $\times 4$

$4V_2 - 12 - 16 + 2V_3 + V_3 - V_4 = 0$

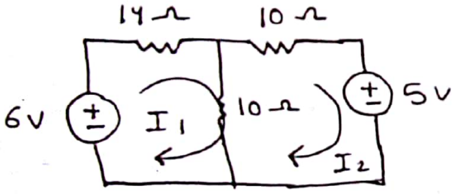
$4V_2 + 3V_3 - V_4 = 28$ ③

$V_2 = 4.2122\,V$ / $V_3 = 5.268\,V$ / $V_4 = 2.4292\,V$.

* إلى هنا مادة الميدترم .

* Mesh analysis: (KVl)

* practice 4.6:



Find I_1, I_2:

① KVL at loop 1:

$-6 + 14I_1 + 10(I_1 - I_2) = 0$

$a = 14 + 10 = 24$, $b = -10$, $c = 6$

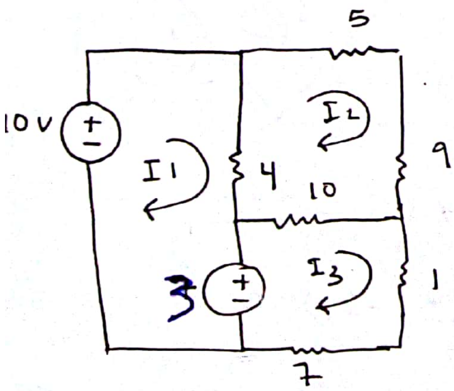
② KVL at loop 2:

$10(I_2 - I_1) + 10I_2 + 5 = 0$

$a = -10$, $b = 20$, $c = -5$

$I_1 = 182.2\,mA$, $I_2 = -157.9\,mA$ ✓

*practice 4.7:



Find I_1, I_2, I_3?

Sol:

*KVL at loop 1:

$-10 + 4(I_1 - I_2) + 3 = 0$

$4I_1 - 4I_2 = 7$.

$a = 4$, $b = -4$, $c = 0$, $d = 7$.

* KVL at loop 2:

$(5+9)I_2 + 10(I_2 - I_3) + 4(I_2 - I_1) = 0$

$a = -4$, $b = 14 + 10 + 4 = 28$, $c = -10$, $d = 0$

* KVL at loop 3:

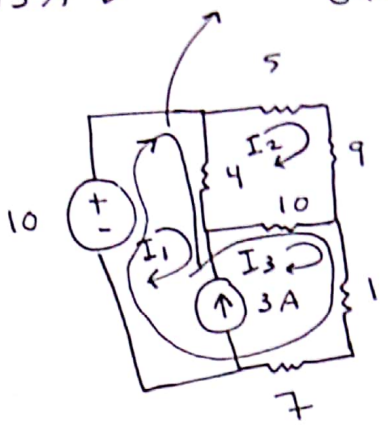
$-3 + 10(I_3 - I_2) + 8I_3 = 0$

$a = 0,\ b = -10,\ c = 18,\ d = 3$

$I_1 = 2.22\ A,\ I_2 = 0.47\ A,\ I_3 = 0.43\ A$ ✓

outside مرّ

* Super Mesh: 4.9



(*) 3A joins I_1 and I_3 (Super Mesh).

① KVL at loop 2:

$4(I_2 - I_1) + 14(I_2) + 10(I_2 - I_3) = 0$

$a = -4,\ b = 4 + 14 + 10 = 28,\ c = -10,\ d = 0$

* Super Mesh:

② inside: $3 = I_3 - I_1 \rightarrow a = -1,\ b = 0,\ c = 1,\ d = 3$

(I_3: 3A عكس اتجاه, I_1: 3A مع اتجاه)

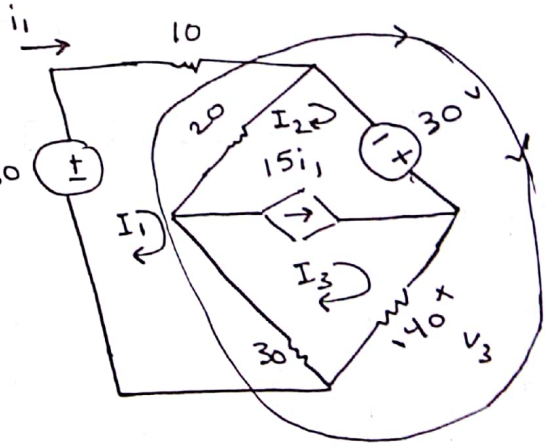
③ outside: $10 + 4(I_1 - I_2) + 10(I_3 - I_2) + 8(I_3) = 0$

$a = 4,\ b = -4 - 10 = -14,\ c = 18,\ d = 10$

* ثابت دائماً بننقله للطرف الثاني.

* practice 4.10:

Find V_3?



Sol:

① $-80 + 10I_1 + 20(I_1 - I_2) + 30(I_1 - I_3) = 0$

$a = 60,\ b = -20,\ c = -30,\ d = 0$

* For Super Mesh:

inside ②: $15I_1 = I_3 - I_2$

$a = 15,\ b = 1,\ c = -1,\ d = 0$

* $15i_1 = 15I_1$

outside: ③ $-30 + 40(I_3) + 30(I_3 - I_1) + 20(I_2 - I_1) = 0$

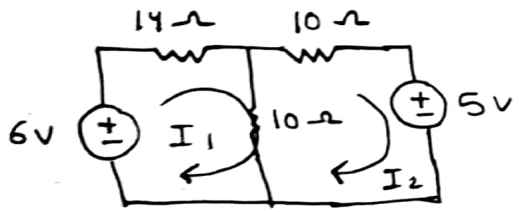
$a = -50,\ b = 20,\ c = 70,\ d = 30$

$I_1 = 0.584A,\ I_2 = -6.15,\ I_3 = 2.604,\ V_3 = +I_3(40)$

$= \boxed{104.2V}$

* Mesh analysis: (KVL)

* practice 4.6:



Find I_1, I_2:

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$a = 14 + 10 = 24$, $b = -10$, $c = 6$

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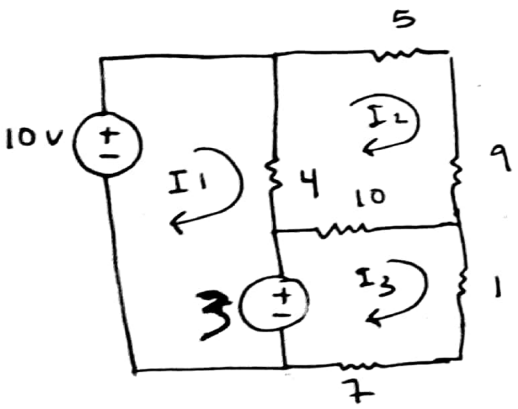
$10(I_2 - I_1) + 10I_2 + 5 = 0$

$a = -10$, $b = 20$, $c = -5$

$I_1 = 182.2mA$, $I_2 = -157.9mA$ ✓

* practice 4.7:



Find I_1, I_2, I_3?

Sol:

* KVL at loop 1:

$-10 + 4(I_1 - I_2) + 3 = 0$

$4I_1 - 4I_2 = 7$.

$a = 4$, $b = -4$, $c = 0$, $d = 7$.

* KVL at loop 2:

$(5+9)I_2 + 10(I_2 - I_3) + 4(I_2 - I_1) = 0$

$a = -4$, $b = 14 + 10 + 4 = 28$, $c = -10$, $d = 0$

* KVL at loop 3:

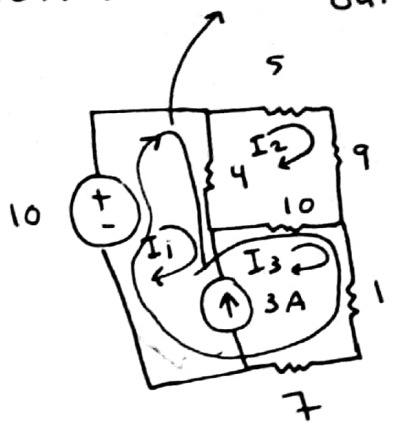
$-3 + 10(I_3 - I_2) + 8I_3 = 0$

$a = 0,\ b = -10,\ c = 18,\ d = 3$

$I_1 = 2.22\ A,\ I_2 = 0.47\ A,\ I_3 = 0.43\ A$ ✓

outside مرّة

* Super Mesh: 4.9



④ 3A joins I_1 and I_3 (Super Mesh).

① KVL at loop 2:

$4(I_2 - I_1) + 14(I_2) + 10(I_2 - I_3) = 0$

$a = -4,\ b = 4 + 14 + 10 = 28,\ c = -10,\ d = 0$

* Super Mesh:

② inside: $3 = I_3 - I_1$ → $a = -1,\ b = 0,\ c = 1,\ d = 3$

(I_3 عكس اتجاه 3A, I_1 باتجاه 3A)

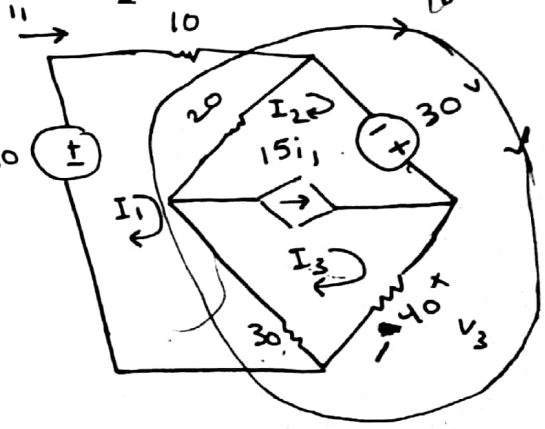
③ outside: $10 + 4(I_1 - I_2) + 10(I_3 - I_2) + 8(I_3) = 0$

$a = 4,\ b = -4 - 10 = -14,\ c = 18,\ d = 10$

* practice 4.10:

Find V_3?

* إشارة دائماً بتنعكس للطرف إلتاني.



Sol:

① $-80 + 10I_1 + 20(I_1 - I_2) + 30(I_1 - I_3) = 0$

$a = 60,\ b = -20,\ c = -30,\ d = 0$

* For Super Mesh:

inside & ② $15I_1 = I_3 - I_2$

$a = 15,\ b = 1,\ c = -1,\ d = 0$

* $15i_1 = 15I_1$

outside & ③ $-30 + 40(I_3) + 30(I_3 - I_1) + 20(I_2 - I_1) = 0$

$a = -50,\ b = 20,\ c = 70,\ d = 30$

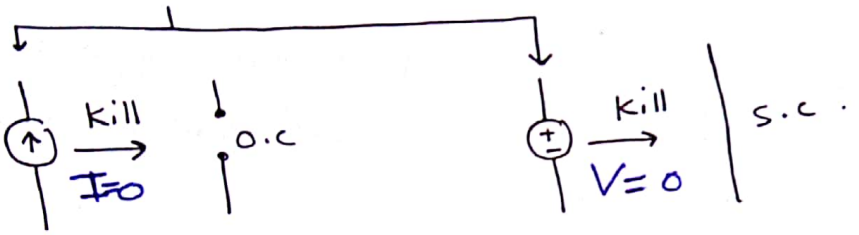
$I_1 = 0.584A,\ I_2 = -6.15,\ I_3 = 2.604,\ V_3 = +I_3(40)$

$= \boxed{104.2V}$

* Super position:

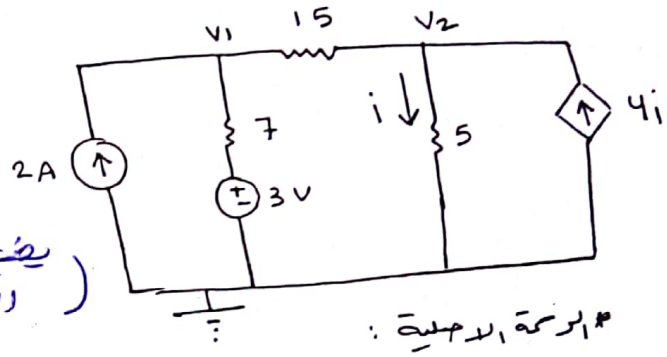
- من خلاله سنقدر نلغي دور كل سورس في الدائرة / شوتاً يتم عمل باقي العناصر.

- بنشغل واحد كل مره ونطفي الباقي (Killing the source).



* practice 5.2:

Find: V_1, V_2, due to each current and voltage source.



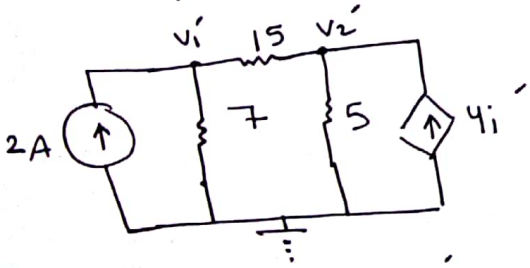
* الدائرة الاصلية:

: Sol

* due to 2A: (يضل ظل 2A شغال وطفي الباقي)

Kill 3V → s.c

* (Killing the source is only for indep sources).

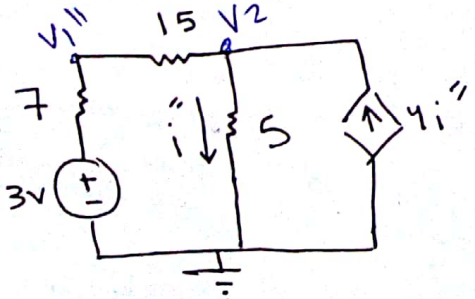


nodal → V_1', V_2' (كل طريقة الطبيعية)

منها نجد

* due to 3V:

Kill 2A → o.c



nodal → V_1'', V_2''

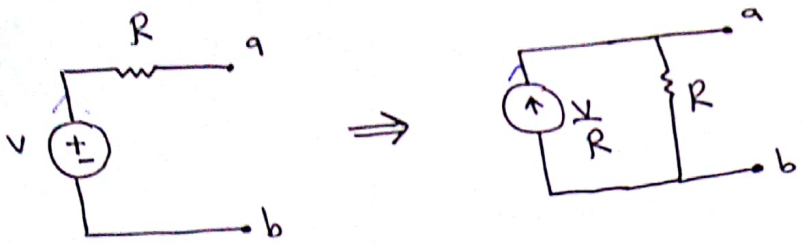
منها نجد

* الناتج النهائي يكون على شكل:

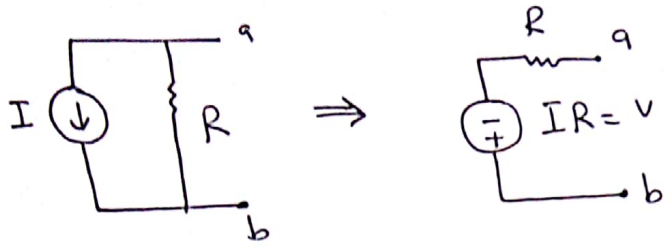
$V_1 = V_1' + V_1''$ (طالبين)

$V_2 = V_2' + V_2''$ (طالبين)

* 5.2: Source transformation:



* اتجاه التيار في السورس الجديد طالع من الموجب تبع السورس القديم

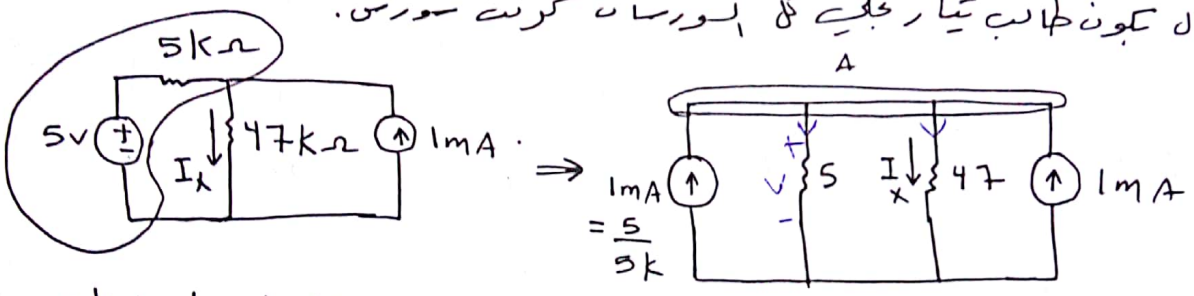


* قطبية الفولتج الجديد موجب من محل ما طلع التيار من السورس القديم.

*practice 5.3:

Find I_x by S.T?

* لا السؤال تكون طالب تيار فلي كل السورسات كونتة سورس.



*KcL at node A:

$$-1-1+\frac{V}{5}+\frac{V}{47}=0$$

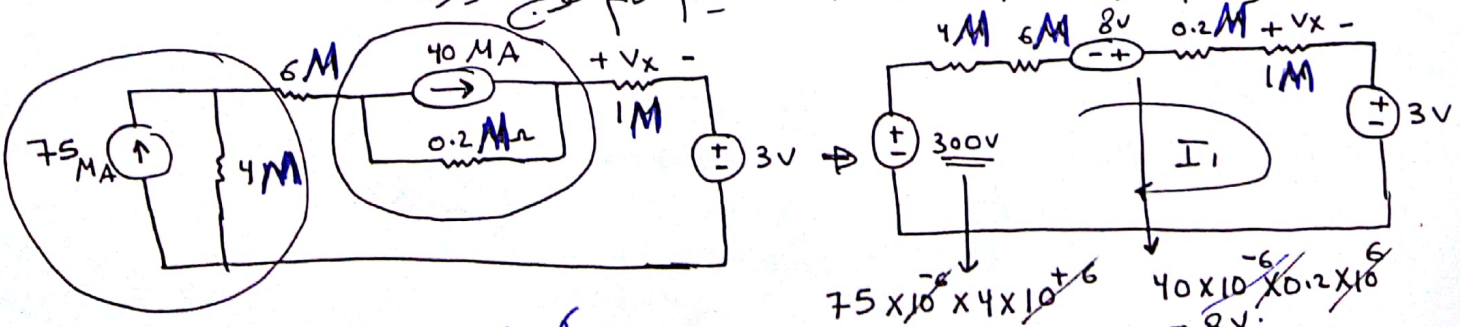
$V = 9.04$ volt.

$$I_x = \frac{V}{47k} = 192.3\,\mu A$$ ✓

*practice 5.4:

Find V_x by S.T?

* لا تكون السؤال طالب فولتيه بادل اخليهم كلهم فولتج سورس.



M ⇒ Mega (10^6)

M ⇒ Micro (10^{-6})

* الكتابة باطليجا.

* KVL:

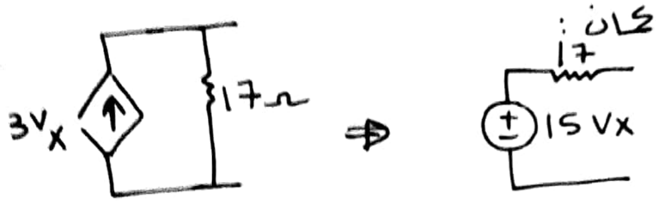
$-300 + i(4+6+0.2+1) - 8 + 3 = 0$

$I = \frac{300+8-3}{11.2} = 27.23\ \mu A$

لم ابلها كيلو لانه المقاومات كانت بالميجا.

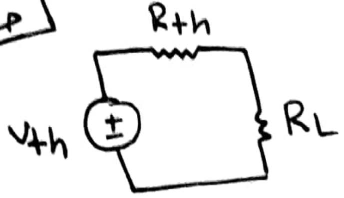
$V_x = IR = 27.23 * \mu * M = 27.23\ V.$

ملاحظة: ال S.T تنفع لل dep sources كمان:



* Thevenin and Norton eq cct:

حفظ

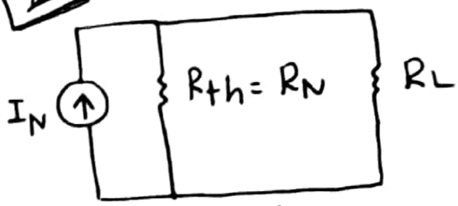


The eq cct:

$R_{th} = R_N$

$I_N = \frac{V_{th}}{R_N} = \frac{V_{th}}{R_{th}}$

حفظ



N eq cct:

$V_{th} = I_N R_N$

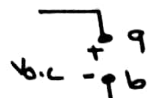
نفس القانون.

* Case 1: R + indp
* Case 2: R + ind + dep.

* Case 1: R + ind:

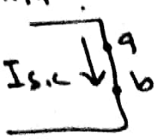
1. نفصل R_L ونحط مكانها o.c ونحسب $V_{o.c}$ عليها وهاي التولتية هي نفسها V_{th}

$V_{o.c} = V_{th}$ at R_L



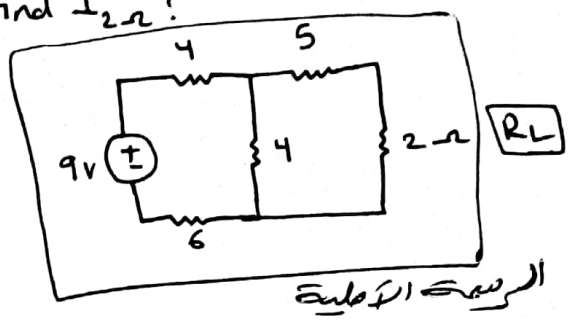
2. نحسب R_{eq} اللي بنشوفها بين اطراف R_L بعدما نشيلها ونعمل Kill للمصادر على فرض انه كلهم ind

3. عشان احسب I_N
- اذا كنت حاسب V_{th} , R_{th} ← $I_N = \frac{V_{th}}{R_{th}}$
- اذا بدي احسبها قبل ما احسب R_{th} و V_{th} نعمل شورت سيركت على اطراف R_L



*practice 5.6:

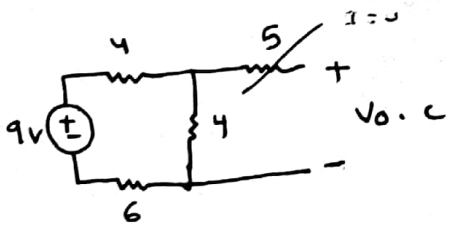
Find: V_{th}, R_{th}, I_N at $R_L = 2\Omega$ and Find $I_{2\Omega}$?



الرسمة الأصلية

* For V_{th}:

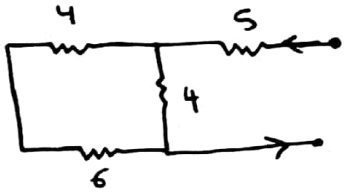
$V_{o.c}$ at R_L:



$$V_{o.c} = V_{4\Omega} = V_{th} = 9 * \left(\frac{4}{4+4+6}\right) = 2.57\,v.$$

* For R_{th}:

Req between R_L terminals after killing the sources (only indep):



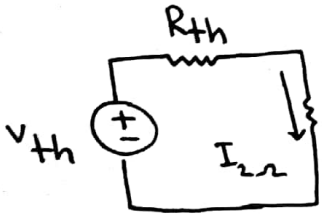
$$\Rightarrow R_{eq} = [10 // 4] + 5 = 7.857\,\Omega.$$

لأنه صوت ما بلغني الـ 5 لأنه ضيعا تيار.

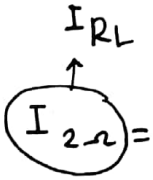
* For I_N:

$$I_N = \frac{V_{th}}{R_{th}} = \frac{2.57}{7.857} = 327.2\,mA.$$

* For $I_{2\Omega} = I_{R_L} = I_N$.

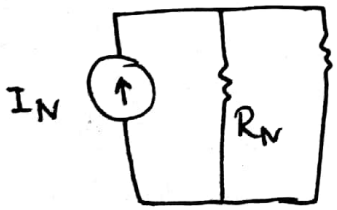


$\Rightarrow$



$$= \frac{V_{th}}{R_{th} + R_L} = \frac{2.571}{9.857} = 260.8\,mA.$$

OR



$$\Rightarrow I_{R_L} = I_N \left(\frac{R_N}{R_L + R_N}\right)$$

$$= 327.2 \left(\frac{7.857}{9.857}\right) = 260.8\,mA.$$

* Case 2: ind + dep + R.

method 1:

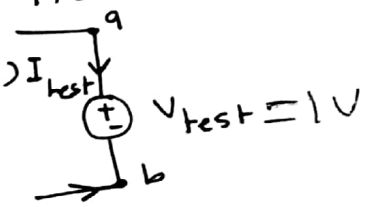
1. Calculate $V_{o.c}$ at R_L
2. = $I_{s.c}$ at R_L

→ 3. $R_{th} = \frac{V_{o.c}}{I_{s.c}} = \frac{V_{th}}{I_N}$

* ملاحظة: ما نقدر احسبها عن طريق Req لانه صعوبة ما نقدر نعمل kill لل dep.

method 2:

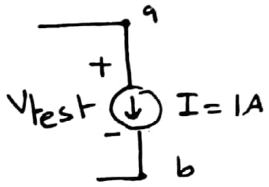
1. kill ind. sources. (خلي dep شغالين).
2. Put V_{test} with $\Rightarrow V = 1v$, Then calculate $I_{test} \rightarrow R_{th} = \frac{1}{I_{test}}$.



. (b ← a من الموجب ، داخل في I_{test})

3. put I_{test} with → $I = 1A$, Then calculate $V_{test} \rightarrow R_{th} = V_{test}$.

* تكملة السورس الطبيعية

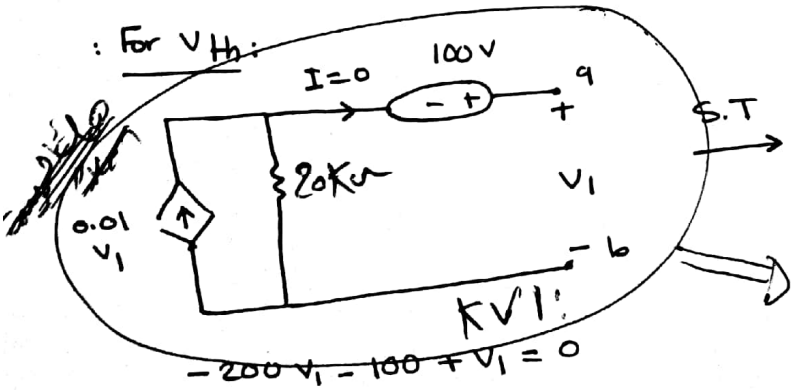


* ملاحظة: طالما لسه ما تعلمنا عشان اجيب R_{th} فعمليا ($V_{test} \neq V_{th}$ ، $I_{test} \neq I_N$).

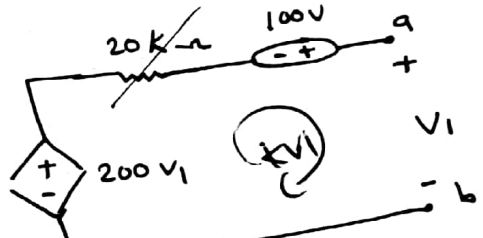
* practice 5.8:

Find the eq. ckt? (V_{th}, R_{th}, I_N).

: For V_{th}:



S.T



من السؤال الـ O.C

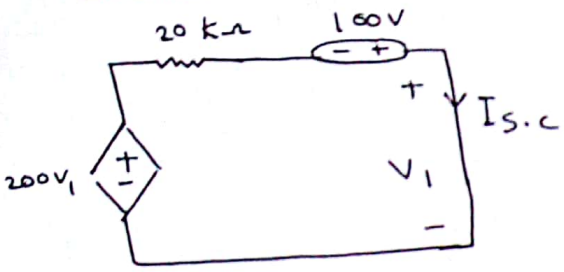
$-200V_1 - 100 + V_1 = 0$

$V_1(-200+1) = 100$

$V_1 = 100 / -199 = -502.5m = V_{th}$ ✓

$V_1 = V_{th}$. ← b و a بين O.C + الدائرة بالأساس عليها

: For I_N :



* $V_1 = V_{s.c} = 0$

$200\,V_1 = 0$

$*(20\,k)\,I - 100 = 0$

$I = 5mA$

: For R_{th}: $V_{Th} / I_N = -100.5\,\Omega$.

* السالب هنا للدلالة على ان هناك مقاومة $+100.5$ لكن التيار يكون داخل في القطبية السالبة للمقاومة.

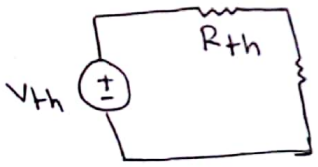
* بالامتحان اذا كان بالخيارات كالتالي لنفس السؤال:

a) 100.5 , b) −100.5 , c) none .

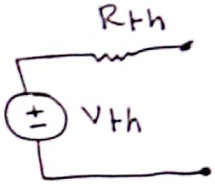
OR

a) 50.1 , b) −100.5 , c) none

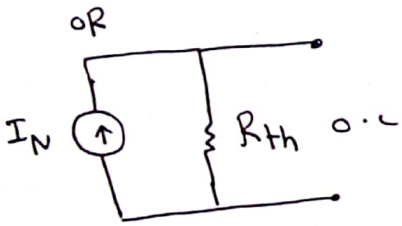
the eq cct →



→



OR

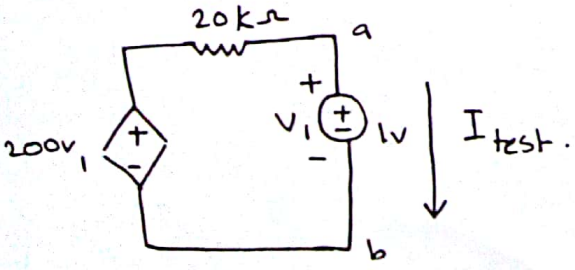


*practice 5.8:

+ نفس السؤال السابق لكن بدي احسب الـ R_{th} باستخدام الـ Test Source .

: Sol:

1. kill all ind sources.
2. put $V_{test} = 1v$.



$V_{test} = 1$ volt.

$V_1 = 1$ volt .

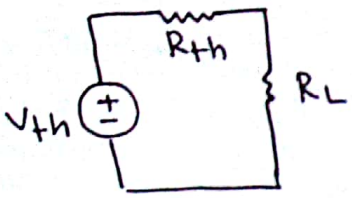
$200\,V_1 = 200$ volt.

KvL: $-200 + 20\,k\,(I) + 1 = 0$

$I_{test} = \frac{200-1}{20k} = 9.95\,mA$ ✓

$R_{th} = 1 / I_{test} = 100.5\,\Omega$.

5.4 : Maximum power transfer:



$$P_{at\ R_L} = \frac{V^2}{R_L} = \left(\frac{V_{th} \cdot R_L}{R_L + R_{th}}\right)^2 \cdot \frac{1}{R_L} = \boxed{\frac{V_{th}^2 \cdot R_L}{(R_L + R_{th})^2}}$$

$P_{at\ R_L}$ ← certain value (قيمة معينة)

$\frac{V_{th} \cdot R_L}{R_L + R_{th}}$ ↓ voltage devider.

$\frac{1}{R_L}$ ↓ ضرب

At maximum power → $R_L = R_{th}$ → $\boxed{P_{Max} = \frac{V_{th}^2}{4 R_{th}}}$ ضرب

① What is R_L at Maximum power? $\left(R_L\big|_{\text{Max Power}} = R_{th}\right)$.

② What is the Maximum power delivered by R_L?

$$P_{Max} = \frac{V_{th}^2}{4 R_{th}} \leftarrow R_{th} = V_{th}$$ حيث

③ What is the values of R_L at a certain power?

يعني اي قيمة غير الـ Maximum

$$P = \frac{V_{th}^2 R_L}{(R_{th} + R_L)^2}$$

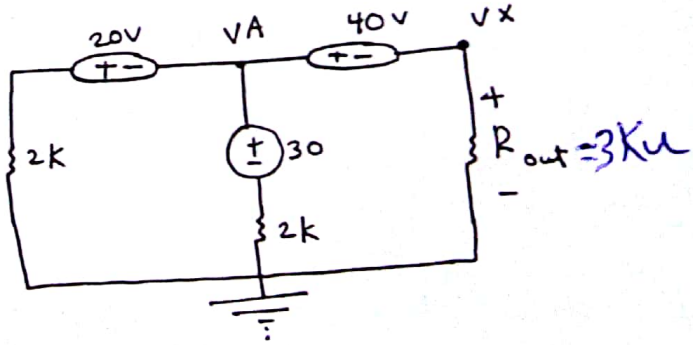
↳ R_{th}، V_{th} تكون في دالة P في حيث منها

قيم R_L بتعليل العبارة الرتبعية.

* practice 5.10 :

a) if $R_{out} = 3k\Omega$

Find power delivered to it (P_{abs})?



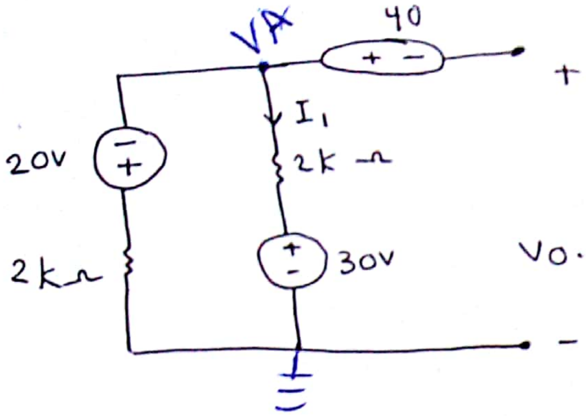
use nodal → $V_A = 13.75$

$V_A - V_X = 40 \rightarrow V_X = -26.25V$

$\rightarrow V_{R_{out}} = V_X - 0 = -26.25\ V$

$$P_{abs} = \frac{V^2}{R} = \frac{689.0625}{3 * 1000} = 0.230W = 230mW$$

b) Find V_{th} at Rout? and R_{th}? P_{Max} at any R_L?



$V_A = 5V$

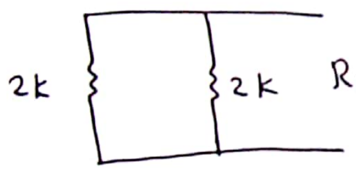
nodal $\longrightarrow$ $I_1 = \frac{5-30}{2} = -12.5mA$ ✓

$-V_{o.c} - 40 + I_1(2) + 30 = 0$

$V_{th} = -40 - 12.5 * 2 + 30$
$= -40 + 30 + (-25)$
$= -35V$ ✓

$R_{th} \longrightarrow$ Kill all indep sources: (s.c)

* لازم كلهم voltage source.



$R_{th} = 1k\Omega$

P_{Max} at any R_L = $P_{Max}\Big|_{R_L = R_{th}} = \frac{V_{th}^2}{4R_{th}} = \frac{(-35)^2}{4 * 10000} = 306\ mW.$

c) Find R_L values if $p = 20mW$?

$P_{at}\Big|_{R_L = ?} = 20mW$ (Maximum مش
$R_L \neq R_{th}$)

$P = \frac{V_{th}^2 R_L}{(R_L + R_{th})^2} \longrightarrow 20 \times 10^{-3} = \frac{1225 R_L}{(1000 + R_{th})^2}.$

$\longrightarrow 0.02 R_L^2 - 1205 R_L + 20000 = 0$

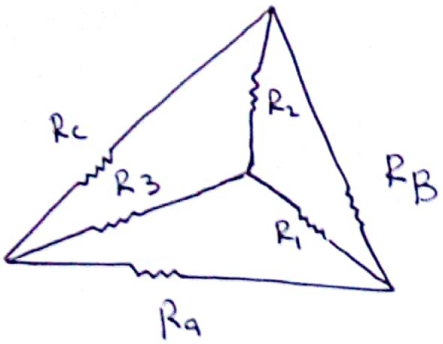
* بالآلة الحاسبة ما بنحركشان الثابت لبعد المساواة يعني لازم بعد المساواة يكون صفر بس. (هو بمثلك الشوارد والسينش).

$a = 0.02,\ b = -1205,\ c = 20000$

$R_{L_1} = 60.26\ k\Omega$ / $R_{L_2} = 16.60\ \Omega.$

* إذا طلع منهم واحدة سالبة ما بوخذها.

5.5: delt to why transFormation:



$\Delta \longrightarrow Y$

$$R_1 = \frac{R_a R_B}{R_a + R_B + R_c}$$

$$R_2 = \frac{R_B R_c}{R_a + R_B + R_c}$$

$$R_3 = \frac{R_a R_c}{R_a + R_B + R_c}.$$

$Y \longrightarrow \Delta$.

$$R_a = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_2}$$

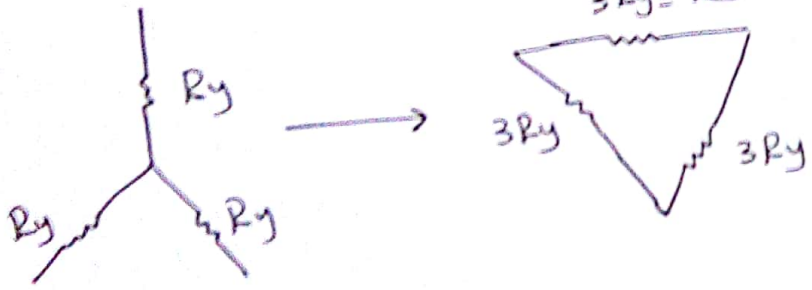
$$R_b = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_3}$$

$$R_c = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_1}$$

---

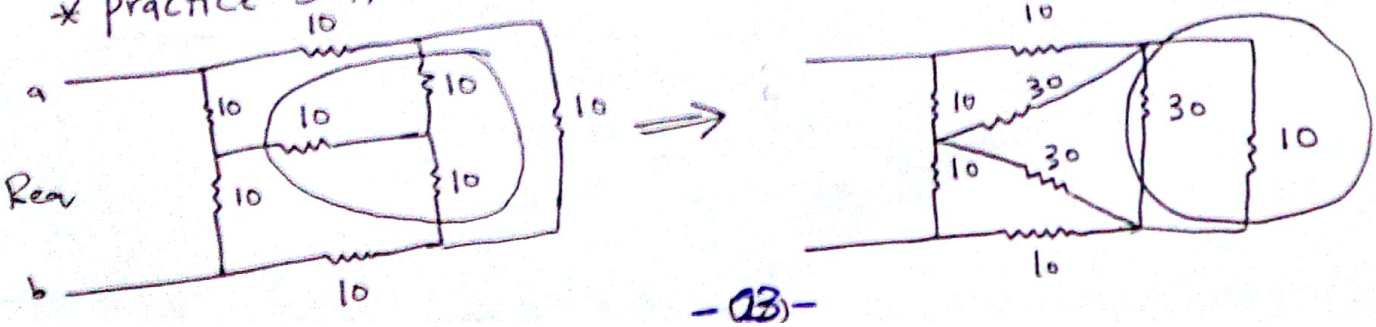
* إذا كانت المقاومات متساوية

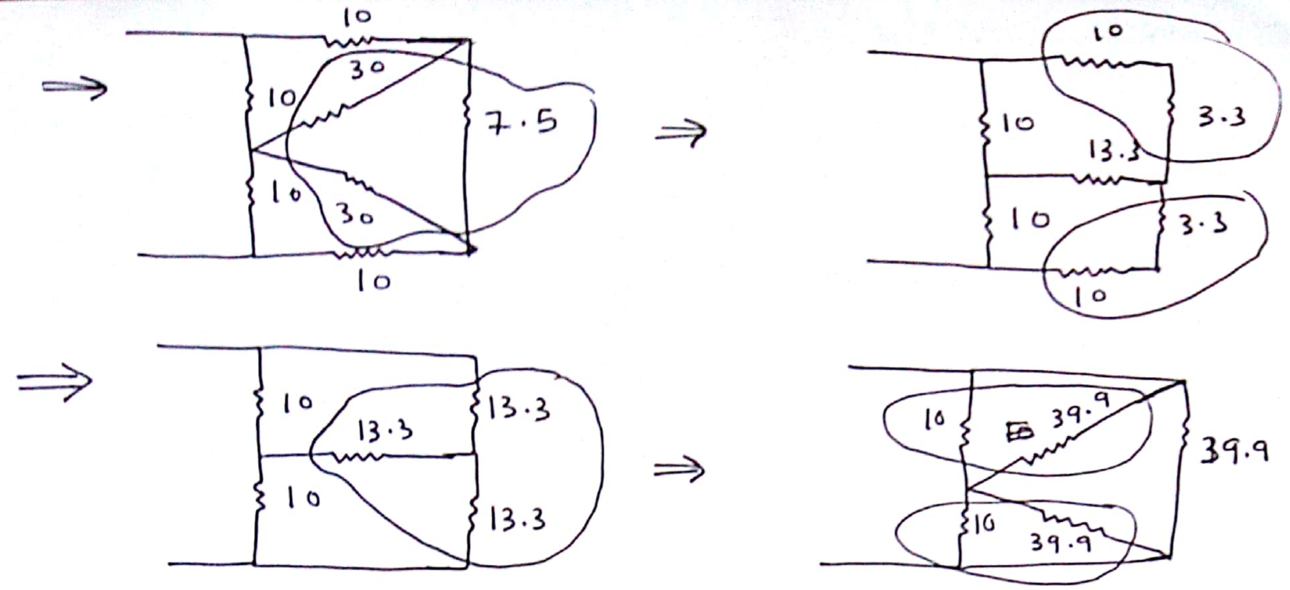
$$R_y = \frac{R_\Delta}{3}$$

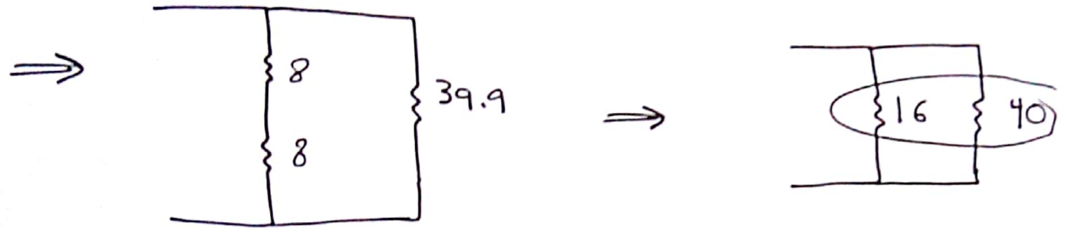


$$R_\Delta = 3R_y$$

* practice 5.11: R=10 For each; Find Req?



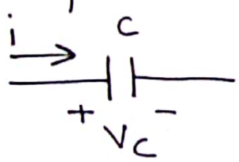




$R_{eq} = 11.43\ \Omega$.

* CH. 7: Inductor and capacitor

Capacitor



$i = C \frac{dv}{dt} = C \frac{\Delta V}{\Delta t}$

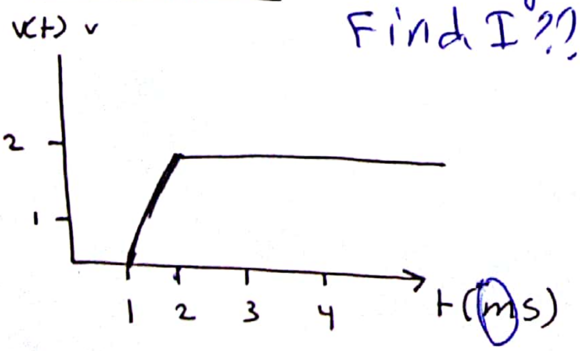
↓ نستخدمه لما V تكون اقتران بدلالة الزمن .

↓ نستخدمه لما V تكون رسمة بيانية مع الزمن

$* \ V_c(t) = \frac{1}{c} \int_{t_0}^{t} i_c(t) \cdot dt + V(t_0)$

* الجهد في المواسع متصل (لاستثناء المتصل تكون قانونه تكامل) .

* practice 7.1 : C = 100pF Find I ??



C = 100 pF

Find I?

* Sol. نقسم الرسمة لفترات (كل قطعة الها ميل واحد بأخذها بفترة وحدة)

For $t \leq 1 \rightarrow$ slope $= 0 \rightarrow I = C \frac{dv}{dt} = C *$ slope $= 0$

For $1 \leq t \leq 2 \rightarrow$ slope $= \frac{2-0}{10^{-3}}$ (m, 2000) $\rightarrow I_C = 200\,nA$
$= 100 \times 10^{-12} \times 2 \times 10^{3}$

For $t \geq 2 \rightarrow$ slope $= 0 \rightarrow I = 0$.

* For Dc source (For long time) → C → O.C

$I_C = 0,\ V_C = V_{O.C}$

بنعتبرها بطرح المصدر او السكنر.

* For Ac:

* $I_c = C\frac{dv}{dt}$, $V_c = \int_{t_0}^{t} I_c \cdot dt + V_c(t_0)$

* $W_c(t) = \frac{1}{2} C V^2(t)$ → stored energy in capacitor. (Joul)

* $P_c(t) = I_c(t)\ V_c(t)$

* capacitors → series → $C_{eq}^{-1} = C_1^{-1} + C_2^{-1} + C_3^{-1} + \dots$

→ Parallel → $C_{eq} = C_1 + C_2 + C_3 + \dots$

* practice 7.3:

$W_c(t)$ stored in 1mF at $t = 50$ ms if $v_c(t) = 1.5 \cos(10^3 t)$ V? (rad)

Sol

$W_c(50M) = \frac{1}{2} C V^2(50M) =$

* $V = 1.5 \cos(286.62) = 0.43$

$W_c = \frac{1}{2} \times 10^{-3} \times 0.184 = 92.52$ MJ ✓

$V(50M) = 1.5 \cos(10^3 * 50 * 10^{-6})$

$= 1.5 \cos 5$ Rad.

$\frac{\pi}{5} = \frac{180}{\theta}$

$\theta = \frac{180 * 5}{3.14} = 286.62.$

او بخليها 5 وبحول الآلة الحاسبة من D ← R

1) shift
2) mode
3) 4-Rad

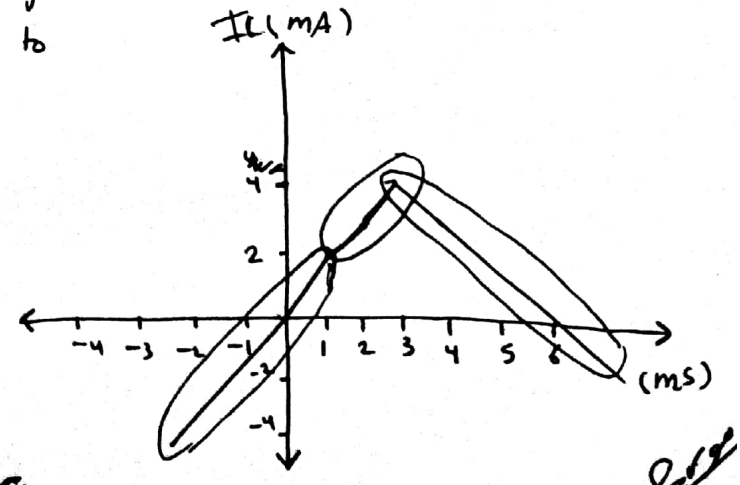
(X) Inductor

$i_L \rightarrow L$

$+ V_L -$

$V_L = L\frac{dI}{dt} = L\frac{\Delta I}{\Delta t}$.

$I_L(t) = \frac{1}{L}\int_{t_0}^{t} V_L(t) + I(t_0)$.



* practice 7.4:

L = 200mH, Assume passive sign (داخل في الموجب)

$i_L \rightarrow L$

$+ V_L -$

Find V_L at t equal?

a) $t=0 \rightarrow$ باخذ slope المنطقة الي موجودها

$$\text{Slope} = \frac{2-(-2)}{1-(-1)} = 2 .$$

$$V_L = L\frac{di}{dt} = L * \text{slope} = 0.2 * 2 = 0.4V .$$

b) $t = 2ms \longrightarrow \text{Slope} = \frac{4-2}{3-1} = 1 , \quad V = 0.2 * 1 = 0.2V .$

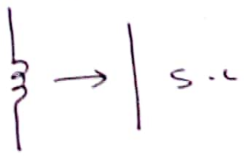
c) $t = 6 \, ms \longrightarrow \text{slope} = \frac{0.-4}{6-3} = \frac{-4}{3} , \quad V = \frac{0.2 * -4}{3} = -0.267 V$

* For DC Source : (For long time)

$V_L = 0 , \; I_L = I_{s.c}$

نعتبرها [illegible]

او [illegible] .



* For AC Source:

$$V_L(t) = L\frac{di}{dt} , \quad I_L(t) = \frac{1}{L}\int_{t_0}^{t} V_L(t) \cdot dt + I_L(t_0) .$$

$$* \; W_L(t) = \frac{1}{2} L I^2(t)$$

$$* \; P_L(t) = V(t) \, I(t)$$

* Inductor → series — نفس المقاومات
→ parallel

Practice 7.6:

$L = 0.1 H , \; V_L(t) = 2e^{-3t} V. , \; i_L(-0.5) = 1$, Find i_L?

Sol :

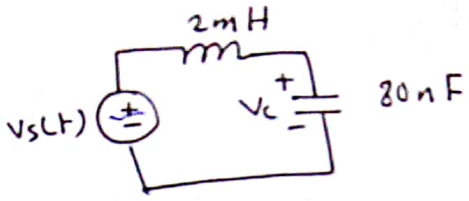
$$i_L = \frac{1}{L}\int_{t_0}^{t} V_L(t) . dt + I(t_0) = \frac{1}{0.1}\int_{-0.5}^{t} 2e^{-3t} . dt + 1$$

$$= \frac{20}{-3} e^{-3t} \Big]_{-0.5}^{t} + 1 = \frac{20}{-3}\left(e^{-3t} - e^{1.5}\right) + 1 = \frac{-20}{3} e^{-3t} + 29.9 + 1$$

$$= \boxed{\frac{-20}{3} e^{-3t} + 30.9} \; A$$

Practice 7.9 :

$L = 2mH$, $C = 80nF$, $V_c = 4\cos 10^5 t$ V, Find $V(s)$?



* $V_s(t) = V_c(t) + V_L(t)$

$= 4\cos(10^5 t) + \boxed{V_L(t)}$?

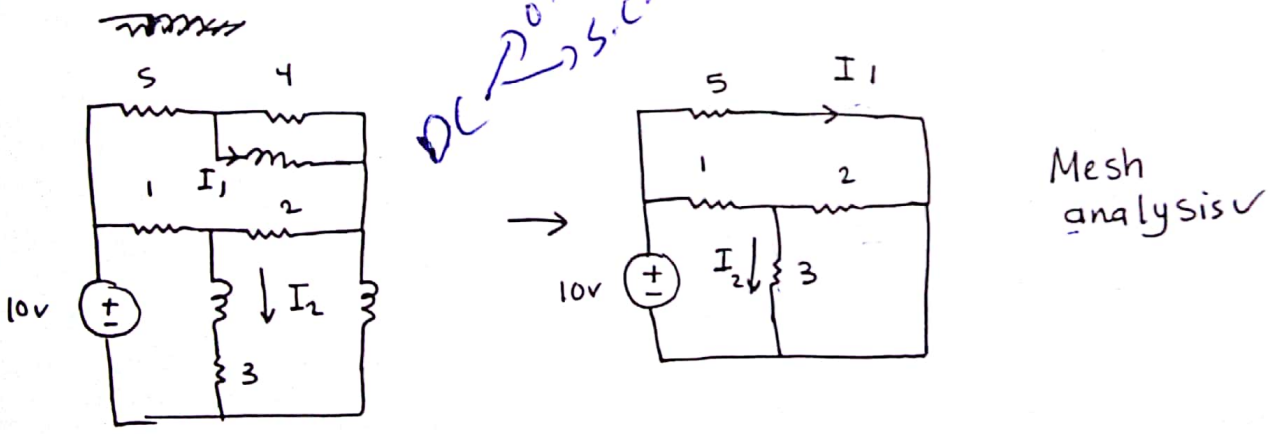
$V_L(t) = L\frac{dI_L}{dt}$; $I_L = I_c$ (series).

$I_c = C\frac{dv_c}{dt} = 80 * 10^{-9}\left(4 * -10^5 \sin 10^5 t\right) = -0.032 \sin 10^5 t$ A.

$V_L(t) = L\frac{dI_L}{dt} = 2 * 10^{-3}\left(-0.032 * 10^5 \cos 10^5 t\right) = -6.4\cos 10^5 t$ V

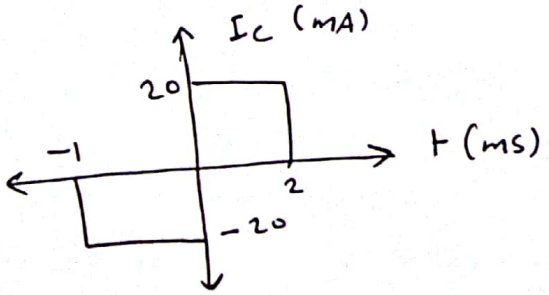
$V_s(t) = 4\cos 10^5 t - 6.4\cos 10^5 t = \boxed{-2.4\cos 10^5 t \text{ V}}$.

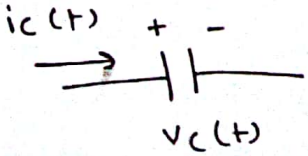
* Example: Find I_1, I_2 ?



Mesh analysis ✓

* Example: C = 5 MF





sketch $v_c(t)$?

$$V_C(t) = \frac{1}{C}\int_{t_0}^{t} I_C(t)\,dt + V(t_0)$$

* نقسم التيار الى فترات من ($-\infty \to \infty$)
* نعبر عنه بفترات متشعب.

$$I_C(t) = \begin{cases} 0\,m, & -\infty < t < -1 \\ -20\,m, & -1 < t < 0 \\ 20\,m, & 0 < t < 2 \\ 0, & 2 < t < \infty \end{cases}$$

⊕ دائماً $V_C(t_0)$ التي تقطع السؤال تكون لفترة معينة وليست ثابتة لكل فترة.

⊖ $V_C(t)$ For $-\infty < t < -1$

$$V_C(t) = \frac{1}{C}\int_{-\infty}^{t} 0\,dt + V(-\infty) = \boxed{0}$$

⊖ $V_C(t)$ For $-1 < t < 0$ ms.

$$= \frac{1}{C}\int_{-1m}^{t} -20\,m\,dt + V(-1)$$

→ نأخذها من الفترة التي قبل

$$= \frac{-20m}{5\mu}\int_{-1m}^{t} dt + 0$$

$$= -4k\,(t + 1ms) = 0$$

$$= \boxed{-4000t - 4}\ V$$

⊖ $V_C(t)$ For $0 < t < 2$.

$$V_C(t) = \frac{1}{C}\int_{0}^{t} 20\,m\,dt + V_C(0)$$

$$= 4k\int_{0}^{t} dt + [-4000(0) - 4] = \boxed{4000t - 4}\ V.$$

⊖ $V_C(t)$ For $2 < t < -\infty$ ؟

$$V_C(t) = \frac{1}{C}\int_{2}^{t} 0\,dt + V_C(2) = 4000(2m) - 4 = 8 - 4 = \boxed{4V}$$

* طريقة الرسم: نعبر عن $V_C(t)$ باتزان تشعبي (متصل):

$$V_C(t) = \begin{cases} 0 & , -\infty \le t \le 1m \\ -4000t - 4, & -1 \le t \le 0m \\ 4000t - 4, & 0 \le t \le 2m \\ 4 & , 2 \le t \le \infty m \end{cases}$$

مناطق الزمن:

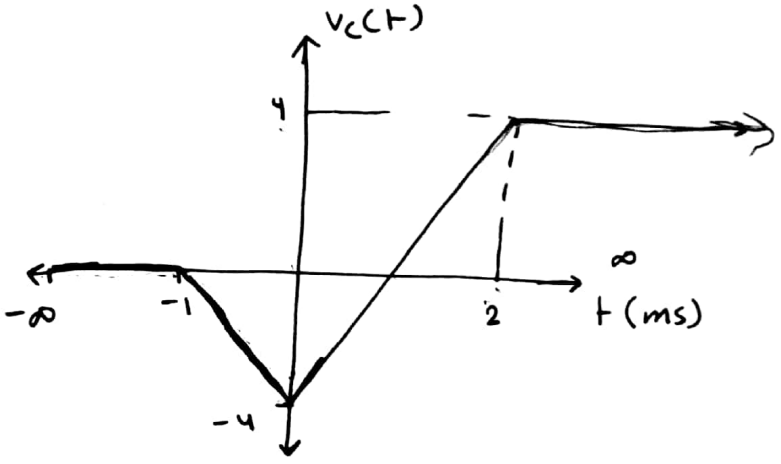
$-\infty \rightarrow V = 0V$

$-1\,ms \rightarrow V = 0V$

$0 \rightarrow V = -4V$

$2\,ms \rightarrow V = 4V$

$\infty \rightarrow V = 4V$



* energy $\rightarrow \frac{1}{2} C V^2(t)$

* Change in energy $\rightarrow \frac{1}{2} C [V(t)^2 - V(t_0)^2]$

t_0 [• (بداية التغير في الحركة
$\rightarrow -\infty$ او ←

* اذا لم تعطاه نجعلها 0

* الـ هنا مادة ، لـ كنه