ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

تلخيص لمادة:

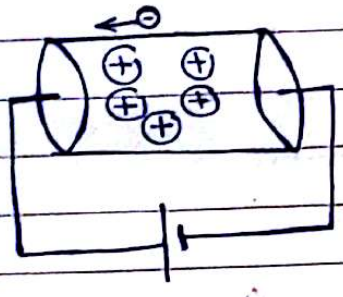
دوائر كهربائية (١)

جزيل الشكر للطالبة:

سارة أبو سارة

* Electric Circuit →

① current :



$$I = \frac{dq}{dt} = \frac{\Delta q\,(C)}{\Delta t\,(s)} \; (A)$$

* if 20 C is moved during 2 sec

Ex

Find $I = \frac{\Delta q}{\Delta t} = \frac{20(C)}{2(S)}$

$I = 10(A)$

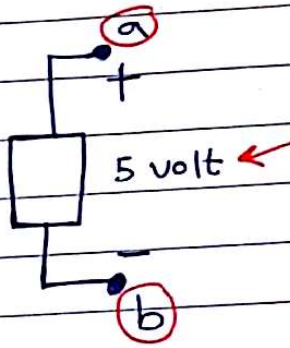
② Voltage (V) :

$$V\,(v) = \frac{dw}{dq} \rightarrow \text{energy } (J)$$

$$= \frac{\Delta w}{\Delta q}$$

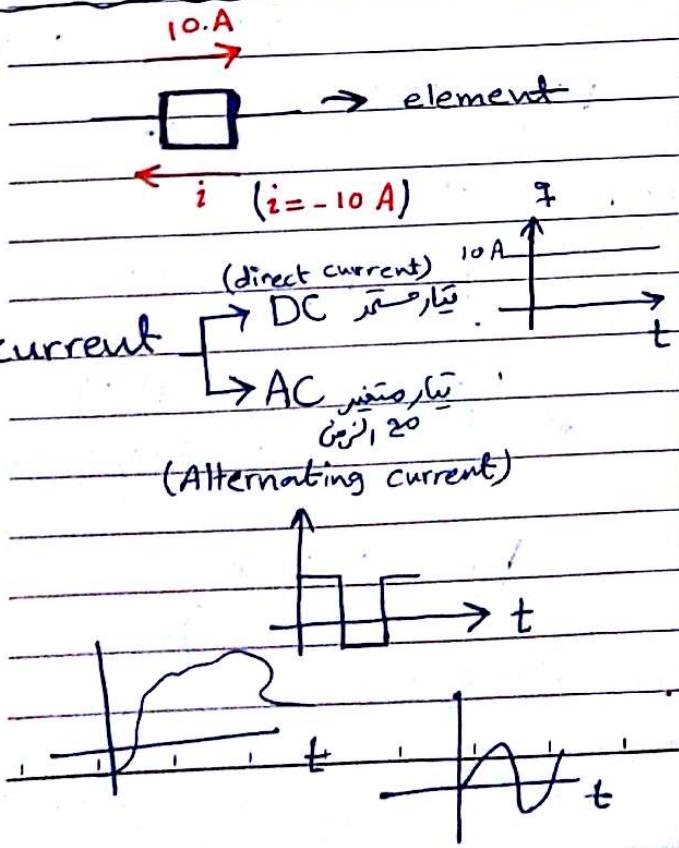
* Voltage → DC
→ AC

*

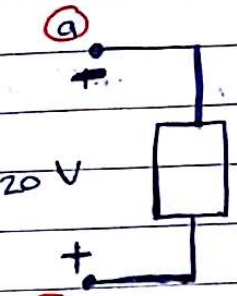


∴ $V_{ab} = 5$ → (أنا انتقلت من a إلى b)

$V_{ba} = -5$ V (أنا انتقلت من b إلى a)



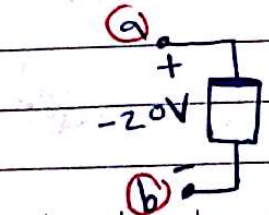
Ex



$V_{ab} = 20$ V

$V_{ba} = -20$ V

عند حساب الجهد من + إلى − السالبة



$V_{ab} = -20$ V

$V_{ba} = 20$ V

Five Angle

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③ power (P) :
معدل استهلاك الطاقة

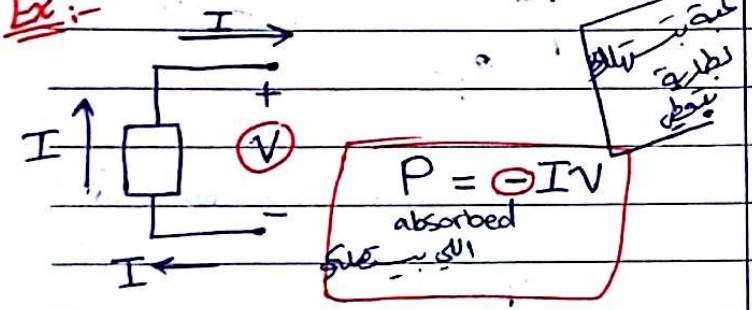
$$P = \frac{dw}{dt} \rightarrow (Joul)$$
(Watt) ← $$\rightarrow (Second)$$

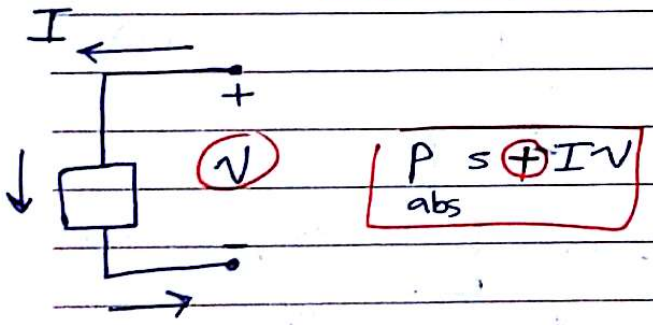
$$= \frac{dw}{dq} \cdot \frac{dq}{dt}$$

$$= VI$$

$$\# \boxed{P = IV}$$

Ex:-



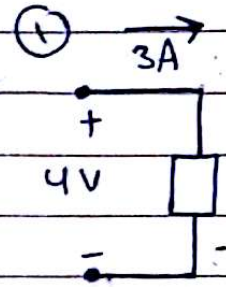


* اذا كان التيار بيمشي مع ⊖ ← ⊕
$P = IV$ فإن

أما التيار من ⊕ ← ⊖ فإن
$P = -IV$

* اذا طلع P بالسالب يبقى التيار بيولد طاقة ($P_{generated}$)
($P_{absorbed}$)

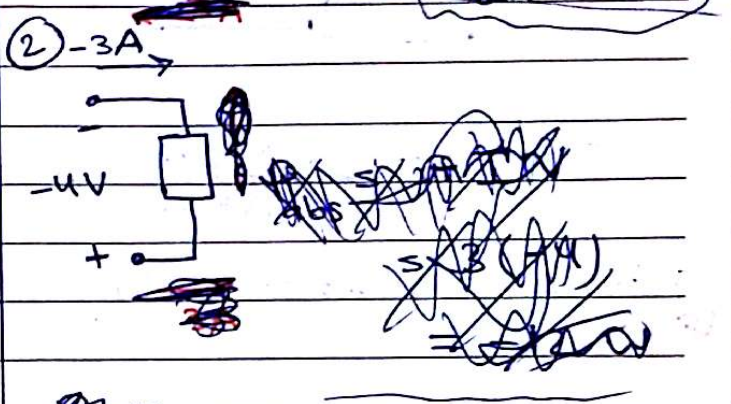
Ex:-



(بيولد طاقة)

$$P_{absorbed} = IV = 12\ W$$

$P_{gen} = -12W$

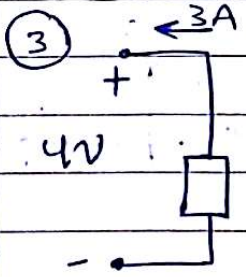


* لقيام التيار بالخروج من القطب السالب (-3A) فاشية
+ ← - من

* $P = -IV$

$= -(-3)(-4) = -12W$

$P_{gen} = 12W$ (بيولد)



$P_{abs} = -IV$

$= -(4)(3)$

$= -12W$

$P_{gen} = 12W$

(بيولد)

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* Circuit Elements :-

Sources | Inductors | Resistors | Capacitors

* Sources → voltage source / current source

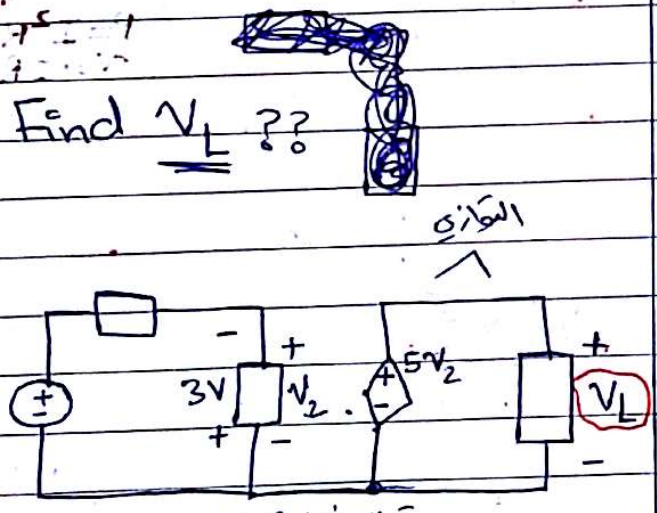


(تذكر)
(البطارية مثل voltage source)

(Indep.) مستقل *

Ex:-

Find V_L ??

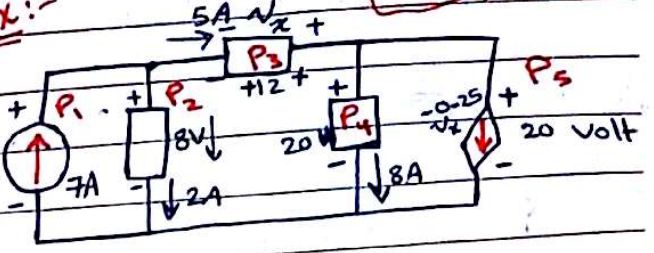


$V_L = 5V_2$

But $(V_2 = -3V)$

$V_L = 5(-3) = -15$ Volt

Ex:-



$V_x = 12$

Calculate the power absorbed by each element?

* $P_{1(abs)} = -(8)(7) = -56$ watt

$P_{1(generated)} = 56$ watt

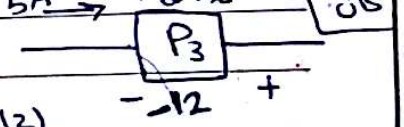
* $P_{2(abs)} = (2)(8) = 16$ watt

$P_{2(gen)} = -16$ watt

* $P_{3(abs)} = -IV$

$= -(5)(12) = -60$ W

(لو كان مستقل)



إذا مستقل ما تتغير

$P_{abs} = -5(12)$

إذا مستقل ما تتغير

$P_{abs} = 5(V_x) = 5(-12)$

if V_x (متغير)

* $P_{4(abs)} = (20)(8) = 160$ W

$P_{gen} = -160$ W

$(-V_x)(5)$

Five Apple

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$\nearrow V \quad \nearrow I$

* $P_5 = +(20)(-0.25 V_x)$

But $(V_x = \blacksquare^{12})$

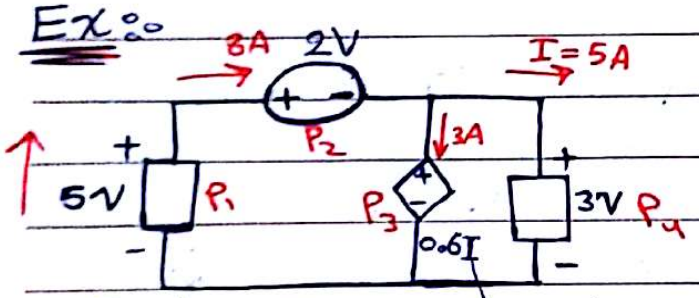
البيانات مهمة
- ← +

$P_5 = -60$ W (abs)

$P_{(gen)} = 60$ W

∴ $\sum P_{abs} = 0$

Ex:



* Find: P_{abs}, P_{gen} by each element :

(البيانات كاملة مو بشرط بالبيانات منفوقط)

* $P_{1\,abs} = -IV$

$= -(8)(5) = -40$ W

$P_{1\,gen} = 40$ W

* $P_{2\,abs} = +IV$

$= (8)(2) = 16$ W

$P_{2\,gen} = -16$ W

* $P_{3\,abs} = +IV$

$= (3)(0.6(5)) = 9$ W

$= \blacksquare$

$P_{3\,gen} = -9$ W

* $P_{4\,abs} = +IV$

$= (5)(3) = 15$ W

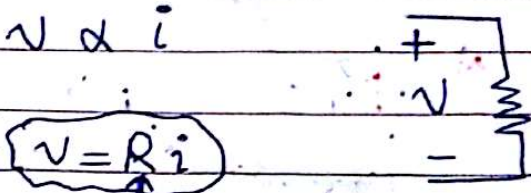
$P_{4\,gen} = -15$ W

* Ohm's Law :

$V \propto i$

$V = Ri$

Ω / ohm



* the power absorbed by any resistor :

$P = IV = \frac{V^2}{R} = I^2 R$ [دائما موجبة المقاومة]

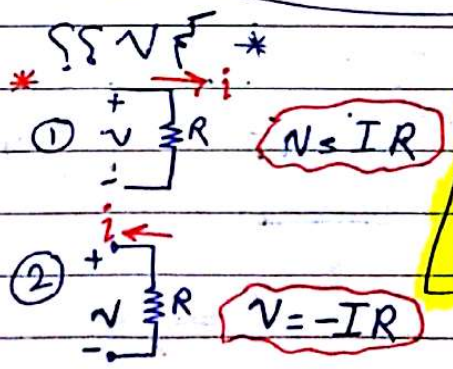
* $R = \frac{\rho L}{A}$

بدنا نميزين
$P = I^2 R$
$V = IR$

* $G = \frac{1}{R}$ (conductance)

$\frac{1}{\Omega}$, Ω^{-1}, semines

* ⚠ V ⚠ *



لو ما كان محدد اتجاه التيار بفرضو أنا

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③ $I \neq 0$, $R = 0$, $V = 0$ (Short Circuit) (S.C)

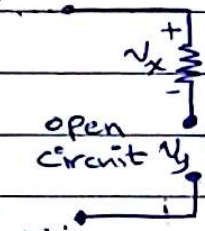
④ $V \neq 0$, $i = 0$, $R = \infty$ (Open Circuit) (O.C)

Notes

① resistor in parallel with Short Circuit (تتلغي وجود المقاومة) remove R



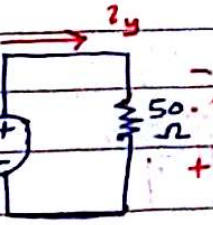
يعني هي بتيار يصون Short إلى بدون مقاومة تنحو ...

② 

any resistor in series with open circuit (remove R)

$V_x = IR = 0$ but $V_y \neq 0$

Ex:



* Find V_x and i_y

$V_x = -30$

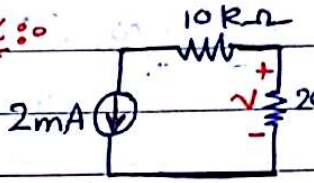
$i_y =$

$i_y = \frac{-V_x}{50} = \frac{-(-30)}{50} = 0.6$ A

(انتبهي لأنو عكس العطيني)

(حايدي الـ Voltage source لأنطع التيار لبرى المقاومة)

Ex:



* Find V and P_{abs} by 10kΩ?

$V = -I \cdot R$

$= -(2 \times 10^{-3})(20 \times 10^{3})$

$= -40$ V

$P_{abs} = I^2 R$

$= (2 \times 10^{-3})^2 (10 \times 10^{3})$

$= 40$ mW

(التيار يتساوى في التوالي) يروح للسالب مع التربيع

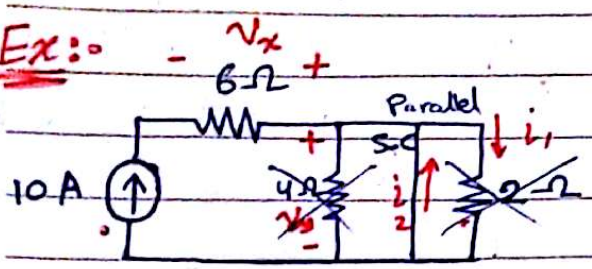
$P_{abs} = -I^2 R$ ؟؟

(P_{abs}) للأنو دائماً الـ المقاومة موجبة

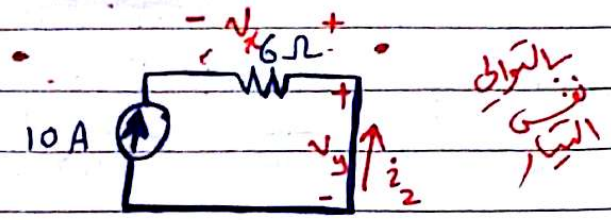
Five Apple

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Ex:- V_x



* Find i_1, i_2, V_y, and V_x ??



بالتوازي
السيارات

$i_1 = 0$

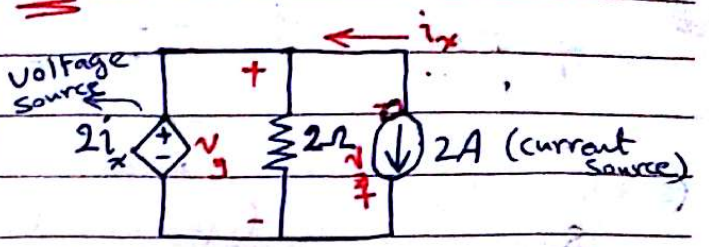
$i_2 = -10$ A

$V_y = 0$

$V_x = -IR = -(10)(6)$

$= -60$ volt

Ex:-



* Find V_y and V_z ?

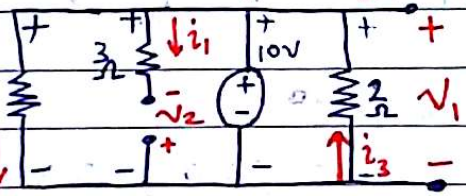
$V_y = 2i_x$

But $i_x = -2$ A

$V_y = 2(-2) = -4$ volt

$V_z = -V_y = 4$ volt

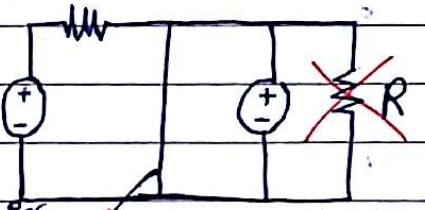
Ex:-



* Find i_1, i_2, i_3, V_1 and V_2?

- $V_1 = 10$ V , $V_2 = -10$ V (بالتوازي كلهم فولتية)
- $i_1 = 0$ (O.C)
- $i_2 = +\frac{V}{R} = +\frac{10}{5} = +2$ A
- $i_3 = -\frac{V}{R} = -\frac{10}{2} = -5$ A

Note



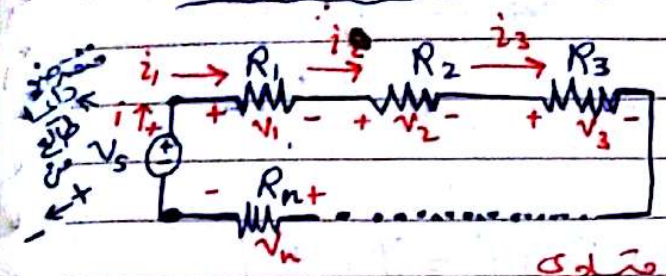
(short circuit R يعني)

العنصر (element) ما بينزل

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توصيل المقاومات

* Series Resistors →



التيار متساوي
* $i_1 = i_2 = i_3 = i_n$ أيهم يتوزع

* $R_{eq} = R_1 + R_2 + R_3 + \dots + R_n$

* $V_1 = i_1 R_1$

$V_2 = i_2 R_2$ ( )

: : :

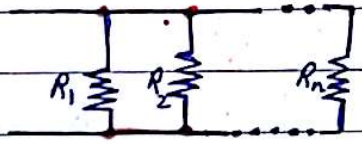
* (ما يكون معنا أيهم الكل لمقاومات موصلة على التوالي)

∴ $V_1 = \frac{V_s R_1}{R_1 + R_2 + \dots + R_n}$ → Voltage divider ← مقاومات كسان بدهم مقاومة واحدة من

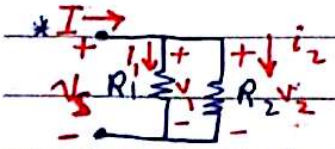
∴ $V_n = \frac{V_s R_n}{R_1 + R_2 + \dots}$

(إذا كان في أكثر من مقاومة) بحوكم من المقاومات الموصولة (مقاومة) التوالي ...

* parallel Resistors →



لازم يكونوا مشتركين بنفس الـ Nodes



$R_{eq} = \frac{R_1 * R_2}{R_1 + R_2}$

* $V_1 = V_2 = V_s$

* current division ∴

مقاومات توازي

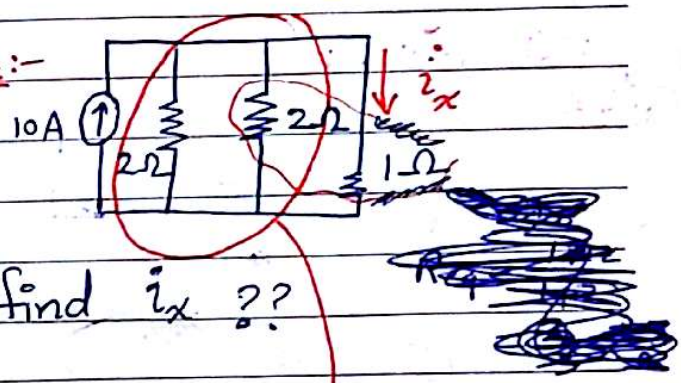
$i_1 = \frac{(\pm) I_s R_2}{R_1 + R_2}$ ← المقاومة البعيدة

(اذا كانة I_s نفس حالة القطبية + واذا عكس القطبية −)

$i_2 = \frac{(\pm) I_s R_1}{R_1 + R_2}$

(إذا كان عندي بس مقاومتين على التوازي) ولو كان عندك ٣ مقاومات قلك بوجه الجهاز (٢) وخلي ١

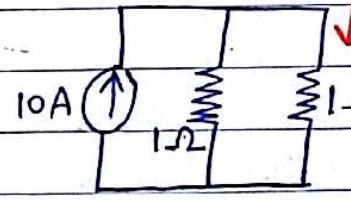
Ex:-



find i_x ??



(بيسط هاد الجزء)

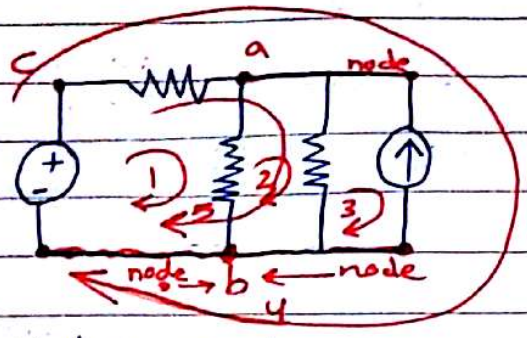


$i_x = \frac{10(1)}{1+1} = \frac{10}{2} = 5A$

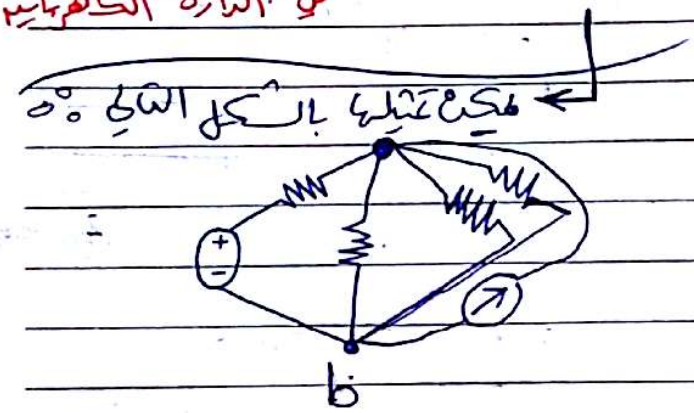
Five Apple

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* Nodes, Loops and meshes :o



* Nodes : a, b, c
* Loops : 1, 2, 3, 4 and 5
* meshes : 1, 2, 3 ← (small Loop) in the cct



* Kirchoff's Laws :o

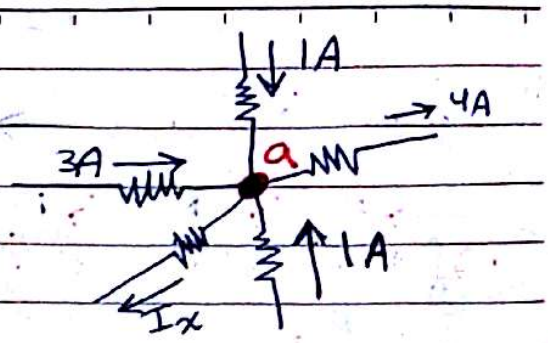
① Kirchoff's current Law → (KCL)

∑ currents at any node = 0

$$\sum \text{leaving currents} - \sum \text{entering current} = \emptyset$$

$$\sum \text{leaving currents} = \sum \text{entering currents}$$

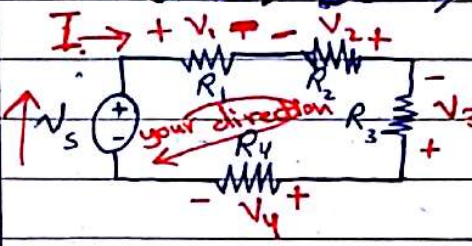
ex



$$1 + 3 + 1 = I_x + 4$$

$$I_x = 1\ A$$

② Kirchoff's voltage Law (KVL) →



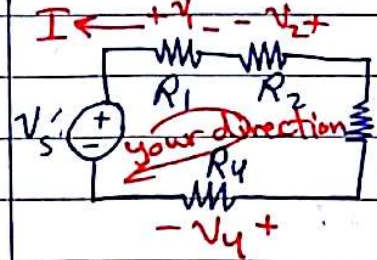
∑ voltages around any loop = ∅

(لازم كذ الاتجاه اللي بنأخذ منه)

* $-V_s + V_1 - V_2 - V_3 + V_4 = \emptyset$ (−IR)

$$V_s \pm IR$$

$$-V_s + I(R_1 + R_2 + R_3 + R_4) = \emptyset$$



* لو كانت

$$-V_s - I(R_1 + R_2 + R_3 + R_4) = \emptyset$$

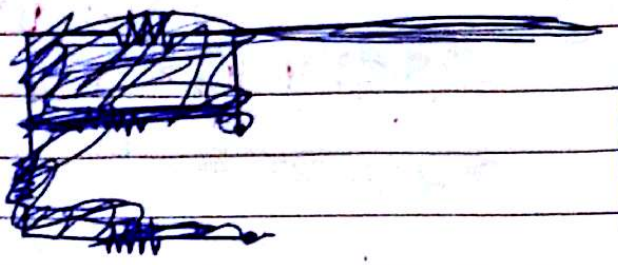
Five Apple

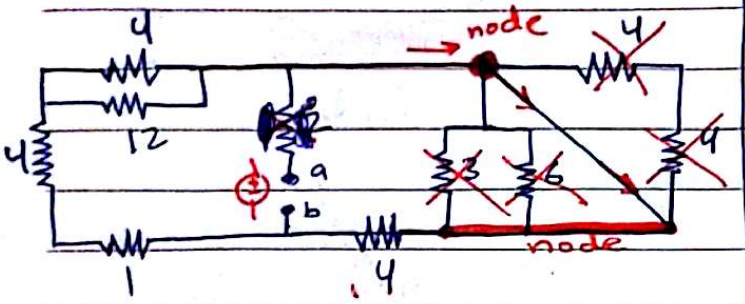
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ملاحظة (مهم جداً)

Find Req ما منشوف فيه وجود O.C فيه وجود source بدهم للتغطية

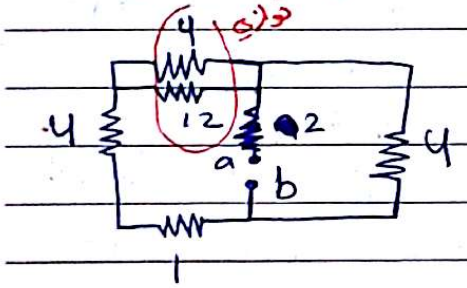
Ex:-

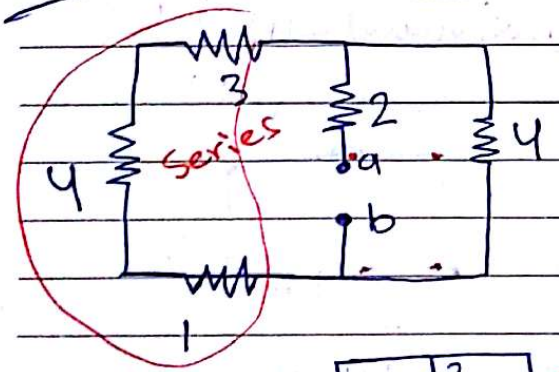


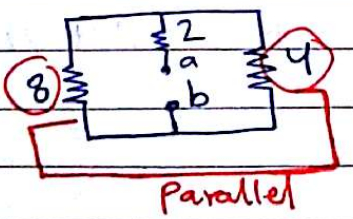


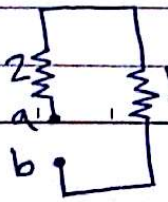
find Req between a and b

لو طلبت source بين a و b وتتبع اتجاه التيار اللي صابح في تيار خارجي









$R_{eq} = 4.7\ \Omega$

ملاحظات

* لا تكون كل تيارات الدارة معروفة ما عدا تيار واحد لفرع ما .. تقوم بإيجاده عن طريق (KCL)

التيارات الخارجة $\sum$ = $\sum$ التيارات الداخلة

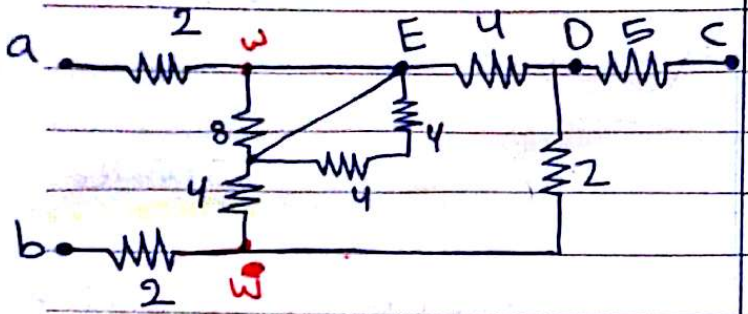
* انظري ص 44 من الكتاب عم الأسئلة والأضلاع اكامل بوجود التغطيتين a و b

Mechatronics Engineering
Sarah Abu-Sarah

Five Apple

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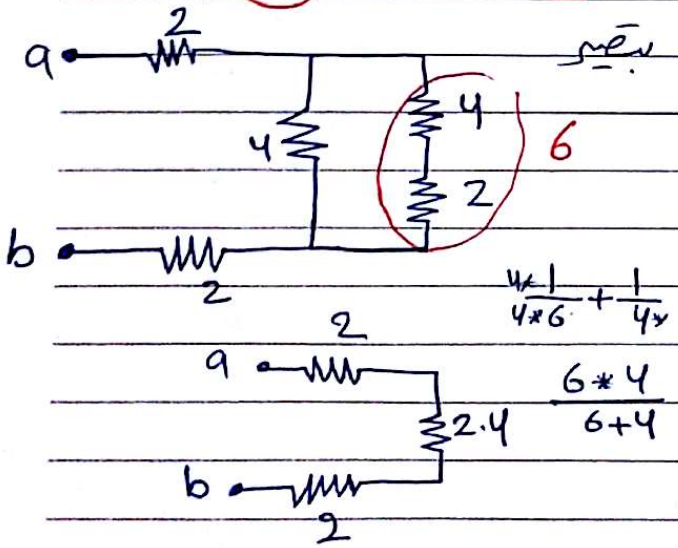
Ex:-



① Find Req between a and b
② = = = a and d
③ = = = C and d
④ = = = D and E

→ ① تيار يطلع من a ويدخل في الـ b مع الأخذ بعين الاعتبار الـ O.C (بلغيها) DC *
والأخذ بعين الـ S.C* والمقاومة الموصولة معها على التوازي (بلغيها)

نشيل (DC) ونشيل 8, 4, 4
S.C O.C



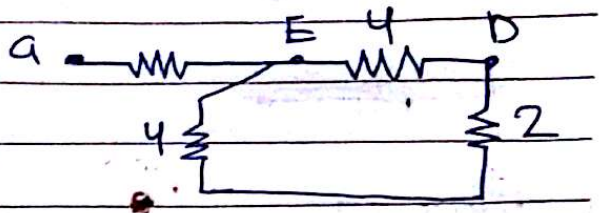
بنعيد

$\frac{4*1}{4*6} + \frac{1}{4}$

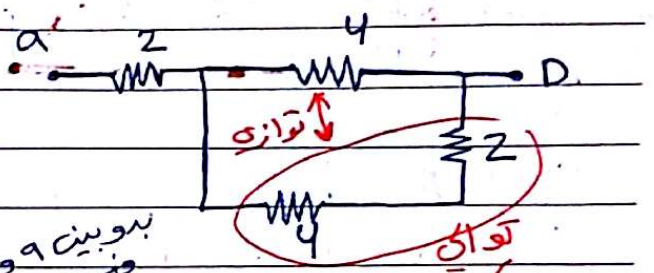
$\frac{6*4}{6+4}$

Req = 2 + 2 + 2.4 = 6.4 Ω

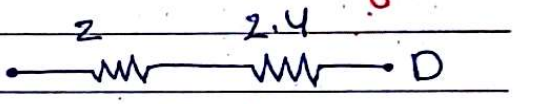
② نشيل (O.C) bW
نشيل 4, 4, 8 (S.C)



بنعيد



بدوبين a و d فنحسب حساب الـ (d)

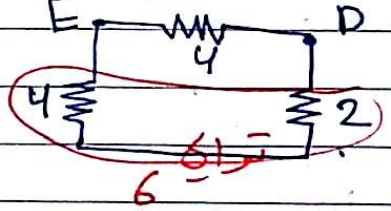


Req = 4.4 Ω

هيدر تيار ومنشوف كيف بيشي وناخذ بعين الاعتبار O.C و S.C

③ بال (O.C) Req = 5 Req || بين نقطتين هي عبارة عن المقاومة اللي بينهما.

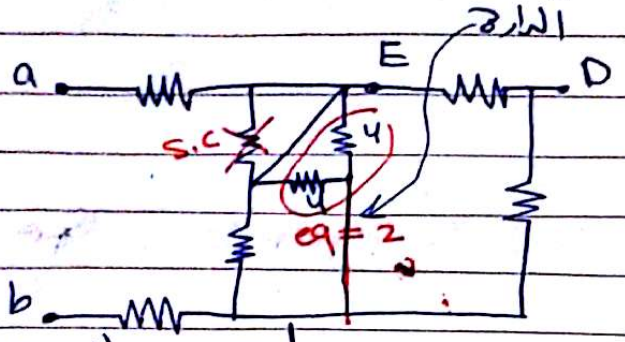
④ نشيل (DC) و (aW) و (bW)
نترك (O.C)



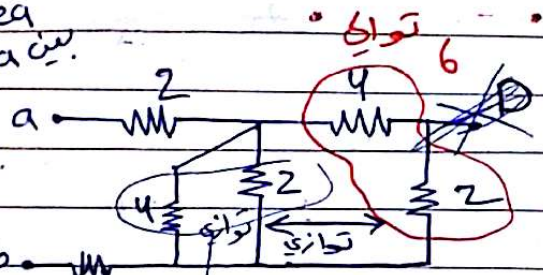
Req = 2.4 Ω

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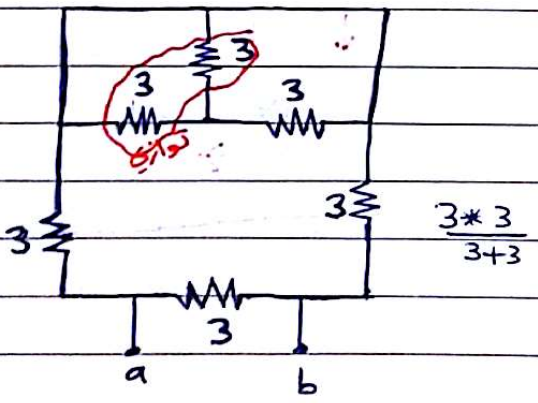
مثال السؤال السابق لو كانت الدارة



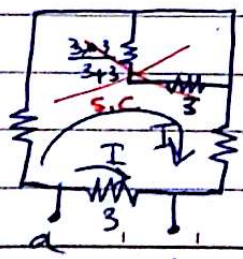
(كيف أحسب Req بين a و b)



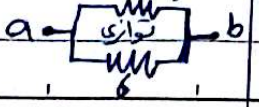
Ex :-



Find Req between a and b :-



3+3 = 6



3*6/6+3 = 18/9 = 2Ω

Ex :-

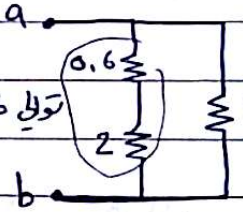


Find Req between a and b

If :- ① R = 1Ω

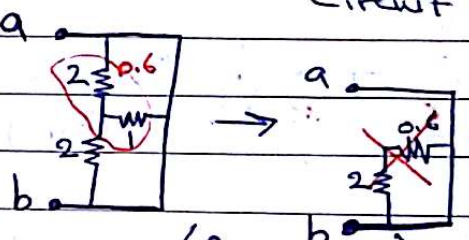
② R = Ø

① R = 1



$R_{eq} = \frac{2.6 * 1}{3.6}$ Ω

② R = Ø when → Short Circuit يعني



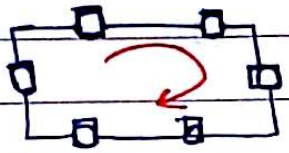
(Req = Ø)

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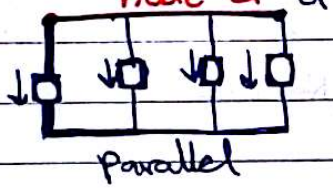
لازم تكون فيه كهربي مجموعة من المقاومات الموصولة على التوازي

Hints

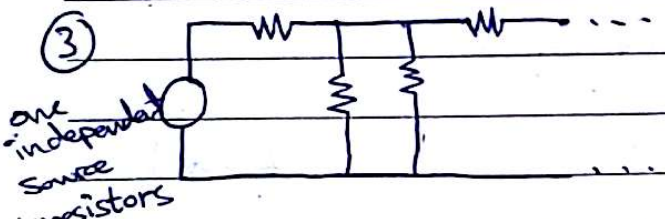
① Single loop (حلقة واحدة) بس أطبق (KVL) around loop



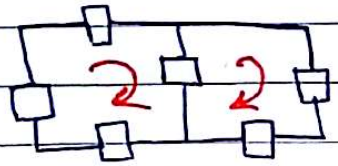
② node a (عقدة) أطبق (KCL) at node (a)



③ one independent source + resistors

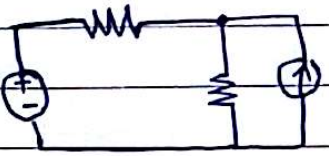


(ببسط المقاومات تعاقبي وتوازي) current divided

④  أطبق (KCL) and (KVL)

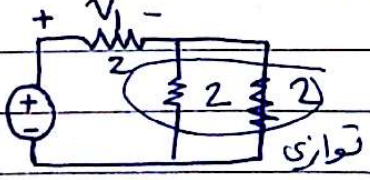
تعاقبي: 2 nodes مشتركين بـ

Notes احفظوهن

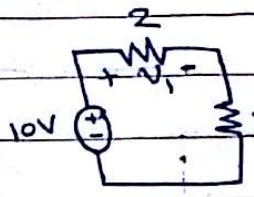
1]  ما منستخدم (V.D C.D)

Sources كتير

ex :

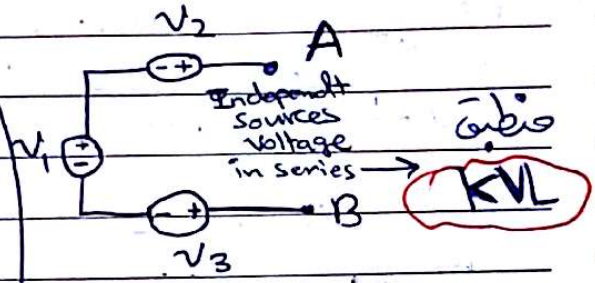


using V.D مثلا

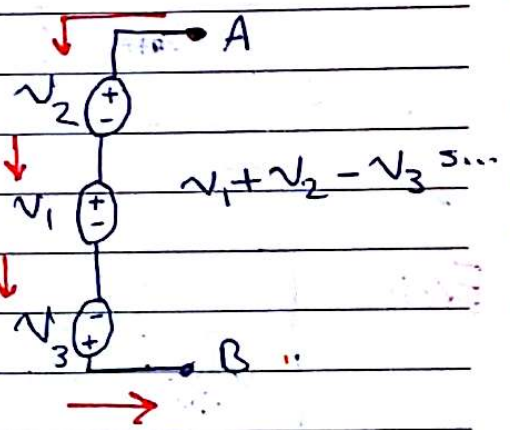


$$V_1 = \frac{10 * 2}{1+2} = \frac{20}{3}\ Volt$$

2]



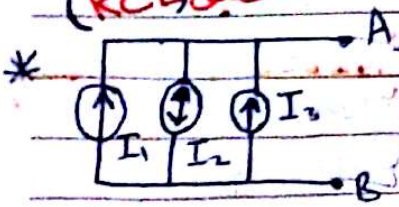
بسبب بدل تعاقبي الاتجاهات القطبية



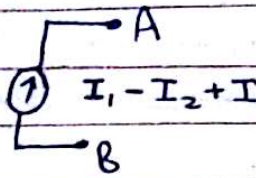
Scanned by CamScanner

مصادر ملغاة

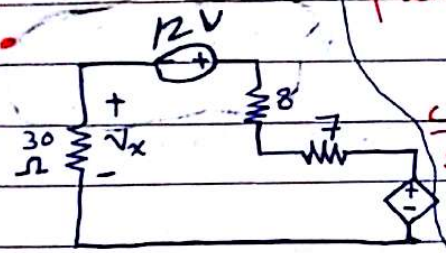
منطبق (KCL)



Independent current sources in parallel



Ex:-

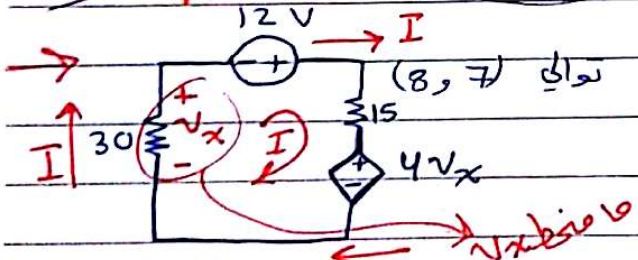


هاد الجزء نستخدم فيه V.D لأنو عندي sources على توالي بل اطبق KVL

① Find V_x ??

② Find P_{gen} by dependent Source and independent

③ find P_{abs} by 30 Ω ??



① By KVL :-

$$-12 + I(15+30) + 4V_x = 0$$

45

But

$$V_x = -30I \rightarrow IR$$

$$-12 + I(45) - 4(30)I = 0$$

$$I = \frac{-12}{75} \text{ A}$$

So, $V_x = -30 * \frac{-12}{75} = 4.8$ Volt

② $P_{abs,12V} = -IV$

$$= -(12)\left(\frac{-12}{75}\right) = \frac{144}{75}$$

$$P_{gen} = \frac{-144}{75} \text{ W} = -1.92 \text{ W}$$

③ $P_{abs,dep.} = +IV$

$$= \left(\frac{-12}{75}\right)(4V_x)$$

$$= \left(\frac{-12}{75}\right)(4)(4.8)$$

$$= -3.07$$

$P_{gen,dep} = 3.07$ W (المعطاة)

③ $P_{abs} = +30\left(\frac{-12}{75}\right)^2 = \dots$ W

I^2R

* KVL ← دارة وحدة
* KVL & KCL ← مصادر ملغاة
* V.D ← مقاومات توالي

$$V_1 = \frac{V_S R_1}{R_1 + R_2 + \dots}$$

(عدد غير محدود من المقاومات)

* C.D ← مقاومات توازي

$$I_1 = \frac{I_S R_2}{R_1 + R_2}$$

(مقاومتين فقط)

Five Apple

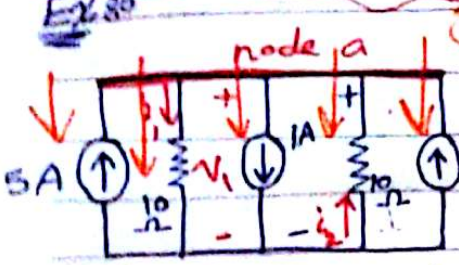
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$5 - 1 + 6 = 10\,A$ (source) * نقدر أجمع الـ

$V = 5(10) = 50$ volt

Ex:



نفترضهم صح ونطلع غلط

Find V_1, i_1 and i_2 ??

P_{abs} by 1A, and P_{gen} by 5A source ??

→ applied KCL at node a (كلهم تمازي)، اذن مباشرة KCL أطلع (V) بما إنو مشترك بينهم

$$10 * \left[-5 + \left(\frac{V}{10}\right) + 1 + \left(\frac{V}{10}\right) - 6 = 0 \right]$$

$I = \frac{V}{R}$ هاي المقادير

(إذا كان بيتبع الفرق حاسبين من) (إذا كنت بيتبع طرحين من إعطية) + ← −

+ ← −

* صح يكون أنا اعتبرت كل

$-50 + V + 10 + V - 60 = 0$

$V = 50$ volt

* $i_1 = +\frac{V}{R} = \frac{50}{10} = 5A$

$i_2 = -\frac{V}{R} = \frac{-50}{10} = -5A$

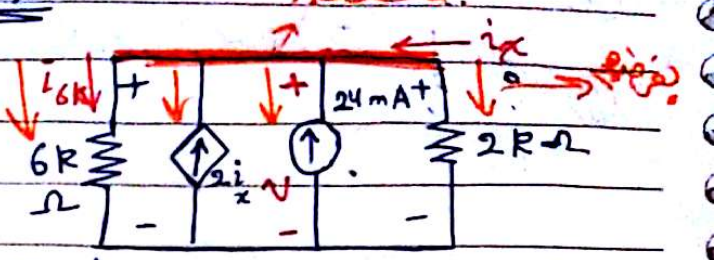
البيتا، وعين من الجاية الطالعة

$P_{abs,5A} = -IV$
$= -(5)(50)$
$= -250$

$P_{abs} = +IV$
$= (1)(50) = 50$ W

$P_{gen} = 250$ W

Ex:



* Find i_x, V, i_6, P_{abs} by dependent source ??

→ applied KCL at node a

$$* \left[\frac{+V}{6} - 2i_x - 24m + \frac{V}{2k} = 0 \right]$$

But $i_x = \frac{-V}{2k}$

منعوضها بالمعادلة اللي فوق

$$6 * \left[\frac{V}{6} + \frac{V}{1k} - 24\times10^{-3} + \frac{V}{2k} = 0 \right]$$

$$V + \frac{V}{1k} - 24*10^{-3} + 3V = 0$$

$V = 14.4$ volt

* $i_x = \frac{-14.4}{2k} = -7.2$ mA ... ماتنسيها

* $i_6 = +\frac{V}{6k} = \frac{+14.4}{6k}$

$= 2.4$ mA

* $P_{abs} = -IV$
$= -2i_x(14.4)$
$= (-2)(i_x)(14.4)$
$= 207.3$ mW

Five Apple

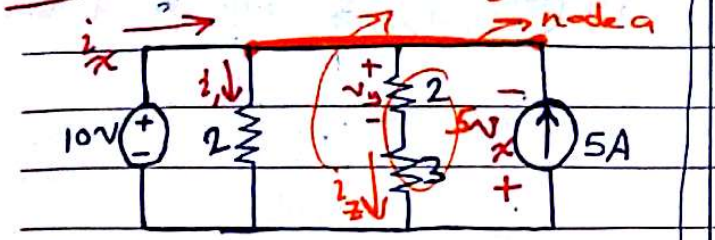
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* to find (i_x) applied KCL at node a

$i_x = i_1 + i_2 - 5 = 2A$

Ex:

$i_2 = \frac{10}{5} = 2A$



Find v_x, i_1, v_y, and i_x?

→ إذن (بالكلية) v ليست

$i_1 = \frac{10}{2} = 5A$

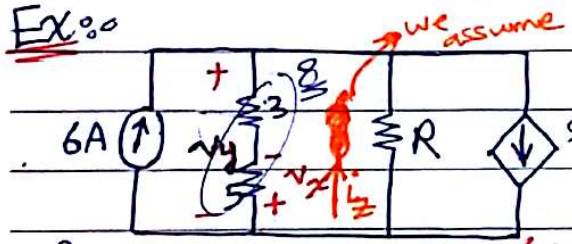
$v_x = -10$ Volt (عكس القطبية)

$v_y = \frac{(10)(2)}{2+3} = \frac{10 * 2}{5}$

$= 4$ (Volt)

(وبما أن الكلية v تطلع i_2 أو متعلقة i_2 كمان أو i_x) $v_y = 2(i_2) = 4$

Ex:



if $v_x = 10$ volt. Find (P_{abs}) by dependent Source ??

→ $P_{abs} = +2 v_y (v_y)$ (I)

* to find v_y →

$i_2 = \frac{v_x}{5} = \frac{10}{5} = 2A$ (التيار يساوي في التوالي)

$v_y = -IR = (-2)(8)$

$= -16$ (Volt)

(الإشارة سالبة لأن i_2 عكس اتجاه v_y)

$P_{abs} = +IV = (2v_y)(v_y)$ (الكلية v هي نفسها v_y)

$P_{abs} = 2(-16)^2$

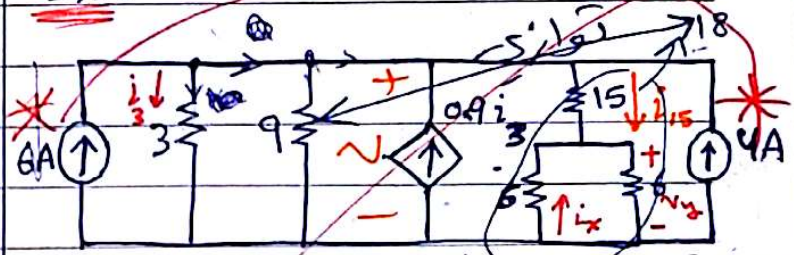
$= 512$ W

أو يستخدم V.D

$v_x = \frac{-v_y(5)}{5+3}$

$6 - 4 = 2$

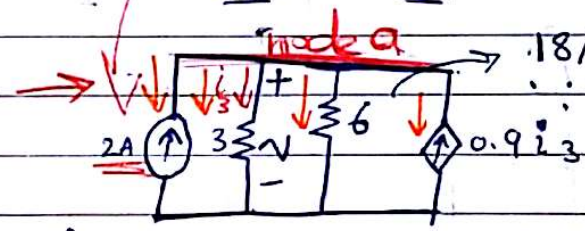
Ex:



* ① Find P_{gen} by dependent source

② = P_{abs} = resistor (15 Ω)

③ Find i_x and v_y ??



(نوجد i_3 لأنها متعلقة depend source بمتغير كلي)

KCL (نطبق عند node a)

نعوض اتجاهات تكبيرية سالبة

$-2 + \frac{v}{3} + \frac{v}{6} - 0.9 i_3 = 0$

But $i_3 = \frac{v}{3}$

$-2 + \frac{v}{3} + \frac{v}{6} - 0.9\left(\frac{v}{3}\right) = 0$

$v = 10$ Volt

$i_3 = \frac{10}{3} = \ldots A$

① $P_{abs} = -(0.9 i_3)(10)$

$= -0.9 * \frac{10}{3} * 10 =$ Fix Supply

$P_{gen} \rightarrow$ عكس الإشارة $= 30$ W

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(2) $P_{abs,15\Omega} = I^2 R$

$= (15)(i_{15})^2 = 15 * \left(\frac{10}{18}\right)^2$ = ...

But, $i_{15} = \frac{v}{18} = \frac{10}{18}$

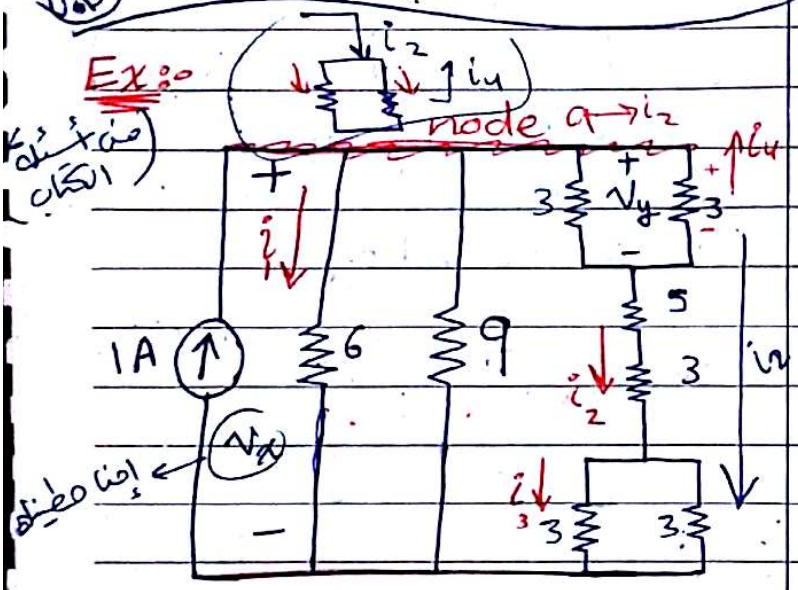
(3) $i_x = \frac{-i_{15} * 6}{6+6}$ = ... -0.275 A

$v_y = -6 i_x$

$= -6(-0.275) = 1.65$ volt

(1.D)

Ex:



Find: (1) $P_{(gen/source)}$

(2) Find P_{abs} by 9Ω

(3) Find

i_1, i_2, i_3, i_4 and v_y?

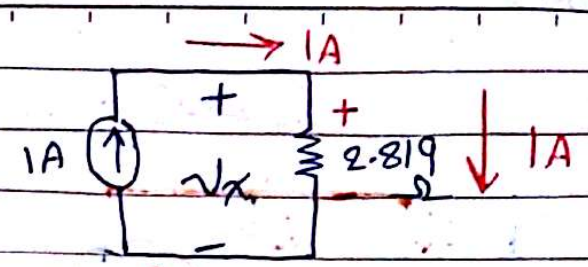
→ KCL at node (a)

* $3 // 3 = 1.5$

$1.5 + 8 + 1.5 = 11\ \Omega$

* $11 // 9 // 6 = 2.819\ \Omega$

R_{eq} seen by the source



$v_x = (2.819)(1)$

$= 2.819$ volt

(1) $P_{abs} = -IV$

$= -1(2.819)$

$= -2.819$

So, $P_{gen} = 2.819$ W

(2) $P_{abs} = \frac{(v_x)^2}{9}$

$= \frac{(2.819)^2}{9} = 0.883$ W

(3) $i_1 = \frac{v_x}{6} = \frac{2.819}{6}$

$= (\ldots)$ A

$i_2 = \frac{v_x}{11} = \frac{2.819}{11}$

$= 0.2$ A

$i_3 = \frac{i_2(3)}{3+3} = \frac{(0.2)(3)}{6} = 0.1$

(C.D)

$i_4 = \frac{-i_2(3)}{3+3} = \frac{(-0.2)3}{6}$

$= -0.1$ A

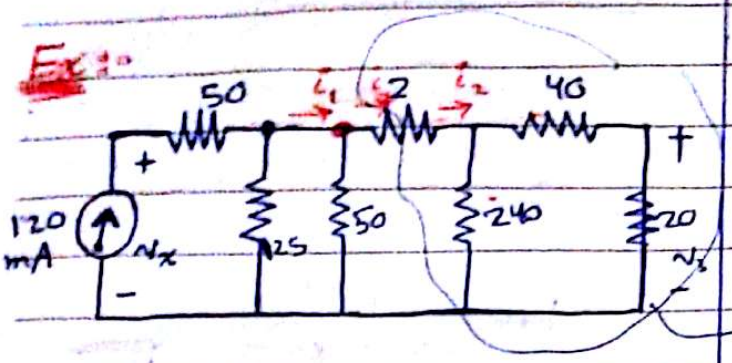
$v_y = -i_4(3) = (0.1)(3)$

$= 0.3$

Five Apple

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Ex :-



* Find i_1, i_2, V_3 and V_x ?

Sol

20 + 40 = 60

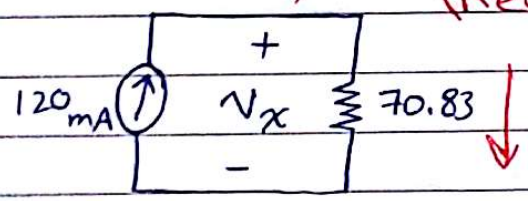
60 // 240 = 48

48 + 2 = 50

50 // 50 = 25

25 // 125 = 20.83

20.83 + 50 = 70.83 (Req)

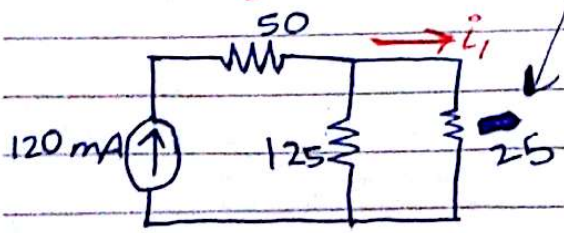


* $V_x = IR$

$= (120 \times 10^{-3})(70.83)$

$= 8.5$ volt

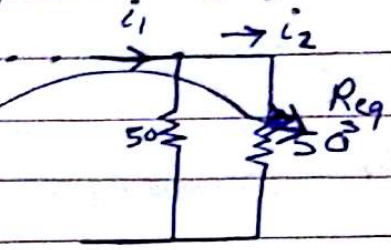
* لكي أوجد (i_1) لازم لأستخدم C.D أبسط المقاومات اللي جنبها



* using C.D :-

$$i_1 = \frac{(120m)(125)}{125+25} = 100\,mA$$

→ to find (i_2) :-



* $i_2 = 50\,mA$

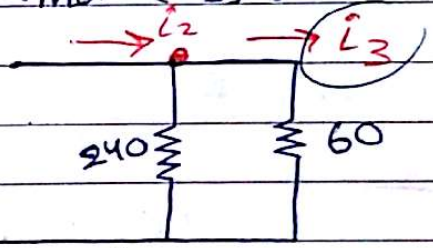
or

$$i_2 = \frac{100m * 50}{50+50}$$

$$= \frac{5000}{100}$$

$= 50\,mA$

* to find (V_3) :-



C.D

$$i_3 = \frac{i_2 * 240}{240+60} = 40\,mA$$

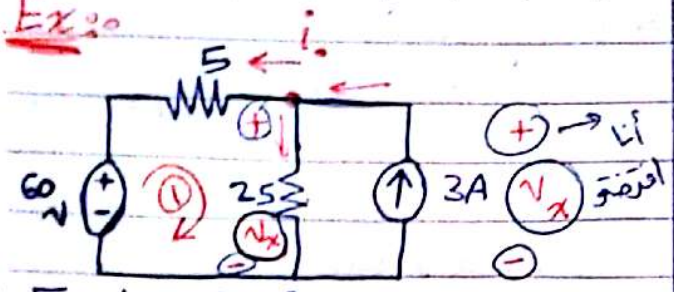
$V_3 = 20 i_3$

$= (20)(40m)$

$= 800\,mV = 0.8$ Volt

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Ex:



* Find: ① i_o ?
② $P_{abs,\ current\ source}$?

→ N.D → C.D ما بقدر أستخدم *
في أكثر من source ← بستخدم *
note KVL مع KCL

ولو كانت
مقاومة ثانية توازي مع (25) ما بتخدم C.D
لأنو التيار صيتوزع عالـ source كمان



* لو كان عندي هيك دائرة
لو جا كان عدد الـ sources بيزيد هون
أستخدم C.D ضغط كل جزء

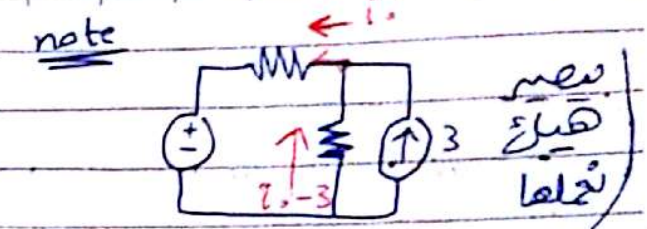
(KCL) بطبق *
Current passing through
$25\ \Omega = 3 - i_o$

KVL around loop ①
$-60 - 5i_o + 25(i_o - 3) = 0$

$60 = -5i_o + 25i - 75$

$i = 0.5\ A$

note



بصير هيك نحلها

* $P_{abs\ 5-3} = * V_x$
$= (-3)(62.5) = -187.5$ volt

But, $V_x = 25(3 - i_o)$
$= 25(2.5)$
$= 62.5$ volt

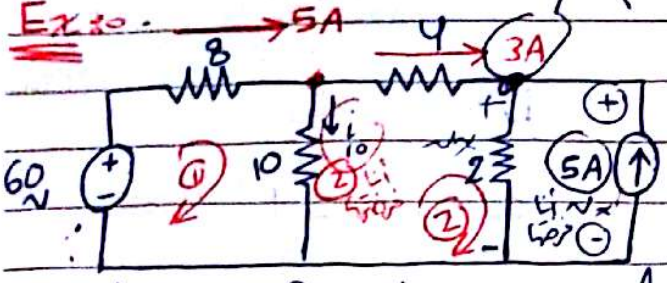
⑨ KVL ← تمثل الفولت
KCL ← تيارات الدارة
$V = IR$
$i = \frac{V}{R}$

ملاحظات
* جيبي بالك كل هي
① متى تستخدمي C.D و V.D
② كيف تباشري بالحل
③ تذكري إنو ممكن تطلعي
أكثر من KVL لما
إذا كان عندي طلعات فيهم توازي
وتوالي
أو (KCL) إذا كان عندي
بس مقاومات توازي
④ لما يكون عندك (1 source)
بسط كل المقاومات اللي حولت
وحسب أكثر من الكل
⑤ تتبعي اتجاه التيار، واتبعي
توصيل المقاومات (توالي/توازي)
⑥ افرضي اتجاه للتيارات غير المعروفة
وعددي القطبية للمقاومات
⑦ ميزي بين P_{gen} و P_{abs}
بالنهاية بتعكسي الإشارة

كل ما في step by step ⑧ خليكي

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Ex:- 

* Find the P_{gen} by current source?

* Loop ① (C.D أستخدم ما يقدر)

$-60 + 5(8) + 10\, i_{10} = 0$

$i_{10} = 2\,(A)$

* $P_{abs} = -5 V_x$

$P_{gen} = 5 V_x$

* KVL around Loop ②

(I_{10} ② ⑩ → R)

$-20 + (3)(4) + V_x = 0$

$V_x = 8$ volt

$P_{gen} = (5)(8) = 40$ W

..طريقة step by step ⑦ طبقي

* power absorbed ⑧
Power delivered هي نفسها to

* Power generated
Power supplied هي
(delivered by)

Notes

① ديري بالك متى تستخدمي KCL ومتى KVL ..

* تيار واحد مجهول والباقي معروفين مباشرة KCL وطلعي المجهول

* تذكري بـ KCL بتقدري تطلعي V
اذا كانت R معطاة $I = \frac{V}{R}$

* تذكري أن KCL عم تشتغلي ع تيارات أو $(\frac{V}{R})$ وأن KVL عم تشتغلي ع جهود أو (IR)

② ديري بالك P_{abs} دايماً موجبة و P_{gen} و إنو P_{abs} للمقاومات دايماً موجبة وتساوي (I^2R)

③ افرضي اتجاهات التيارات وقطبية العناصر في حال لم يكن معطاة

④ ديري بالك كيف تباشري بالحل

⑤ انتبهي لما توصل المقاومات توازي وتوالي وطلبي بتقدري تستخدم V.D وحتى تستخدمي الـ C.D

V.D ← مقاومات توالي ماخذ أي source بينهم ...

C.D ← مقاومتين توازي ماخذ أي source بينهم ...

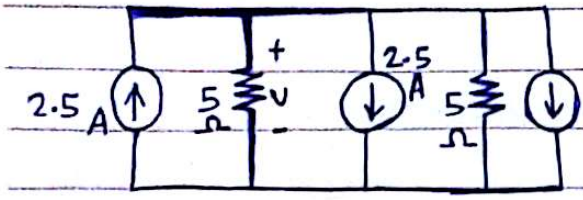
⑥ ما يكون عندي (I source) دايماً بطبق عليها كل المعادلات (بداية وطلعت (eq) وتوصلي اجهد الكل، آخر ما كان مقطوع

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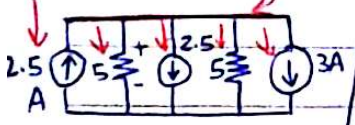
Notes

Ex: (انا كان مش دايخ كيف اخذ الطريقة)



بالكتاب

KCL at node (a)



$-2.5+\frac{V}{5}+2.5+\frac{V}{5}+3=\emptyset$

$\frac{2V}{5}=-3$

$V=-7.5$ (Volt)

Create new source

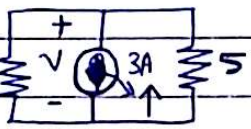
$2.5-2.5-3=\ominus 3A$

اتجاهه من ⊖ ← ⊕

السهم (بجلط)

أو من ⊕ ← ⊖

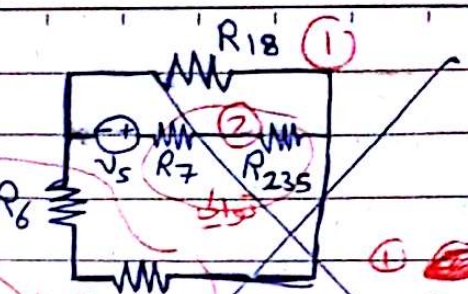
وبعكس الاشارة (3A)



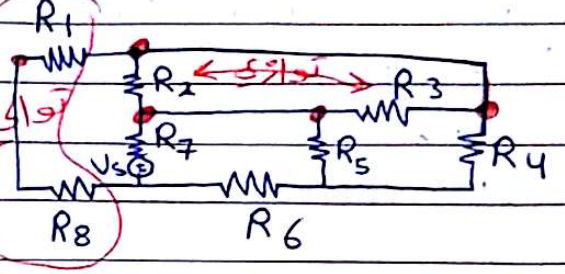
KCL

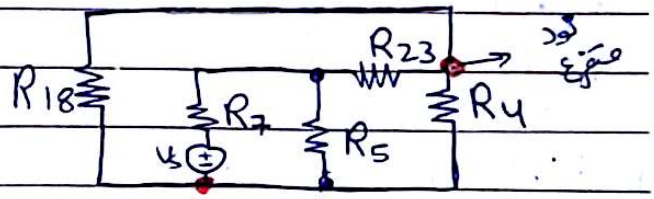
$-3+\frac{V}{5}+\frac{V}{5}=\emptyset$

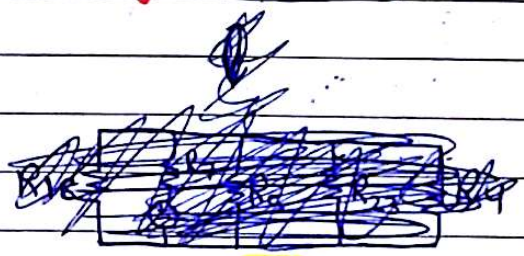
$V=7.5$ (Volt)



صح (2) توالي بقية





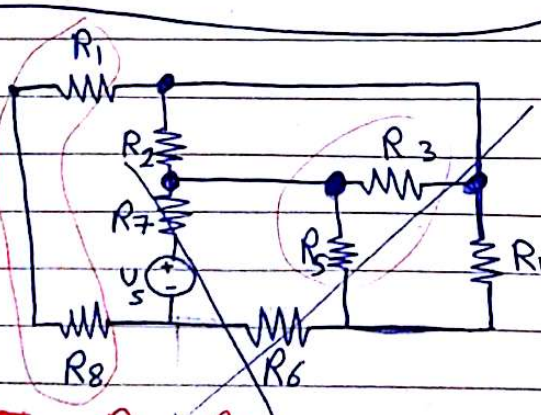


حلة

ملاحظة

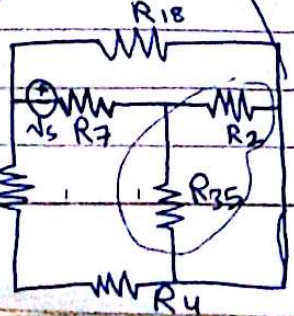
* عشان يكون توازي لازم تشترك المقاومتين بـ 2 nodes فقط.
* وعشان يكون توالي لازم يشتركو بـ (node) واحد فقط غير مشترك.

Ex:



$R_1 = R_8$

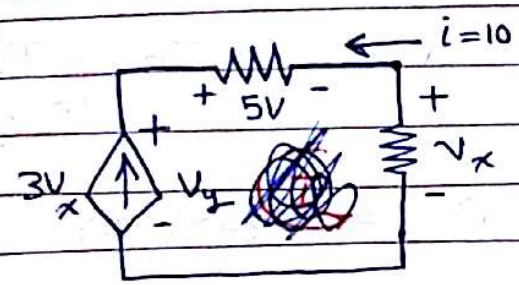
$R_5 // R_3$



$R_2 // R_{35}$

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Ex:: Find ::

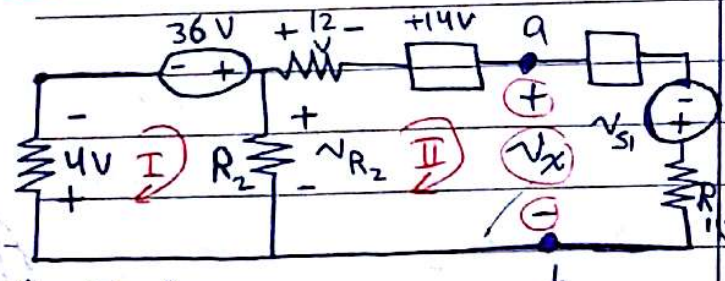


* Find V_x ::

$3V_x = -10$

$V_x = \frac{-10}{3}$ V

Ex::



* Find:

V_{R2} and V_x ?

KVL around (I)

$-36 + V_{R_2} + 4 = 0$

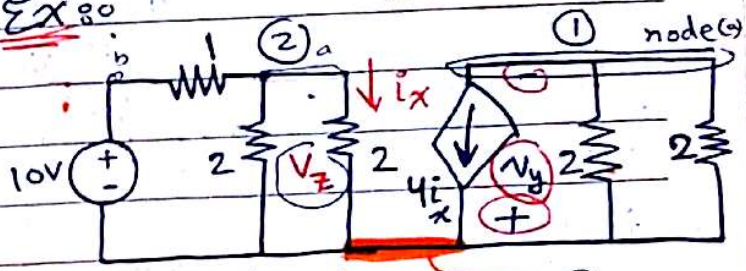
$V_{R_2} = 32$ V

KVL around (II)::

$+12 + 14 + V_x - 32 = 0$

$V_x = 6$ V

Ex::



*Find Pabs by dep. Source?

→

$I = 0$ *

* $P_{abs} = -(4i_x)(V_y)$

[بنعوض بالعمود ① و ②
$V_y \neq V_z$ لأنهم على التوازي]

- to find (i_x) ::

$V_z = \frac{10(2//2)}{(2//2)+1} = \frac{10(1)}{2}$

(voltage divider لأنهم على التوازي)

$= 5$ Volt

$i_x = \frac{V_z}{2} = \frac{5}{2} = 2.5$ A

- to find (V_y) →

$V_y = 4i_x(2//2)$

$= 4(2.5)(1)$

$= 10$ Volt

KCL at node(a)

$10 - \frac{V}{2} - \frac{V}{2} = 0$

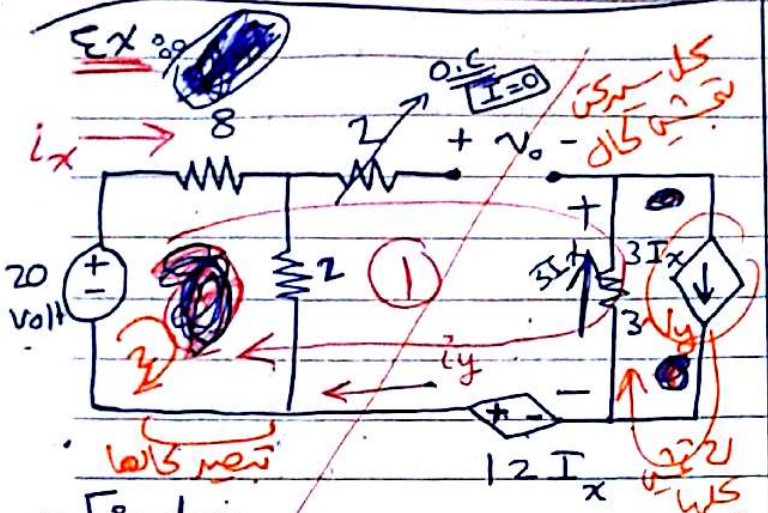
Five Apple

$V = 10$ V

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* $P_{abs} = -(10)(10) = -100$ W

Ex:



* Find:

i_y , V_o , P_{abs} , dependant current source ?

① $(i_y = 0)$

لأنه (O.C) من فوق

(Open circuit لأنه لا يمر تيار KVL في)

② * KVL around ① ③ (المجهول تقدر تقدر)

$-20 + 8I_x + 0 + V_o - (3I_x) = 0$

$-12 I_x = 0$

to find (I_x) ; KVL around ②

$-20 + 8I_x + 2I_x = 0$

$I_x = 2$ A

$-20 + 8(2) + V_o - 3(2) = 0$

$-12(2) = 0$

$V_o = +46$ Volt

③ $P_{abs} = -(3I_x)(V_o)$

* But $(I_x = 2A)$

Also $V_y = 3(3I_x) = 9I_x$

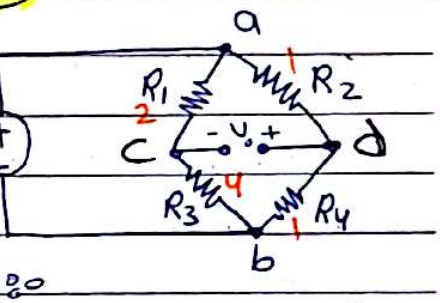
$= 18$ Volt

$\Rightarrow P_{abs} = -(3 \times 2)(18)$

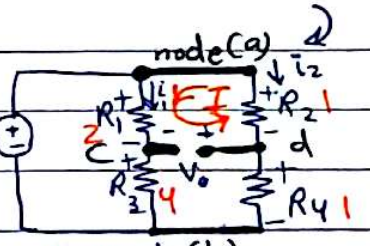
$= -108$ W

مهم

Ex:



* Find (V_o)



(KVL around I)

$-V_o - i_2 + 2i_1 = 0$

* $i_1 = \frac{V_s}{R_1 + R_3} = \frac{15}{2+4}$

$= 2.5$ A

* $i_2 = \frac{15}{2} = 7.5$ A

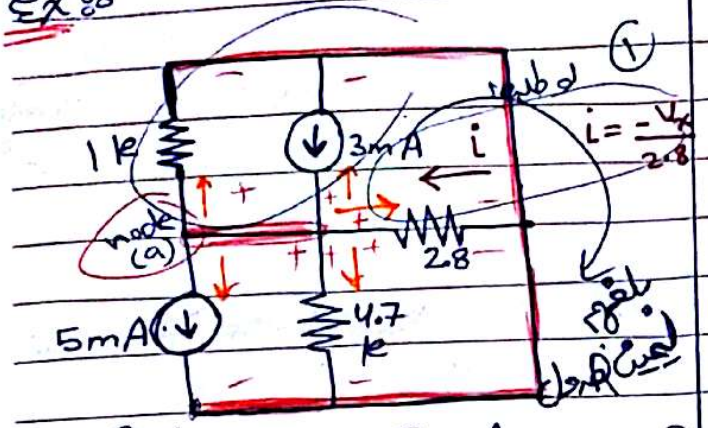
$-V_o - 7.5 + 2(2.5) = 0$

$V_o = -2.5$ Volt

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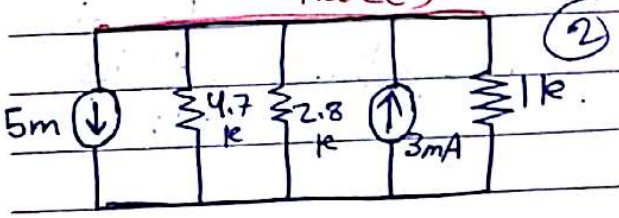
* (Parallel وعناصر مشتركين بـ 2 تتوزع وهامش Path/الطريق) ← SC
أطراف العنصرين مشتركة

Ex:



1.) Find P_{abs} by 3mA source?
2.) Find P_{abs} by 1kΩ ?

(Parallel كلها تعتبر node)



* KCL at node(a):

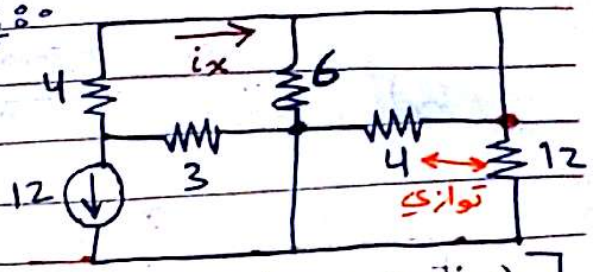
$$\frac{5}{m} + \frac{V}{4.7k} + \frac{V}{2.8k} - 3m + \frac{V}{1k} = 0$$

$$V = -1.28 \text{ Volt}$$

$$* P_{abs,3m\ Source} = -(3m)(V) = -(3*10^{-3})(-1.28)$$
$$= 3.84*10^{-3} \text{ W}$$
$$= 3.84 \text{ mW}$$

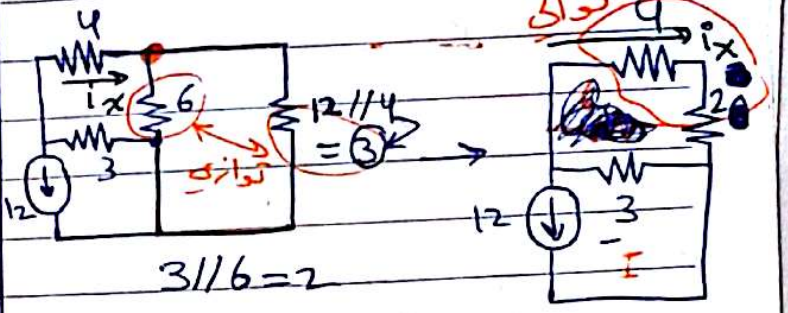
$$* P_{abs,1k} = \frac{(V_x)^2}{1k} = \frac{(1.28)^2}{1*10^3}$$
$$= 1.6 \text{ mW}$$

Ex:



[(one indep. + Sources) بسيط الحقاومات]

* Find i_x?



3//6 = 2

$$I_x = \frac{-12(3)}{6+3} = -4 \text{ A}$$

(مقاومتين توازي) C.D

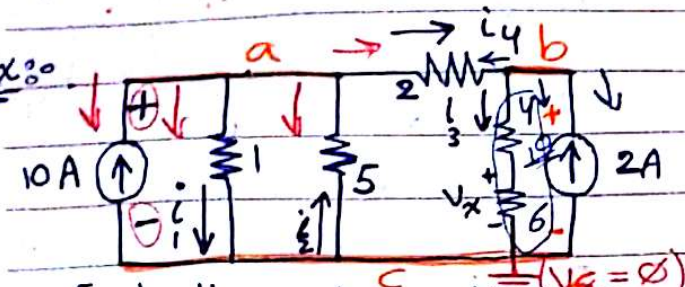


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Ch.4 :: Nodal Analysis

node بكل بساطة

Ex::



1. Find the node voltages?
2. Find i_1, i_2, i_3, i_4 and v_x ?
3. Find the power generated by 10A source?
4. Find power absorbed by 2Ω-resistor?

لازم توقف بكيف a و b و c

→ Apply KCL at node (a)

$$* \left(-10 + \frac{V_a - \emptyset}{1} + \frac{V_a - \emptyset}{5} + \frac{V_a - V_b}{2} = \emptyset\right) *10$$

$$-100 + 10V_a + 2V_a + 5(V_a - V_b) = \emptyset$$

$$17V_a - 5V_b = 100 \quad \text{eq ①}$$

* Apply KCL at node (b)

$$\left(-2 + \frac{V_b - \emptyset}{10} + \frac{V_b - V_a}{2} = \emptyset\right) *10$$

2Ω نوعها بين a و b

$$-20 + V_b + 5(V_b - V_a) = \emptyset$$

$$-5V_a + 6V_b = 20 \quad \text{eq ②}$$

Notes

condition to use nodal analysis

* No voltage source in the CCT :: (شرط)

① specify the nodes, one of them is Ref.

② Apply KCL at each non-reference node

node بنطرح اللي جاية من (a → b) بنطرح $V_a - V_b$

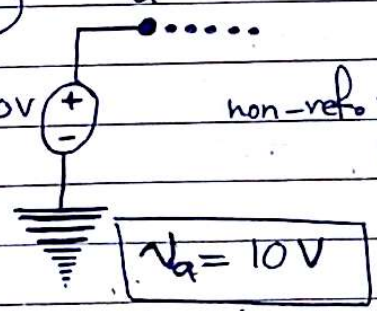
(b) لـ $I = \frac{V}{R}$ بنا نطلع V

I منها كل

KCL equation بـ $\left(\frac{V}{R}\right)$ بكل

* If you have voltage source in the [CCT] ::

①



non-ref. node بين ref. و

$V_a = 10V$

(indep.) أو (dep.) سواء كان

* (reference node) الـ كيف في

لـ وي جنب ...

* لما يطبق KCL يطبق بين 2 nodes

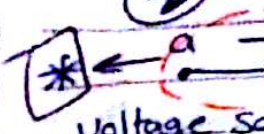
$V_s = V_{node} - V_{node}$ حيث أن $\left(\frac{V}{R}\right)$ وكل

اللي طالع منها — اللي داخل فيها

Five Apple

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(2) super node

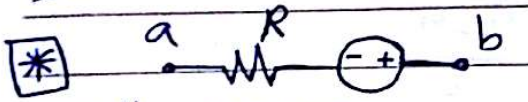


Voltage source between two non-reference nodes

[One node + apply KCL] ... eq (1)

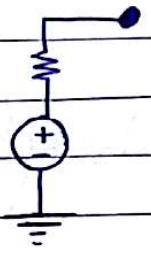
$V_b - V_a = 10$ ... eq (2)

(+) عند a (−) عند b



(3) Voltage source in series with (R)

→ apply KCL at each node



(Voltage source) ما عدا node كل (KCL) طبق

* بنتج من هذا الشي معادلة عن كل (node) بجانبهم بالآخر المجهول والتعويض ...

ملاحظة

Reference node اختاري الـ دائماً بحيث تضم عدد أكبر من الـ (elements) بالسيركت (بتوفري في حالات ومن بالحل)

* ← (تكملة حل المثال)

$17V_a - 5V_b = 100$ حل المعادلتين

$-5V_a + 6V_b = 20$

① $V_a = 9.1$ volt → (5) mode

$V_b = 10.9$ volt

(1) حالتوانج تسهل حلها

D S

(2) $* i_1 = \frac{V_a - V_c}{R}$ (من ⓐ إلى ⓒ)

$i_1 = \frac{9.1 - 0}{1} = \frac{9.1}{9.1}$ A

$* i_2 = \frac{V_c - V_A}{5} = \frac{0 - [redacted]}{5} = \dots$ A

$* i_3 = \frac{V_b - V_c}{R} = \frac{10.9 - 0}{10} = 1.09$ A

$* i_4 = \frac{V_a - V_b}{2} = \frac{9.1 - 10.9}{2}$

$= \frac{-0.9}{\dots}$ A

(i4) داخلة من b إلى a (50)

$V_a - V_b$

آخري V.D

$V_x = \frac{(10.9)(6)}{10}$ ($V_b - V_x$ ، $0 - V_x$)

$* V_x = IR = +(i_3)(6)$

(3) $P_{abs} = -10V_a = -90.1$ W

($V_a - V_x$ ، $0 - V_x$)

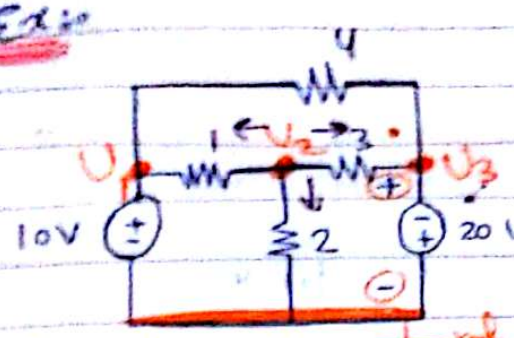
$P_{gen} = 90.1$ W

(4) $P_{abs} = \frac{(V_a - V_b)^2}{2}$

$= \frac{(9.1 - 10.9)^2}{2} = 1.62$ W

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* Ex:



Find nodes voltages ?

→ $V_1 = 10V$

$V_2 = \cdots$ KCL → لأنها بتربط voltage source

$V_3 = -20\ V$ لأنها بتربط voltage source

apply KCL at node (V_2)

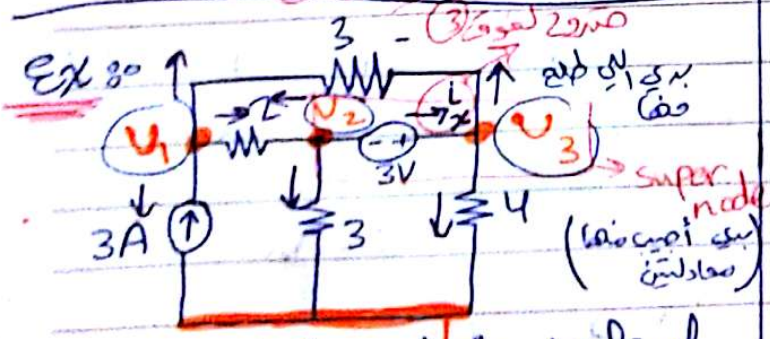
$$\frac{V_2 - \emptyset}{2} + \frac{V_2 - V_3}{3} + \frac{V_2 - V_1}{1} = \emptyset \quad (V_3 = -20,\ V_1 = 10)$$

$$6V_2 + 2(V_2 + 20) + 6(V_2 - 10) = \emptyset$$

$$14V_2 + 40 - 60 = \emptyset$$

$$V_2 = \frac{20}{11} = 1.8\ V$$

Ex 8:



* use nodal analysis to find (i_x) ?

$V = \emptyset$

$$V_3 - V_2 = 3 \quad \text{eq (1)}$$

$$\text{or } V_1 - V_2 + V_3 = 3$$

* apply KCL at supernode

$$\frac{V_2 - V_1}{2} + \frac{V_2 - \emptyset}{3} + \frac{V_3 - \emptyset}{4} + \frac{V_3 - V_1}{3} = \emptyset$$

$$-10V_1 + 10V_2 + 7V_3 = \emptyset \quad \text{eq (2)}$$

* Apply KCL at node (1) V_1

$$-3 + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{3} = \emptyset$$

$$5V_1 - 3V_2 - 2V_3 = 18 \quad \text{eq (3)}$$

$$i_x = \left(\frac{V_3 - \emptyset}{4}\right) + \left(\frac{V_3 - V_1}{3}\right)$$

$= 1.12\ A$

$V_1 = 8.66\ V$

$V_2 = 3.86\ V$

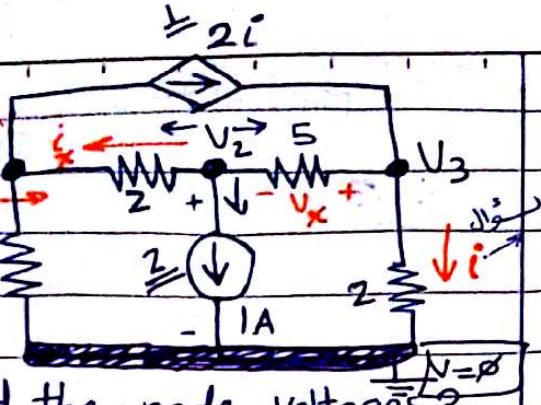
$V_3 = 6.86\ V$

٣ معادلات
mode ⑤ ②

* لما يكون في supernode كيف جبنا معادلتين؟ جبنا 1 node وجبنا بدل المعادلة الثانية $V_a - V_b =$ قيمة الجهد على الـ voltage source

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Ex:



1. Find the node voltages?
2. Find Pabs by each current source?
3. Find (v_x) and (i_x) ?

① → Apply KCL at (V_1) →

$$\frac{V_1}{12} + \frac{V_1 - V_2}{2} + 2i = 0$$

But $i = \frac{V_3}{2}$

$$12 * \left[\frac{V_1}{12} + \frac{V_1 - V_2}{2} + V_3 = 0\right]$$

$$7V_1 - 6V_2 + 12V_3 = 0 \quad (1)$$

→ Apply KCL at (V_2) →

$$10 * \left[1 + \frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{5} = 0\right]$$

$$-5V_1 + 7V_2 - 2V_3 = -10 \quad (2)$$

→ Apply KCL at (V_3) →

$$\frac{V_3}{2} + \frac{V_3 - V_2}{5} - 2i = 0$$

But $i = \frac{V_3}{2}$

$$* \left[\frac{V_3}{2} + \frac{V_3 - V_2}{5} - V_3 = 0\right]$$

$$-3V_3 - 2V_2 = 0 \quad (3)$$

$V_1 = 12\,V$
$V_2 = 6\,V$
$V_3 = -4\,V$

$\rightarrow i = \frac{-4}{2} = -2\,A$

② $P_{abs} = +IV$

$= (2i)(V_1 - V_3)$ ①

$= 2(-2)(12+4) = -64\,W$

$P_{abs} = IV_2$

$= (1)(6) = 6\,W$

③ $V_x = V_3 - V_2$

$= -4 - 6 = -10\,V$

$i_x = \frac{V_2 - V_1}{2} = \frac{6-12}{2} = \frac{-6}{2}$

$= -3\,A$

Five Apple

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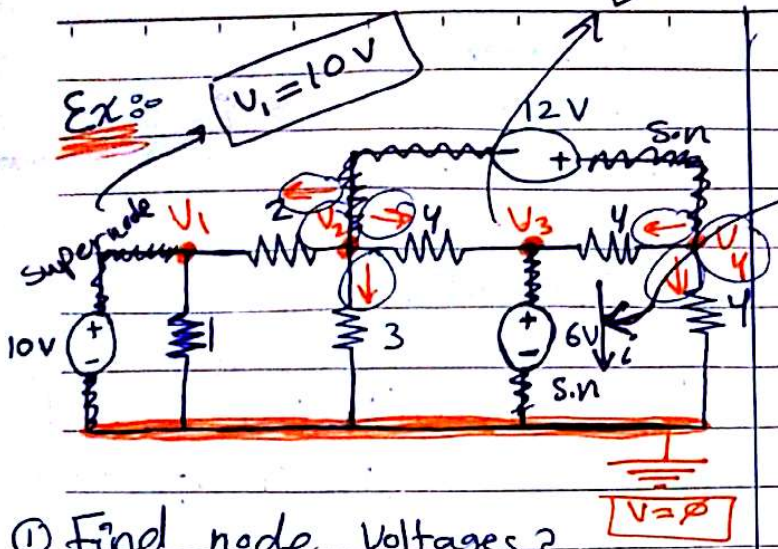
S.n = Supernode

2eq. بجهل

$V_3 = 6V$

Ex:

$V_1 = 10V$



① Find node voltages?

② Find Pabs by 6V-source?

→ ① $V_1 = 10\,V$

$V_3 = 6V$

* from the supernode →

$V_4 - V_2 = 12$ 1

* KCL at supernode ↓

بيكونوا كلهم معادلة وحدة بتقت V_2 و V_4

V_1 V_3

$$\frac{V_2-10}{2} + \frac{V_2}{3} + \frac{V_2-6}{4} + \frac{V_4}{4}$$

V_3

$$+ \frac{V_4-6}{4} = 0$$

$$13V_2 + 6V_4 = 96 \quad 2$$

$V_2 = 1.26\,V$

$V_4 = 13.26\,V$

② $P_{abs} = 6i$

$= 6(\quad)$

نروح نشوف I

But

$I = \frac{V}{R}$ so

$i = \frac{V_2 - V_3}{4} + \frac{V_4 - V_3}{4}$

$i = \ldots\ldots$

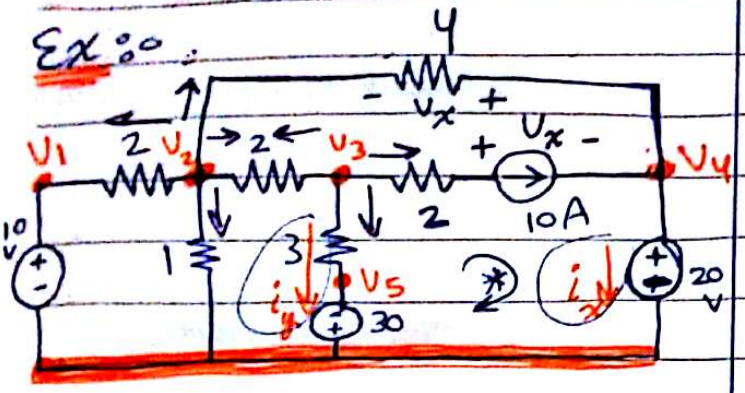
هدخل هيك لازم يكون

↓ i (اللي أنا فرضتها)

Five Apple

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Ex :-



* Find :-

1- V_x using nodal analysis

2- P_{abs} by (20 V - source) and by (30 V source)

3- P_{gen} by (10 A source) ?

Solution

① $V_1 = 10V$

$V_5 = -30V$

$V_4 = 20V$

* Apply KCL (V_2) →

$$\frac{V_2-10}{2} + \frac{V_2-V_3}{2} + \frac{V_2}{1} + \frac{V_2-20}{4} = 0$$

(V_4)

①

* Apply KCL (V_3) →

$$\frac{V_3-V_2}{2} + \frac{V_3-(-30)}{3} + 10 = 0$$

$V_2 = -1.02$

$V_3 = -24.62$

* أو طريقة أخرى للحل :-

- without (V_1) and (V_5) →

$V_4 = 20$

* Apply KCL at ② :-

$$\frac{V_2-10}{2} + \frac{V_2}{1} + \frac{V_2-V_3}{2} + \frac{V_2-20}{4} = 0$$

* Apply KCL at ③ :-

$$\frac{V_3-V_2}{2} + \frac{V_3+30}{3} + 10 = 0$$

② P_{abs} (20V) $= \vec{I}V_4 = 20(4.7) = 94$ W

$i_x = 10 + \frac{V_2-V_4}{4} = \dots 4.7$ (10A, i_x)

P_{abs} (30V) $= -(30)(i_4)$

$= -30\left(\frac{V_3-(-30)}{3}\right)$ ← ما يصير تاخذها $\frac{-30}{3}$ وتعتبرها V_3 وما تعوضها

$= -30\left(\frac{-24.62+30}{3}\right)$

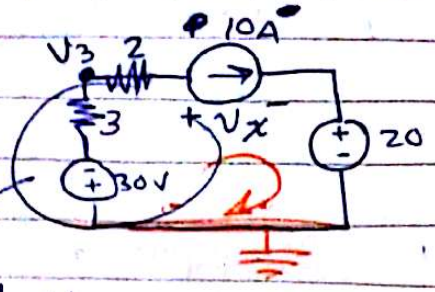
③ P_{gen} (10A) $= IV$ (KVL بدل)

$= -10I$

$= -10\left(\frac{V_2-V_1}{2}\right)$

Five Apple

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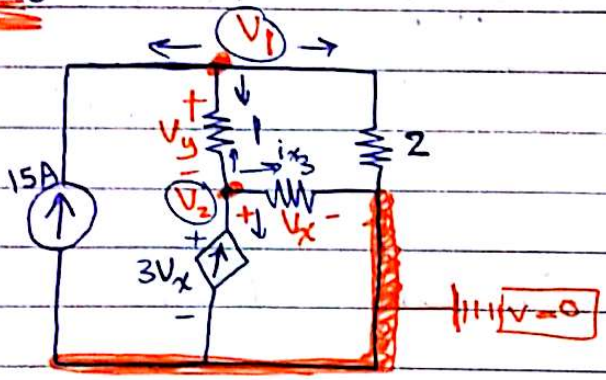
* to find V_x :-

$-V_3 + 2(10) + V_x + 20 = 0$

$V_x =$

(Is side ke liye isko convert kar sakte)

Ex :-



* Find V_y, V_x, P_{abs}, dependent [using nodal Analysis] ?

→ KCL at (V_1) →

$$-15 + \frac{V_1 - V_2}{1} + \frac{V_1}{2} = 0 \quad (1)$$

→ KCL at (V_2) →

$$\frac{V_2}{3} + \frac{V_2 - V_1}{1} - 3V_x = 0$$

But ; $V_x = V_2$

$$\frac{V_2}{3} + V_2 - V_1 - 3V_2 = 0 \quad (2)$$

$V_1 = \frac{50}{7}$ $\quad$ $V_2 = \frac{-30}{7}$

* $V_x = V_2 = \frac{-30}{7}$

* $V_y = V_1 - V_2 = \frac{50}{7} + \frac{30}{7}$

$= \frac{80}{7}$

* $i_x = \frac{V_x}{3} = \left(\frac{-30/7}{3}\right)$ A

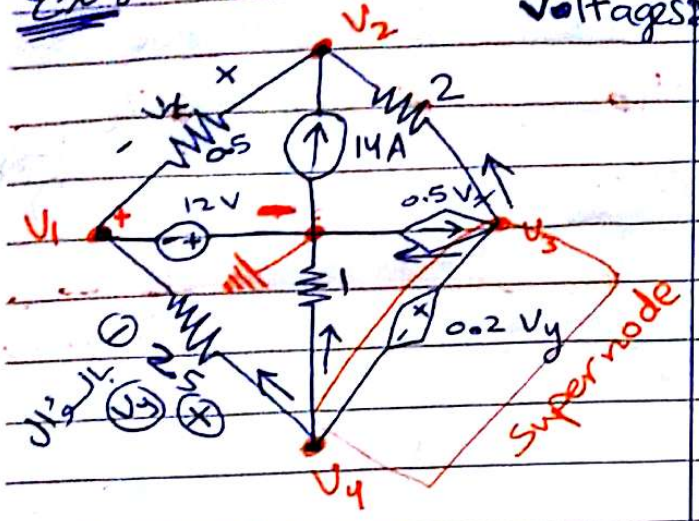
* $P_{abs} = -(3V_x)(V_2)$

$= \ldots$

-55 W

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Ex:: Find node voltages:-



$V_1 = -12\,V$

* $V_3 - V_4 = 0.2\,V_y$

But $V_y = V_4 - V_1$

$V_y = V_4 + 12$

$V_3 - V_4 = 0.2\,[V_4 + 12]$

$V_3 - 1.2\,V_4 = 2.4$ 1

* KCL at supernode →

$$\frac{V_3 - V_2}{2} - 0.5\,V_x + V_4 + \frac{V_4 - (-12)}{2.5} = \emptyset$$

But $V_x = V_2 - V_1 = V_2 + 12$

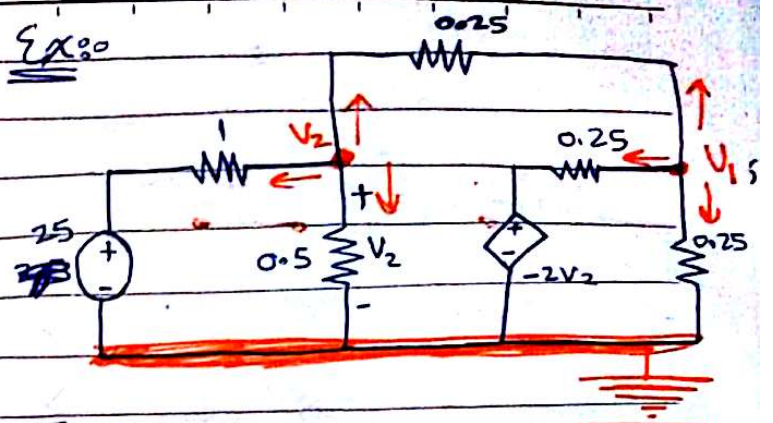
$-V_2 + 0.5\,V_3 + 1.4\,V_4 = \emptyset$ 2

* KCL at node (2) →

$$-14 + \frac{V_2 + 12}{0.5} + \frac{V_2 - V_3}{2} = \emptyset$$

$2.5\,V_2 - 0.5\,V_3 = -10$

Ex::



* Find node Voltages:- $V = \emptyset$

→ at (V_2)

$$\frac{V_2}{0.5} + \frac{V_2 - 25}{1} + \frac{V_2 - V_1}{0.25} = \emptyset$$

→ at (V_1)

$$\frac{V_1 - V_2}{0.25} + \frac{V_1}{0.25} + \frac{V_1 - (-2V_2)}{0.25} = \emptyset$$

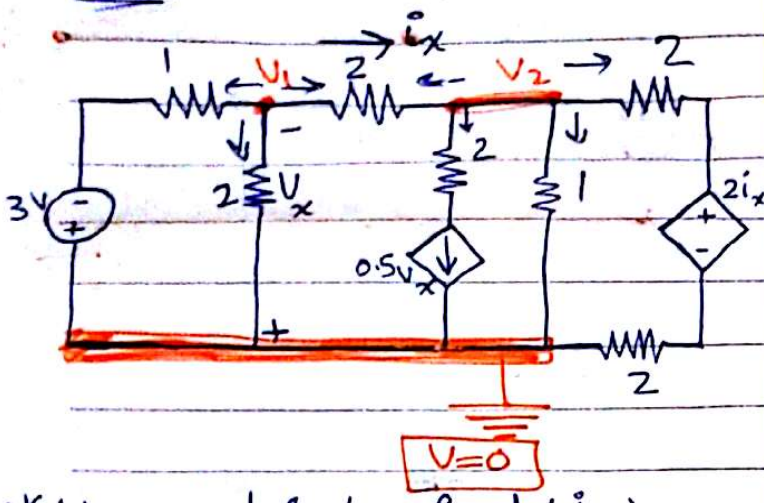
* يطلع عندي معادلتين كلهم مجهولة

* ماخذ دائرة بوجود



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Ex:-



*Use nodal to find (i_x) :-

* KCL at (V_1) →

$$\frac{V_1-(-3)}{1}+\frac{V_1}{2}+\frac{V_1-V_2}{2}=0$$

* KCL at (V_2) →

$$\frac{V_2-V_1}{2}+0.5V_x+\frac{V_2}{1}+\frac{V_2-2i_x}{4}=0$$

But $\left(i_x=\frac{V_1-V_2}{2}\right)$ (i_x and V1, V2 are in series)

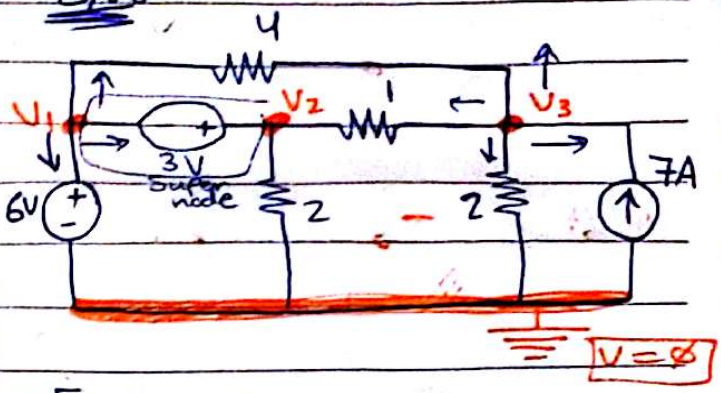
But $\left(V_x=\frac{-V_1}{2}\right)$ بالمعادلة V_2 و V_1 بطلع

$$V_x=-V_1$$

$$V_1=-1.64\ V$$

$$V_2=-0.55V$$

Ex:-



*Find node voltages →

$$V_1=6V$$

$$V_2-V_1=3$$

$$V_2-6=3 \rightarrow V_2=9\ V$$

* apply KCL at (V_3) :-

$$-7+\frac{V_3}{2}+\frac{V_3-9}{1}+\frac{V_3-6}{4}=0$$

$$V_3=10\ (volt)$$

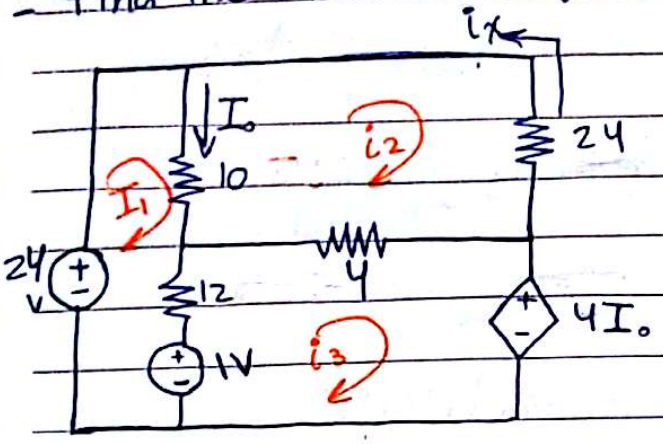
$$i_x=\frac{-1.64+0.55}{2}$$

$$i_x=-0.55\ A$$

(loop / mesh currents)

* Mesh Analysis →

- Find the mesh current i_x



- determine the meshes
- apply (KVL) around each meches
- $V = IR$ (قانون)

- Cases →
  1. no current source
  2. Current Source in only one mesh → (نأخذ التيار على هذا الـ mesh current) في حالة كان التيار على الـ current source
  3. mesh current source between two meches.

كل الـ (meshes) التي تمر من خلال الـ current source

Sol

① KVL around mesh (1)

$$-24 + 10(i_1 - i_2) + 12(i_1 - i_3) + 1 = 0$$

$$22i_1 - 10i_2 - 12i_3 = 23 \quad (1)$$

② KVL around (2) →

$$24i_2 + 4(i_2 - i_3) + 10(i_2 - i_1) = 0$$

$$-10i_1 + 38i_2 - 4i_3 = 0 \quad (2)$$

③ KVL around mesh (3) →

$$4(i_3 - i_2) + 4I_o - 1 + 12(i_3 - i_1) = 0$$

But $I_o = i_1 - i_2$

$$4i_1 - 4i_2 - 1 + 12i_3 - 12i_1 + 4i_3 - 4i_2 = 0$$

$$-8i_1 - 8i_2 + 16i_3 = 1 \quad (3)$$

$i_1 = 0.725\ A$

$i_2 = 0.078\ A$

$i_3 = -0.568\ A$

* Find (i_x) & (I_o)

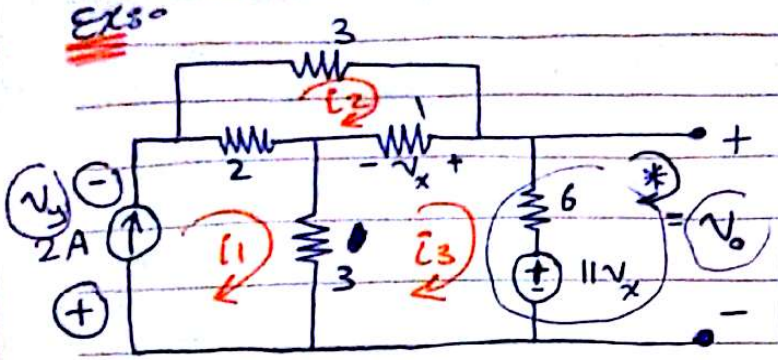
$i_x = -i_2 = -0.078\ A$

$I_o = i_1 - i_2$ (بنفس اتجاه I_o / عكس اتجاه I_o)

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Ex:-



- Find the mesh currents
- Find $(P_{gen,\text{current source}})$
- Find V_o
- Find $(P_{abs,1\Omega})$

(applying KVL)

→ $i_1 = 2$

* KVL around mesh ② →

$3i_2 + 1(i_2 - i_3) + 2(i_2 - i_1) = 0$ ②

$6i_2 - i_3 = 4$

* KVL around mesh ③ →

$6i_3 + 11V_x + 3(i_3 - 2) + 1(i_3 - i_2) = 0$

But $V_x = 1(i_2 - i_3)$

$10i_2 - i_3 = 6$

$V_x = 0.5 + 1$

$V_x = 1.5$ Volt

→ $i_2 = 0.5A$

$i_3 = -1\ A$

$P_{(\text{gen, current source})} = -2V_y = 24\ W$

* to find (V_y) :-

KVL around any loop (mesh)

lets say mesh (1) →

$V_y + 2(2 - i_2) + 3(i_1 - i_3) = 0$

$-12V$ #

* to find V_o :-

KVL around * (1.5)

③ $V_o - 11V_x - 6i_3 = 0$

④ $P_{(abs,1\Omega)} = 1(i_2 - i_3)^2$ ← I^2R

$= (1.5)^2(1)$

$= 2.25\ W$

ملاحظة

① التيار بالـ (mesh) الي فرضتو كم ملفة وكان مغير (current source) فنهاي اذا لقيت التيار الخاص بملفة بساوي الـ current source

② اذا كان مدي ملفتين (current source) مباشرة بعضهم معادلة بين ملفتين $I_{\text{الملفة}} = I_1 - I_2$

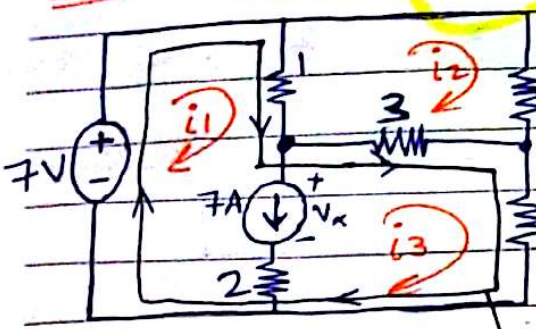
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Supermesh (فكرة الـ)

لا يكون في (current source) بين (2 meshes) فنضطر لعمل لفة حول المصدر نتعامل معه على أنه (current source) الموجود بين الـ 2 meshes

Ex:



- Find i_1, i_2 and i_3 ?
- Find V_x ?

supermesh نكوّن current source between 2 meshes

(current source) نبدأ بالـ

$$7 = i_1 - i_3 \quad (1)$$

* KVL around supermesh:

$$-7 + 3(i_2 - i_3) + 1(i_3) + 1(i_1 - i_2) = 0$$

(ماشين مع i_3 / عكس i_3)

(2 المحاور تتلاقى مع current source فنمشي)

$$i_1 - 4i_2 + 4i_3 = 7 \quad (2)$$

* KVL around mesh (2):

$$2i_2 + 3(i_2 - i_3) + 1(i_2 - i_1) = 0 \quad (3)$$

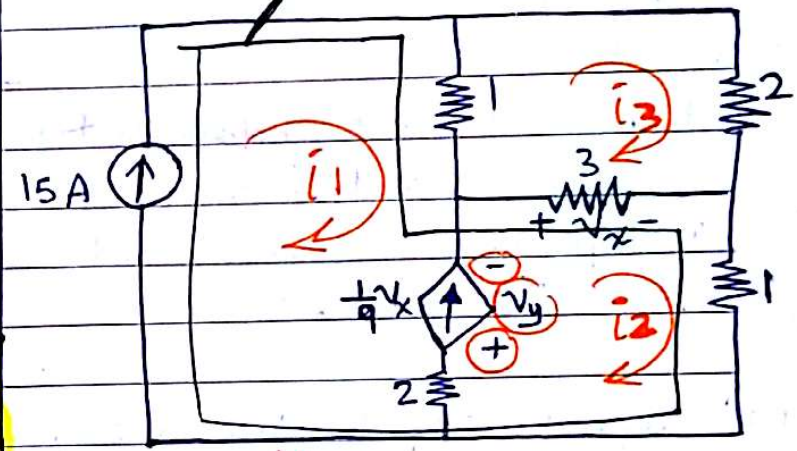
$i_1 = 9A$
$i_2 = 20.5A$
$i_3 = 2A$

to find V_x → KVL around mesh (3)

$$-V_x + i_3 + 3(i_3 - i_2) + 2(i_3 - i_1) = 0$$

current source → 2 meshes (بطرق مختلفة)
current source → 1 mesh (بنفس الطريقة)

Ex:



* Find the mesh currents:

$$i_1 = 15\ A$$

→ KVL around supermesh →

$$\frac{1}{9}V_x = i_2 - 15 \quad *$$

$i_2 = 11$
$i_3 = 17$

but $V_x = 3(i_2 - i_3)$

(* نعوض بالـ V_x اللي طلعت)

$$\frac{1}{3}i_2 - \frac{1}{3}i_3 = i_2 - 15 \quad (1)$$

$$1(i_3 - 15) + 2(i_3) + 3(i_3 - i_2) = 0 \quad (2)$$

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(Linear system) خاص بـ

* The Superposition Principle →

Is used for CCT contains ≥ 2 independent source

(Source) بتشغل ~~[illegible]~~ وبتطفي الباقي ومنشوف الناتج كم وهكذا الجديد بجمع كلهم مع بعض منشوف ماهو مطلوب

ناتج ماهو مطلوب في السؤال

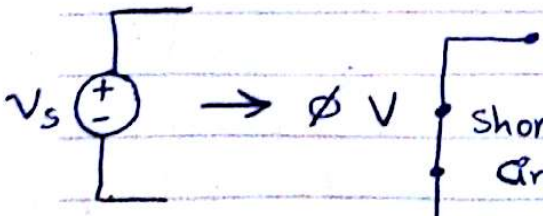
ولكل source بدي اشغله

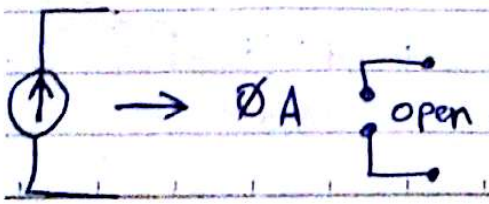
① * turn on only one independent source and kill all other independent sources and find the result. (turn off)

② repeat step 1 for other independent sources.

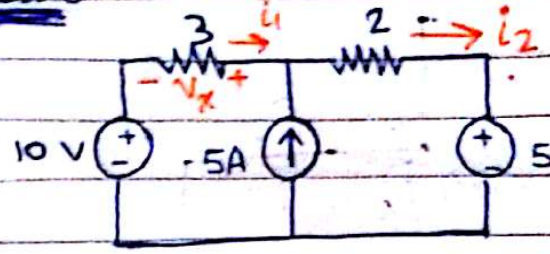
③ Summation

→ to turn off (kill) [voltage source]





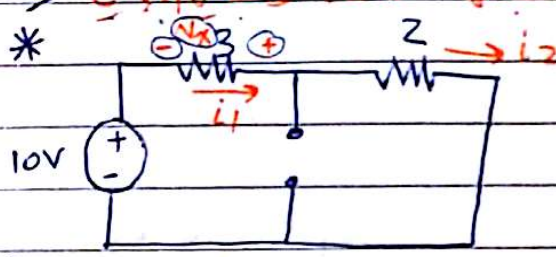
Ex:



① Find I_1, I_2 and V_x using superposition?

② Find Pabs by 2Ω resistor?

① نشغل 10V ونطفي الباقي



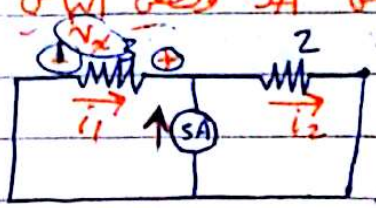
$V = IR$

* $i_1 = \frac{10}{5} = 2A$

$i_1' = i_2' = 2A$

$V_x' = -3 i_1' = -6$ volt

* نشغل 5A ونطفي الباقي



using current divider →

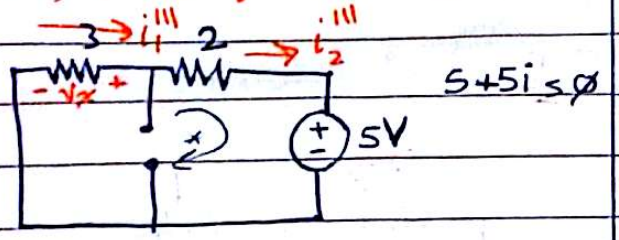
$i_2'' = \frac{5 * 3}{5} = 3A$

$i_1 = \frac{-5 * 2}{5} = -2A$

or $5 + I_1 = I_2$

* $V_x'' = -3 I_1'' = 6$ volt

* نشيل البطارية (5V) ونطفي الباقي



$i_1''' = i_2''' = \frac{-5}{5} = -1$ A

$V_x''' = -3 i_1''' = 3$ volt

$\rightarrow i_1 = i_1' + i_1'' + i_1''' = -1$ A

$i_2 = i_2' + i_2'' + i_2''' = 4$ A

$V_x = V_x' + V_x'' + V_x''' = 3$ volt

(Super position) أو بدون ما أعمل

← جاهز (Vx) الـ

$V_x = -3 i_1$

$= -3(-1)$

$= 3$ volt

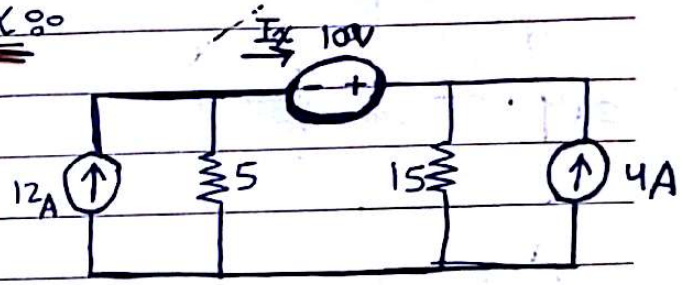
② $P_{abs} = 2 i_2^2$

$= 2(4)^2 = 32$ W

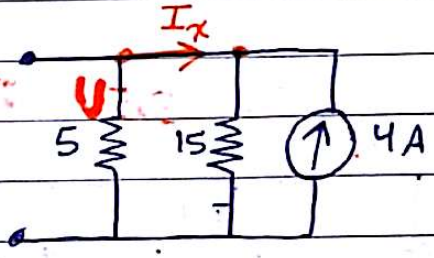
~~$P = P' + P'' + P'''$~~

ما تستخدم Superposition في (Power) لأنه مو linear

Ex:



* Find I_x only due to 4A source



C.D →

$I_x = \frac{-4 * 15}{15+5} = -3$ A

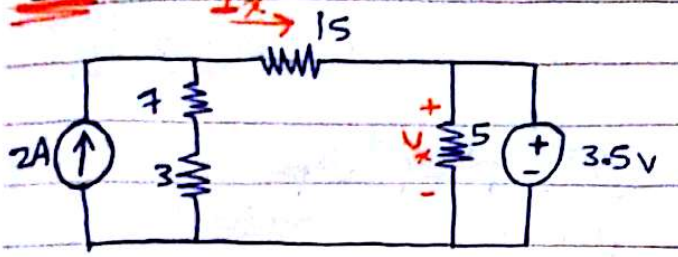
الكمية ماشية نفس اتجاه السهم اعتبرها I_x (-)

$I_x + 4 = I_x$

$I_x = -4 + I_x$

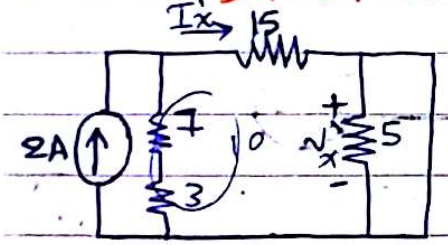
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Ex:



* Find (I_x) and (V_x) using superposition ??

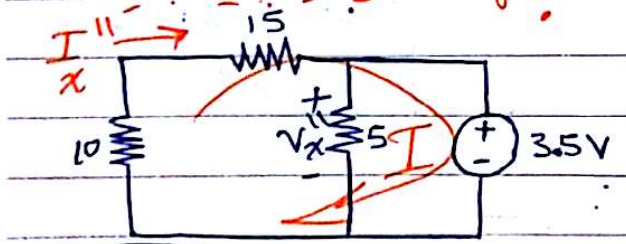
* نشيل (2A) ونطفي الباقي



$V'_x = 0$

CD $I'_x = \frac{10 \times 2}{15+10} = \frac{20}{25}$ A

* نشيل 3.5V ونطفي الباقي



$V''_x = 3.5$

apply KVL around (I)

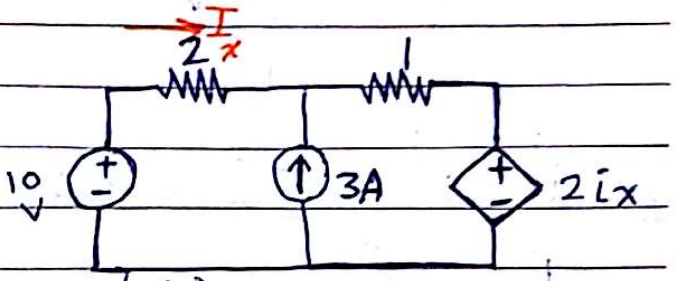
$3.5 + 25 I''_x = 0$

$I''_x = \frac{-3.5}{25}$

$V_x = 0 + 3.5 = 3.5$ V

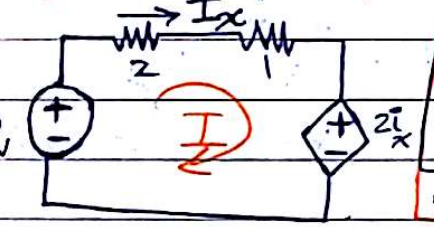
$I_x = \frac{20}{25} - \frac{3.5}{25} = \frac{16.5}{25}$ A

Ex:



* Find (I_x) using superposition?

* نشيل 10V ونطفي الباقي



* لا يكون في depend source كالو بدون أي source دافر يكون الجهد والتيار على التركيب صفر ماكنا بالحاجة

* By KVL →

$-10 + 3I'_x + 2I'_x = 0$

$I'_x = \frac{10}{5} = 2A$

* نشيل 3A ونطفي الباقي



nodal analysis V=0

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$$\frac{V''}{2} - 3 + \frac{V'' - 2i_x''}{1} = 0$$

But $I_x'' = \frac{-V''}{2}$

$$I_x'' = -0.6A$$

$$I_x = I_x' + I_x'' = 1.4A$$

ملاحظات

① يتم (super position) لما يكون (indep. source) في أكثر من

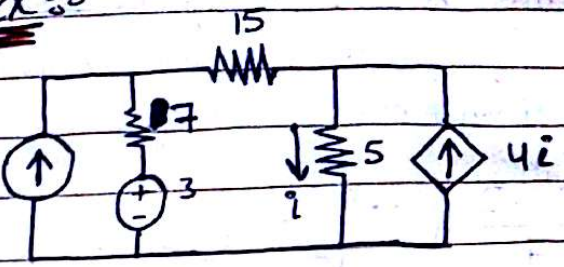
② جميعها اطفي كل الـ (indep.) ما عدا source واحد بكل

S.C بدل (V.S) وقل الـ

O.C بدل (C.S)

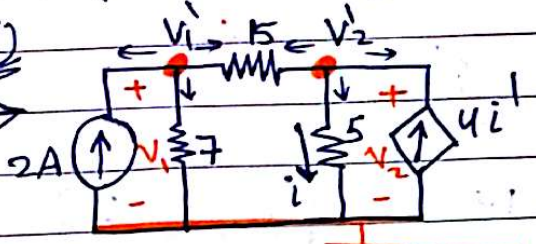
③ (dep. source) لما يكون في (super position) مع بقية ما بيصير على الـ (dep. source) أي تغيير أبدًا ..

* Ex:



Find the voltage across each current source using super position?

①



← using nodal analysis →

* KCL at (V_1):

$$-2 + \frac{V_1'}{7} + \frac{V_1' - V_2'}{15} = 0 \quad \cdots ①$$

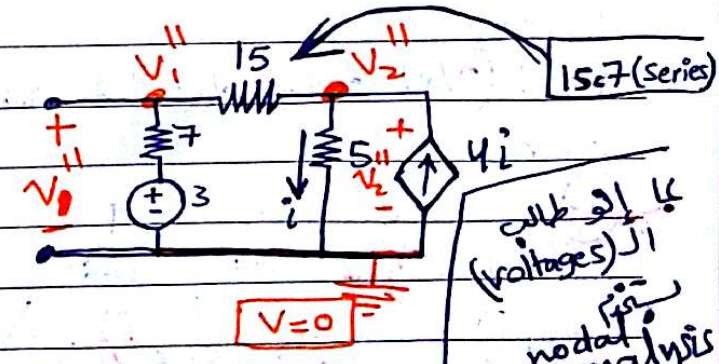
* KCL at (V_2):

$$-4i' + \frac{V_2'}{5} + \frac{V_2' - V_1'}{15} = 0 \quad \cdots ②$$

But $i' = \frac{V_2'}{5}$

$V_1' = 9.18$
$V_2' = -1.148$
→ caused by 2A source

②



بما إنو طالب (voltages) الـ بنستخدم nodal analysis

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using nodal analysis →

* KCL at (V_1'') :

$$\frac{V_1''-3}{7}+\frac{V_1''-V_2''}{15}=0 \quad \ldots (1)$$

* KCL at (V_2'') :

$$\frac{V_2''-V_1''}{15}+\frac{V_2''}{5}-4i''=0 \quad \ldots (2)$$

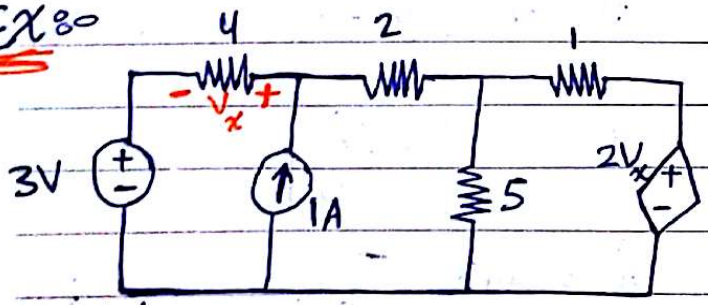
But $i''=\frac{V_2''}{5}$

$V_1''=1.967$
$V_2''=-0.246$
} Caused by 3V source

$V_1=V_1'+V_1''=11.1\angle V$

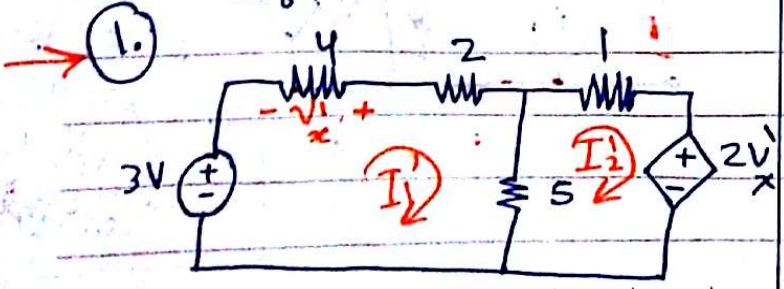
$V_2=V_2'+V_2''=-1.394\angle V$

Ex:



1. Find (V_x) only due 3V Voltage source?
2. Find (V_x) only due 1A-current source?

1.



using mesh analysis →

* KVL around (I_1') :

$$-3+6I_1'+5(I_1'-I_2')=0 \quad \ldots (1)$$

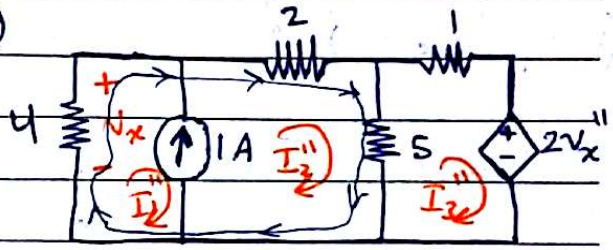
* KVL around (I_2') :

$$2V_x'+5(I_2'-I_1')+I_2'=0 \quad \ldots (2)$$

But $V_x'=-4I_1'$

$I_1'=18\ A$
$I_2'=39\ A$
$V_x'=-4I_1'$
$=-72V$

2.



$$I_2''-I_1''=1 \quad \ldots (1)$$

* KVL around Supermesh →

$$4I_1''+2I_2''+5(I_2''-I_3'')=0 \quad \ldots (2)$$

* KVL around loop 3 →

$$I_3''+2V_x''+5I_3''-5I_2''=0$$

But $V_x''=-4i_1''$

$i_1''=\ldots$
$i_2''=\ldots$
$i_3''=\ldots$

$V_x''=\ldots$

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* Source Transformation

① R, a, V_s, b → $\frac{V_s}{R}$, R, a, b

Voltage source in series with resistor (R)

InDependent Source

I_s, R, a, b → R, a, $I_s R$, b

② R, a, $2i_x$, b → $\frac{2i_x}{R}$, R

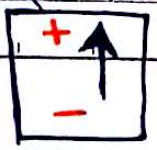
Dependent Source

* نقلب من الـ indep. إلى الـ dep.

* V.S, Series with R ⟷ C.S parallel with R

(سواء أكان dep. // Indep.)

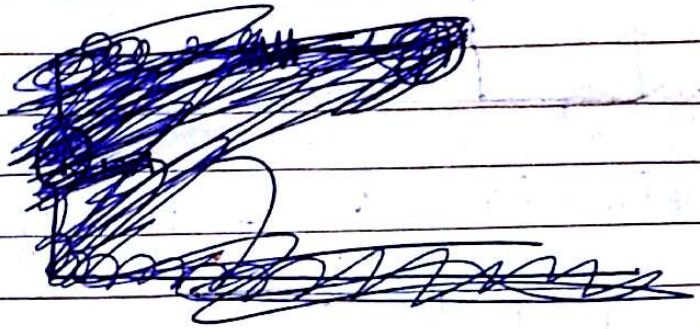
Current source إلى voltage source *

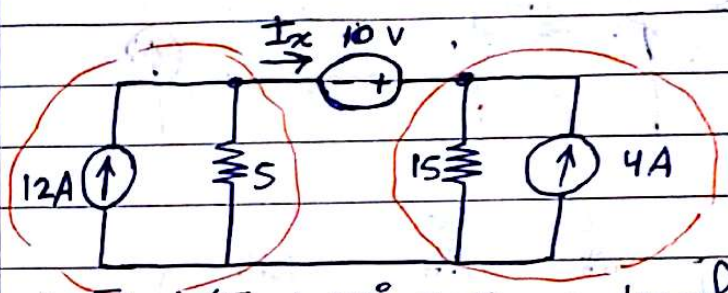


Ex → Source transformation

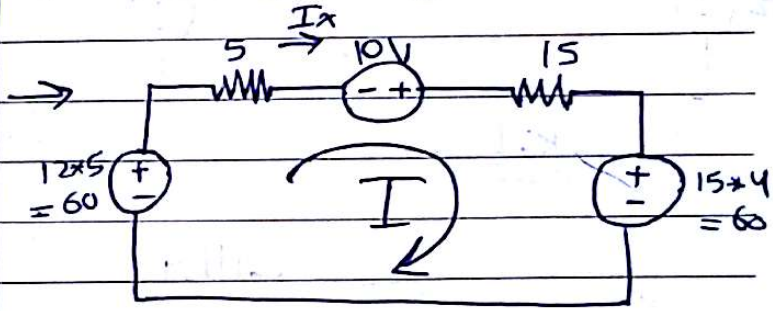
(one loop) بدك الـ current لـ

أو كلم تمارين مع بعض بنفس الطريقة





* Find (I_x) using source transform?



* By (KVL) →

$-60 + I_x(5+15) - 10 + 60 = 0$

$I_x = 0.5\ A$

Recall that $V = IR$, $I = \frac{V}{R}$

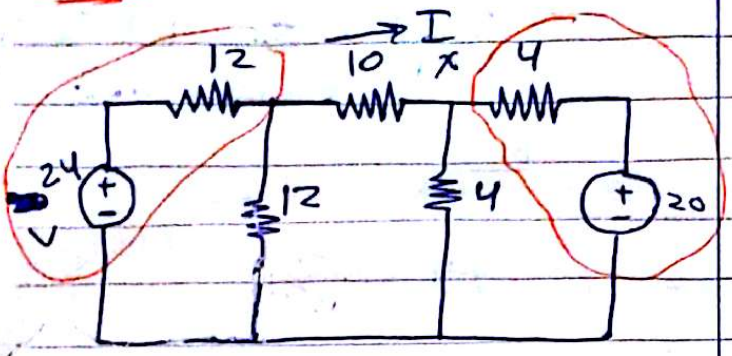
Note ③

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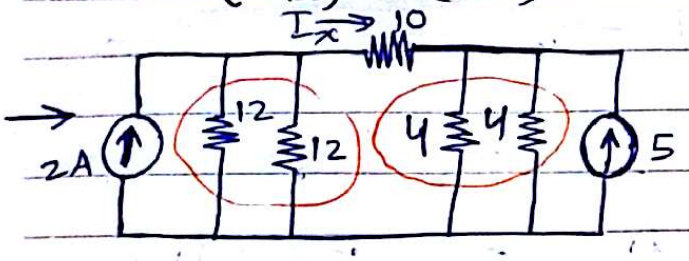
Note ①

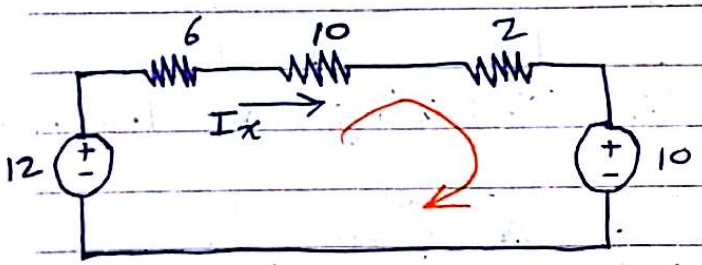
* دائماً تذكري إنو لما منوجد تفصيل بالسيركت يا (elements) معينة ما لحقه بالاشي اللي بدي أوجد عليه هاد التفصيل (I, V, ...) كتير ما بيروح مصدر بالطرف اليمين S.T ..

Ex 80



* Find (P_{abs}) in (10-Ω) resistor?





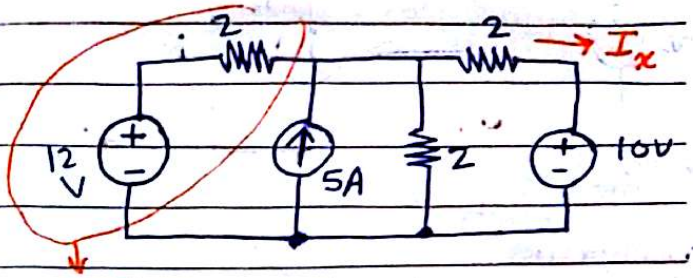
By KVL →

$$I_x = \frac{2}{18} = 0.111\,A$$

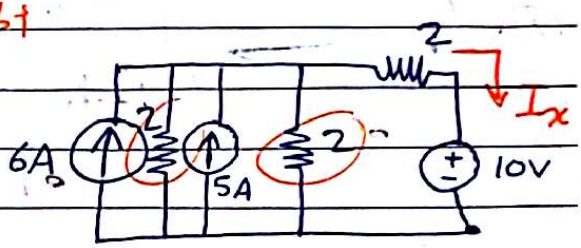
$$P_{abs} = \left(\frac{2}{18}\right)^2 (10) = 0.123\,W$$

Ex 80

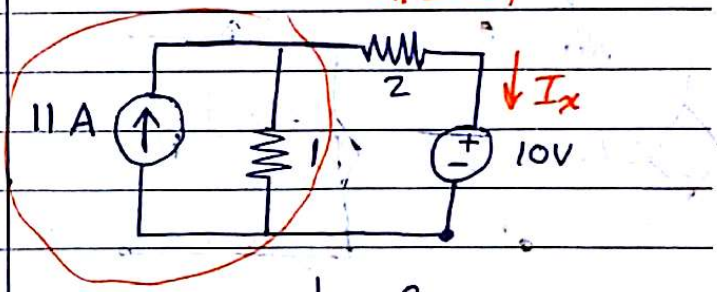
Find (I_x) using Source transformation ..

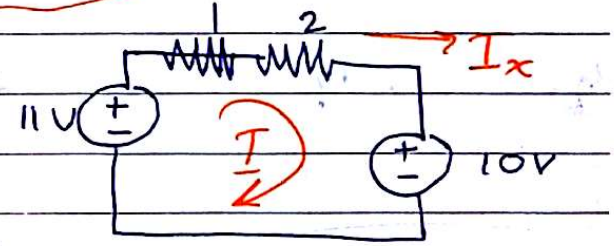


ببلش بس بهاي لأنو هيك بدي I_x طالع عليها



2//2 = 1





KVL around I

$$\boxed{I_x = \frac{1}{3}\,A}$$

$$I_x(3) + 10 - 11 = 0$$

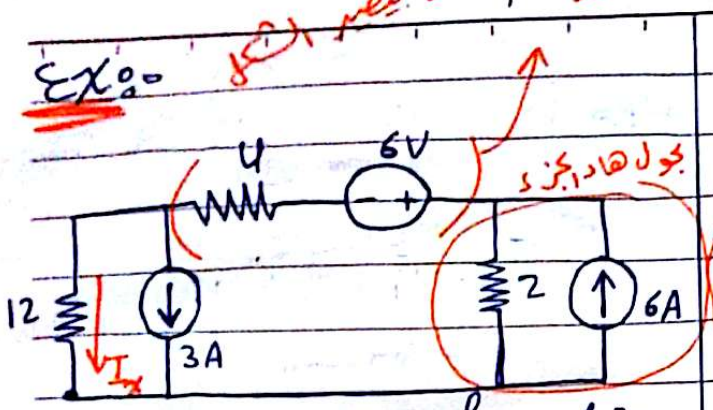
$$I_x = \frac{1}{3} = 0.33\,A$$

Five Apple

Scanned by CamScanner

Note ② * موكل شي بالسركت يحولو اجباري عا الـ T.S ففي هذا المثال صولنا جزء وتركنا جزء لأنو بجوز الي تركناه لواصنا كحولو صيصول الشكل لطريقة معقدة جدا..

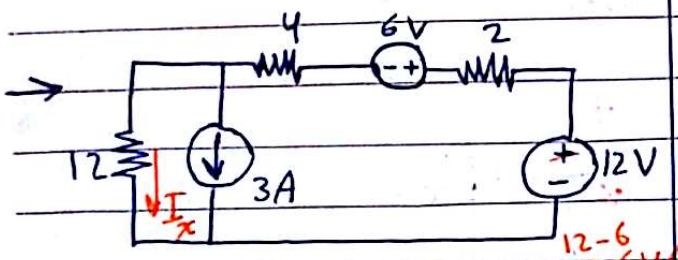
Ex:



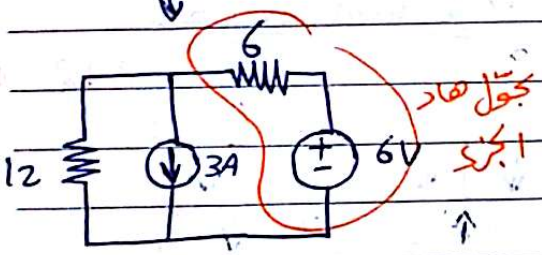
هاد الجزء لو صولتو بيصير اكثر صعب

بحول هاد الجزء

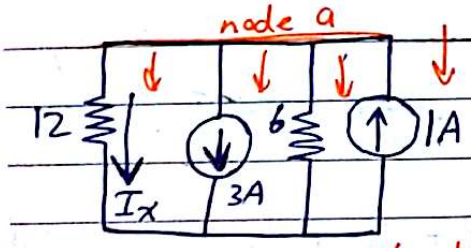
* use source transformation to find I_x ?



12-6 = 6V

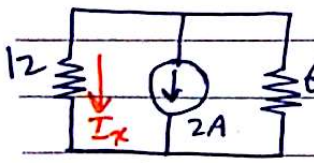


بحول هاد الجزء



apply kcl at node (a)

او ببساطة بركي

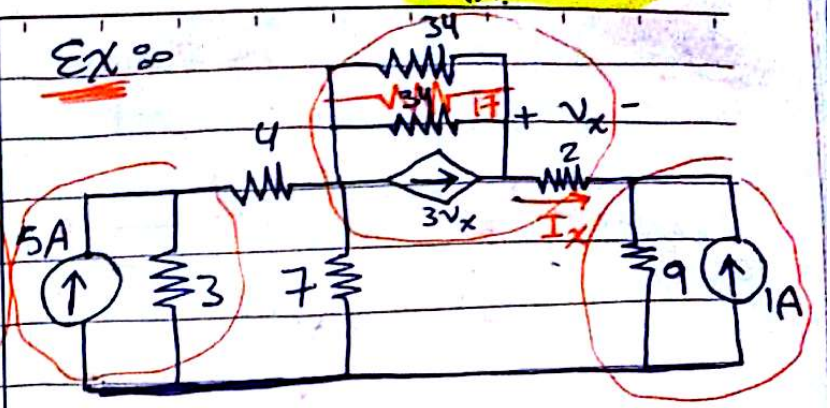


By current divider

$$I_x = \frac{-2*6}{12+6} = \frac{-12}{18}$$

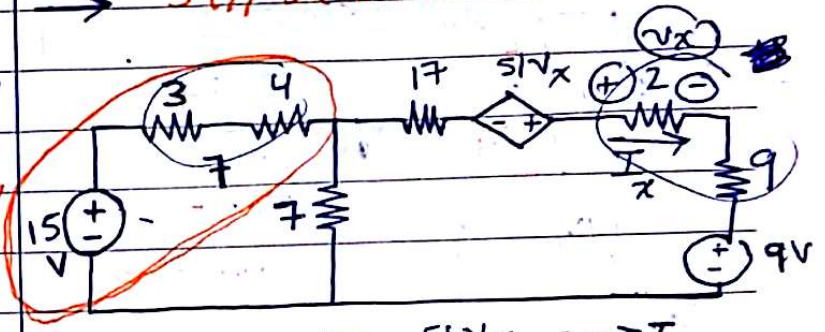
#

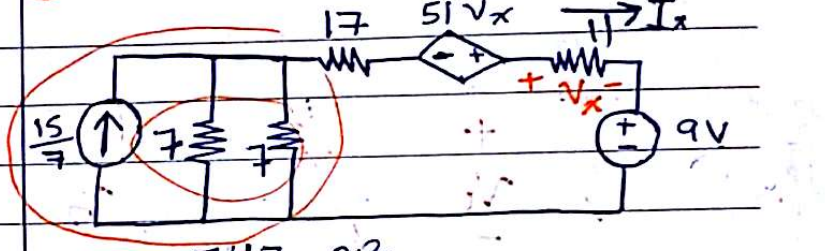
Ex:



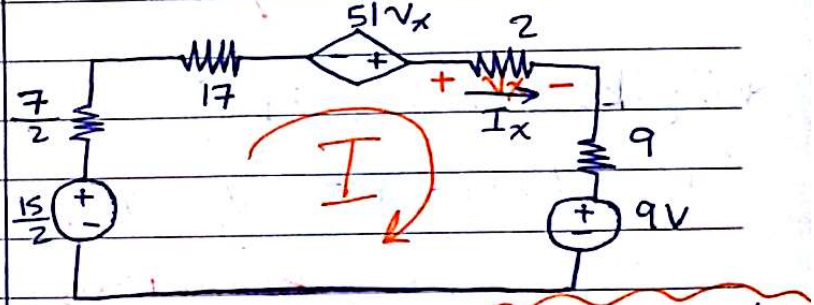
* Find (I_x) using source transformation ?

→ 34 // 34 = 17





7 I 17 = 0 ; 3



KVL around I

$$\frac{-15}{2} + \left(\frac{7}{2} + 17 + 11\right) I_x - 5IV_x + 9 = 0$$

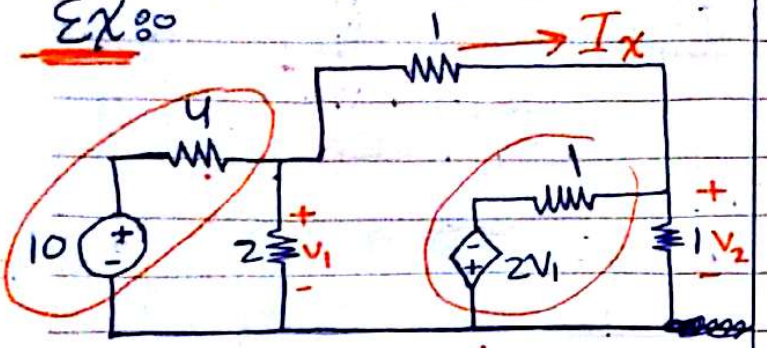
But $V_x = 2I_x$

$I_x = 21.28$ mA

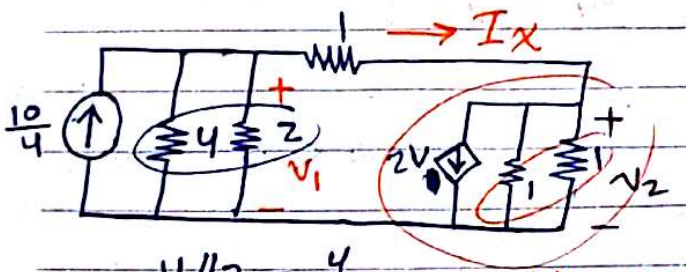
Five Apple

Scanned by CamScanner

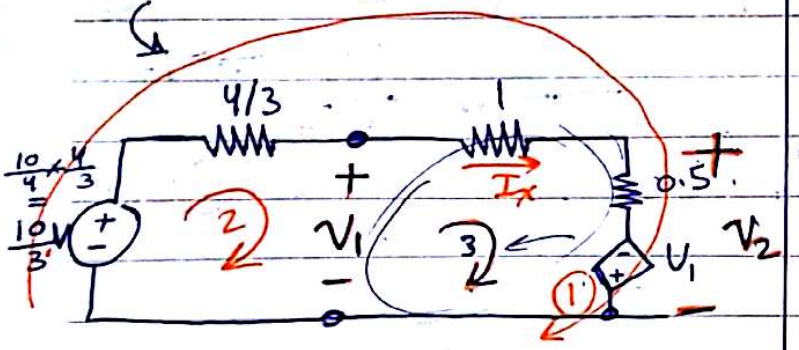
Ex:



* Find I_x, V_1 and V_2 using S.T?



$4 // 2 = \frac{4}{3}$ $\quad 1 // 1 = 0.5$



* By (KVL) around Loop (1) → الكبيرة loop حركة

$$\frac{-10}{3} + \left(\frac{4}{3} + 1 + 0.5\right) I_x - V_1 = \emptyset \quad (1)$$

But $V_1 =$ ← KVL around loop (3)

$$\frac{-10}{3} + \frac{4}{3} I_x + V_1 = \emptyset \quad (2)$$

$I_x = 1.6$

$V_1 = 1.2\,V$

بتعويض المعادلة (2) بدلالة V_1 في المعادلة (1)

* to find V_2 by KVL around (3) →

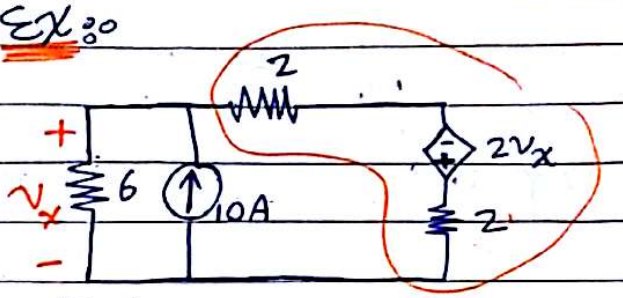
$$-V_1 + I_x(1) + V_2 = \emptyset$$

$V_2 = -0.4$ volt

$$-1.2 + 1.6 + V_2 = \emptyset$$

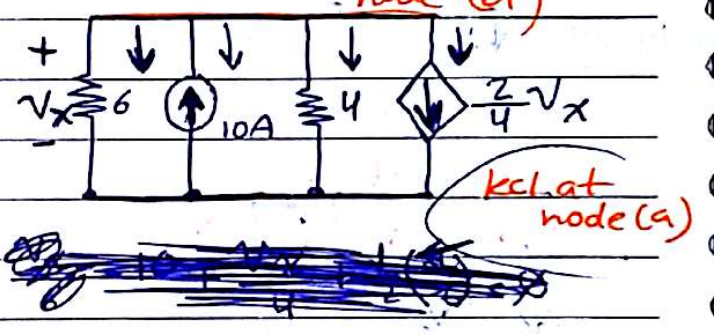
$$V_2 = -0.4\,V$$

Ex:



* Find V_x using S.T →

2+2=4



$$\left(\frac{V_x}{6} - 10 + \frac{V_x}{4} + \frac{1}{2} V_x = \emptyset\right) * 24$$

$$4V_x - 240 + 6V_x + 12V_x = \emptyset$$

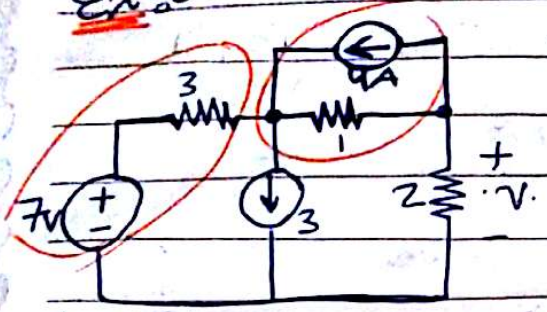
$$22\,V_x = 240$$

$V_x = 10.9$ volt

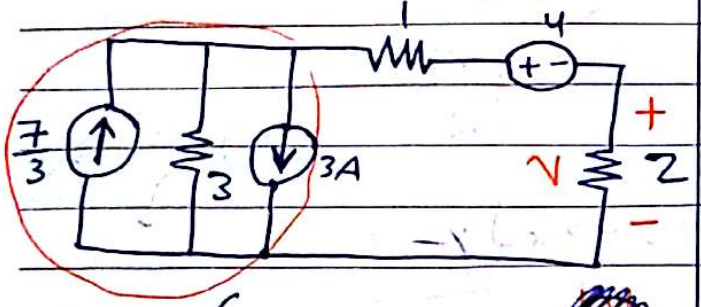
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Lecture 4 [Source Transformation] →

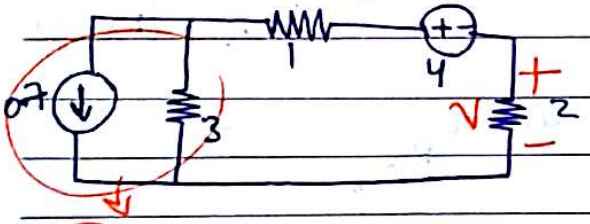
Ex:



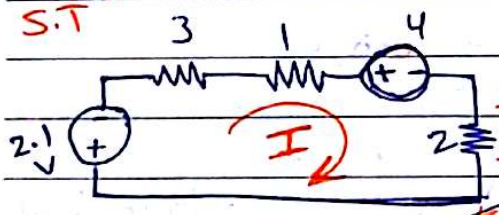
* Find V using S.T ?



$3 - \frac{7}{3} = 0.7A$



S.T



KVL around I

$I(3+1+2) + 4 + 2.1 = 0$

$I = -1.02\ A$

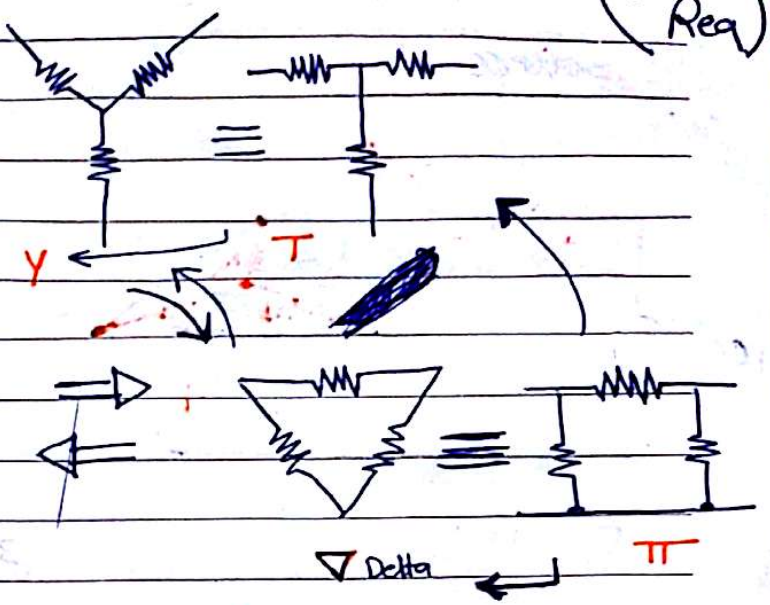
$V = (-1.02)(2)$

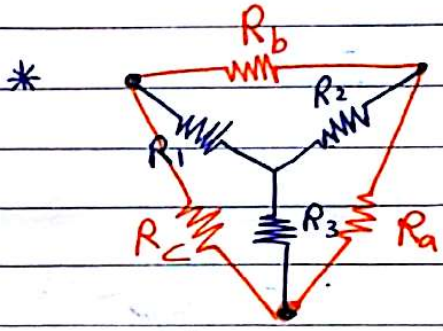
$V = -2.03$ volt

#

* Delta / wye transformations

(Req)





إذا بدي أحول من Δ لـ Y (Π → T)

مجموع حاصل ضرب كل مقاومتين بقسم على المقاومة البعيدة المقابلة

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

إذا بدي أحول من Y لـ Δ (T → Π)

$$R_1 = \frac{R_bR_c}{R_a+R_b+R_c}$$

حاصل ضرب كل مقاومتين مقاومتين ن

$$R_2 = \frac{R_bR_a}{R_a+R_b+R_c}$$

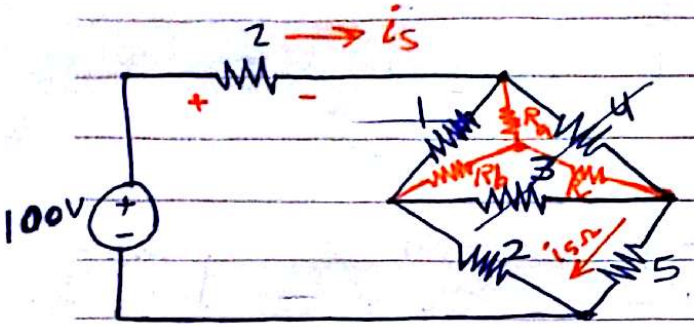
مجموع المقاومات

$$R_3 = \frac{R_aR_c}{R_a+R_b+R_c}$$

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Ex:

* Find (R_{eq}) seen by the Source ?



$R_a = \frac{1*4}{1+4+3} = 0.5\ \Omega$

$R_b = \frac{1*3}{8} = \frac{3}{8}$

$R_c = \frac{4*3}{8} = \frac{3}{2}$

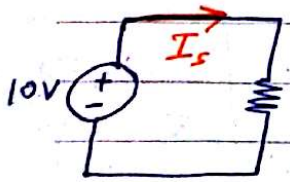
$* R_{eq} = \left(\frac{3}{8} + 2\right) // \left(\frac{3}{2} + 5\right) + 0.5 + 2$ → 1.8 (6.5) (2.4)

$= 4.24\ \Omega$

* Find (i_s) →

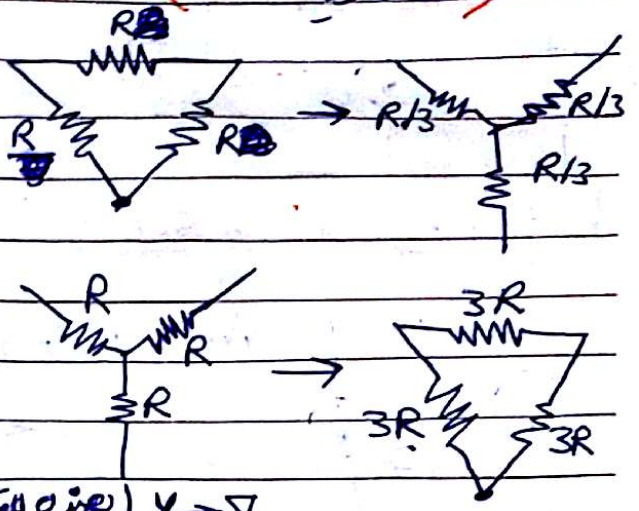
$i_s = \frac{100}{R_{eq}} = \frac{100}{4.24}$

$= 23.59\ A$



* Find $P_{(abs, 5\Omega)} = 5 i_s^2$ →

Note (اذا كانت المقاومات متساوية)

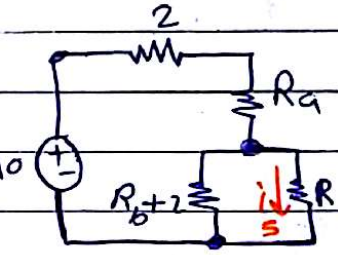


(3 لعوزه المقاومات) Y → Δ

(3 تقسم) Δ → Y

$* i_s = \frac{i_s (2 + R_b)}{(2 + R_b) + (R_c + 5)}$

$= 6.31\ A$

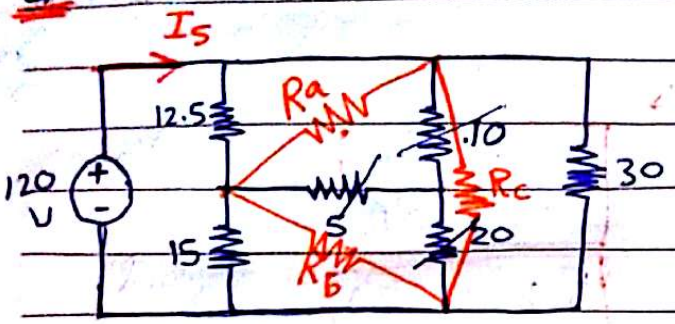


$P = 5 (6.31)^2 = 199.26\ W$

Mechatronics Engineering

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Ex 30



* Find (I_s)
* Find [R_{eq}] seen by the Source?

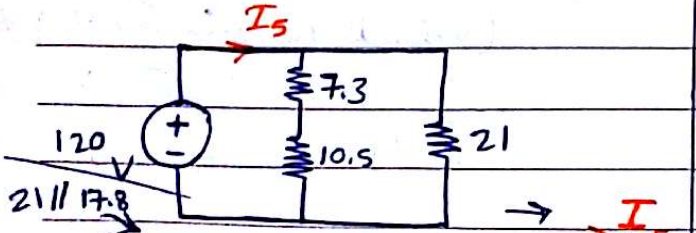
$$\rightarrow R_a = \frac{5*10 + 10*20 + 20*5}{20}$$

$$= 17.5$$

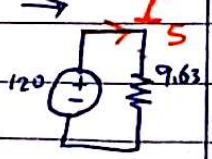
$R_b = 35$

$R_c = 70$

* $R_c // 30 = \frac{70*30}{70+30} = 21$
* $R_a // 12.5 = \frac{17.5*12.5}{17.5+12.5} = 7.3$
* $R_b // 15 = \frac{35*15}{35+15} = 10.5$



$R_{eq} = 9.63$



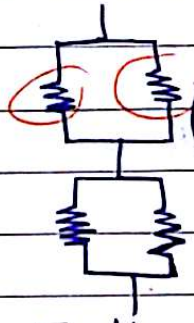
$$i_s = \frac{120}{9.63} = 12.46 \text{ A}$$

* لو طلب التيار المار في (30Ω) الي هنا معلوم



$$I = \frac{120}{30} = 4A$$

* لو طلب الجهد على وحدة من المقاومات



على ال (Voltage divider)

* لو طلب تيار أو جهد على وحدة من المقاومات اللي بدي أخذ عليها كسبب ٧ و ٧ ما بغيرها

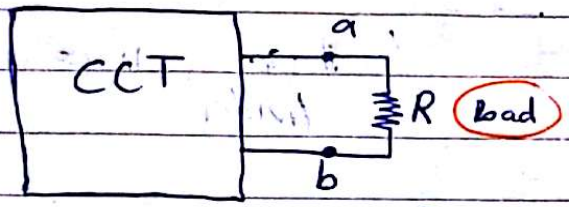
mechatronics Eng

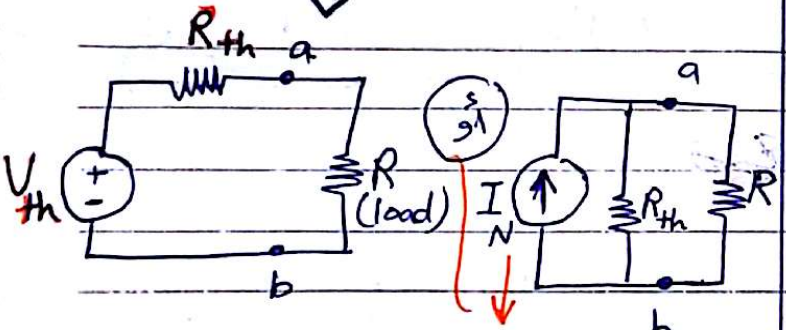
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* Thevenin's Theorem and Norton's Theorem

فكرتها: إني أبسّط الدوائر (voltage source) مع load in series with R

مع ال load كأنه R وبقية current source أو / (R) load





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

$R_{th} = R_N$

NOTES →

Thevenin's theorem states that a circuit between a and b can be replaced by a voltage source in series with a resistor.

Norton's theorem → by a current source (I_N) in series with a resistor.

(بسيطة) وجود ال indep. source

* How to find V_{th}, I_N, R_{th} (R_N) ?

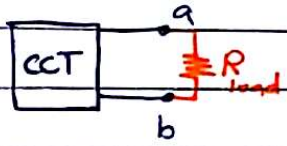
$I_N = \frac{V_{th}}{R_{th}}$

$R_{th} = R_N$

(بسيطة) وجود ال depend. source

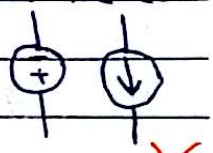
* How to find (V_{Th}) →

Indep. source in the CCT

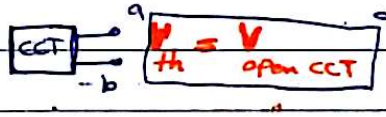


Remove (R_{load}) and find the voltage between a and b → load ال

No indep. source in the CCT



$V_{th} = \emptyset$



* ليكون عندي قيمة لـ (V_{th}) لازم يكون بالدائرة موجود (independ. sources)

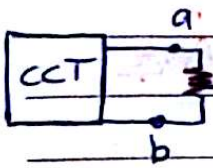
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* How to find (I_N) →

Indep. Source in the CCT

No indep. source in the CCT

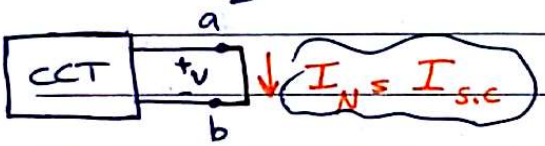
$I_N = \emptyset$



- Remove (R_{load}) and find the short circuit current between (a) and (b)

recall that:

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



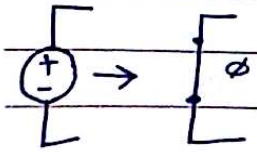
* How to find R_{th} (R_N) →

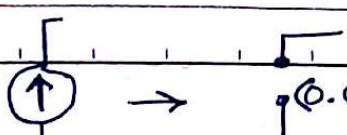
No depend. source in the CCT

- Remove R_{load} (b) ثم (a)
- kill (turn off) all indep. Sources

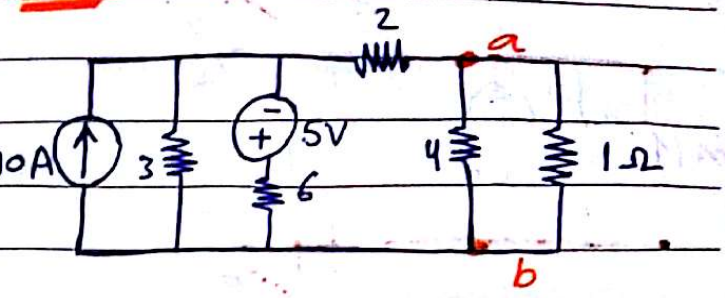
Depend. Source in the CCT

- Remove R_{load}
- kill all indep. source
- use V-test voltage source





Ex :-



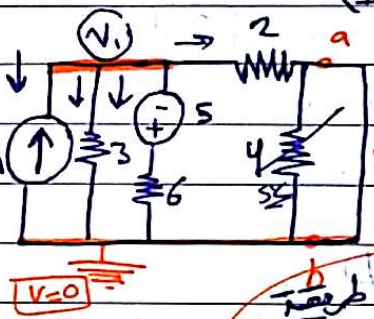
1) * Find (I_N) → $I_{s.c}$

2) * Find (V_{th}) → $V_{o.c}$

3) * Find (R_N) → R_{th} ?

↳

1) indep. source يا انو في (I ≠ 0) اذن



using nodal analysis ← (طبعاً عادي طريقة)

kcl at (4)

$$-10 + \frac{V}{3} + \frac{V}{2} + \frac{V+5}{6} = \emptyset$$

Vs 9.17 volt

$$I_{s.c} = \frac{V}{2} = 4.6\ A$$

↳

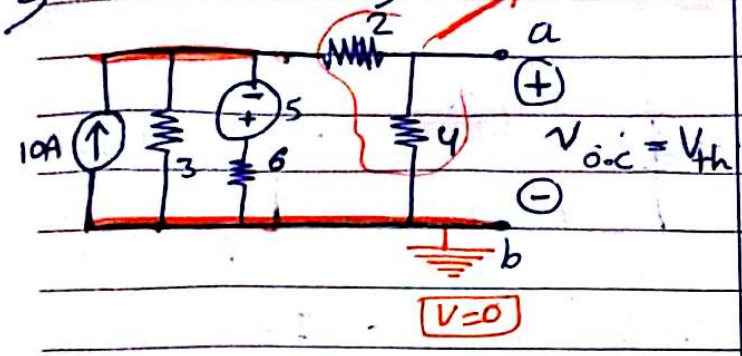
→ then find (R_{eq})

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3)

2) to Find (V_{th}) → إلغاء تأثير التيار



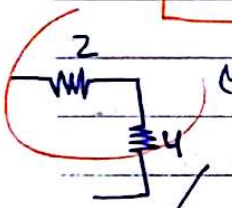
$V_{o.c} = V_{th}$

V=0

*using nodal Analysis :-

$$-10 + \frac{V+5}{6} + \frac{V}{3} + \frac{V}{6} = 0$$

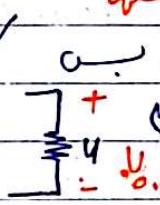
V= 13.75 volt



عبارة عن الجهد الموجود على

كلها

لكن أنا بدي بس



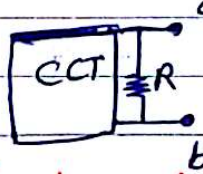
بس الجهد على

using V.D →

$$V_{o.c} = \frac{13.75(4)}{4+2} = 9.17 \text{ volt}$$

ملاحظة

إذا كانت



th. (الكلية) load لا تعتبر R

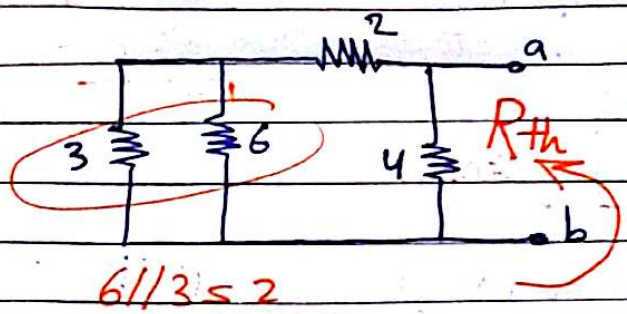
2

3)

* to find (R_{th}) →

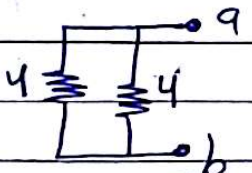
(load) نحيل الـ

(independ.) نرجع الـ



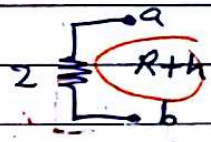
6//3 = 2

2+2=4



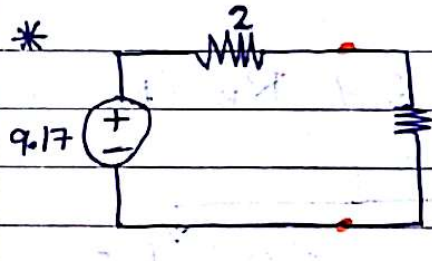
4//4 = 2

(if)

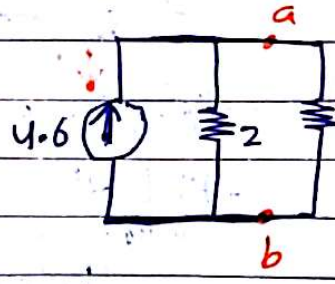


$$R_{th} = \frac{V_{th}}{I_{th}} \approx 1.99 = (2)$$

*



Thevenin



Draw

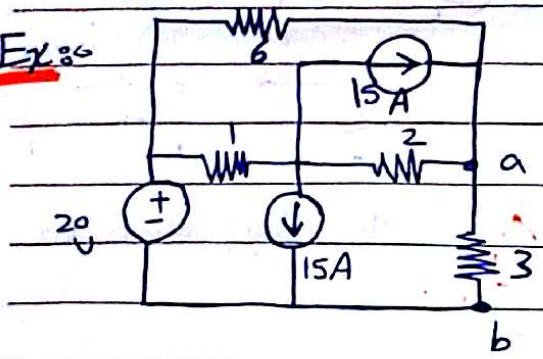
Five Apple

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* Thevenin's theorem and norton's theorem →

V_{th} , I_N , $R_{th}(R_N)$

Ex:

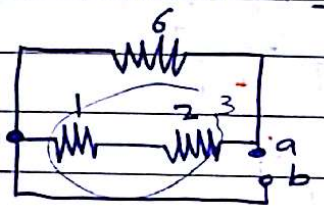


* Find R_{th} , I_N , V_{th} ?

→

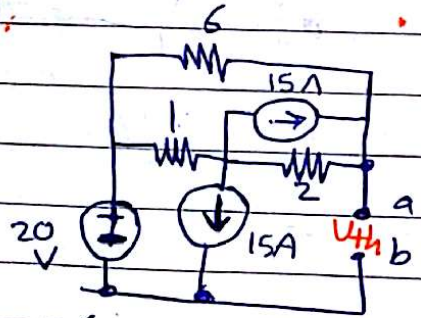
(R_{th}) 3Ω ← (load) ال ... بشيل ... بين a, b.

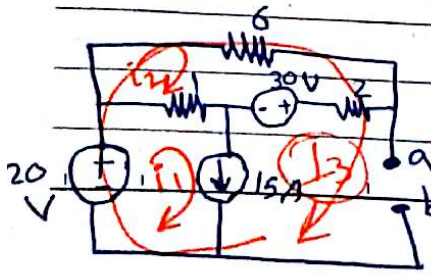
Sources ال ... بطفي



$3//6 = 2\,\Omega$ (R_{th})

(V_{th}).





ال ... بدل ... Source transformation

* using mesh analysis →

KVL around i_2 if ($i_1 = 15A$)

$8i_2 + 30 + 1(i_2 - 15) = 0$

$9i_2 = -15$

(لانو في ... بين ... super mesh ... لما يكون ... ما في)

$$i_2 = \frac{-15}{9}$$

* to find V_{th}, apply KVL around any loop (I_3) (i_2)

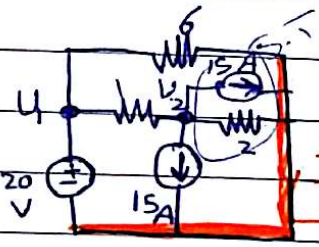
$-20 + 6i_2 + V_{th} = 0$

($V_{th} = 30$ volt)

* to find I_N →

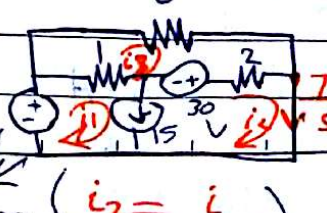
$$I_N = \frac{V_{th}}{R_{th}} = \frac{30}{2} = 15\ A$$

* Short CCT ... بين ... a, b



(nodal) ...

(S.T + mesh)

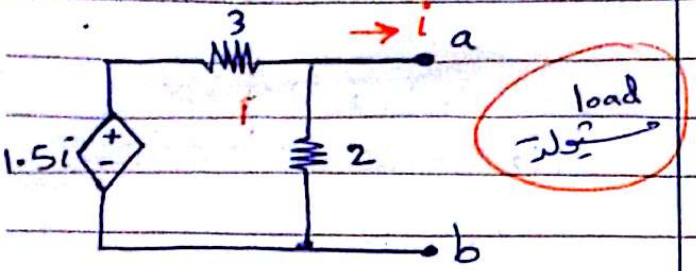


($i_2 = i_{s.c}$) ...

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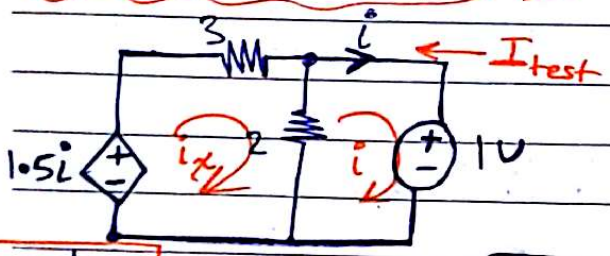
Ex:- Find the thevenin eq. Circuit →



$\begin{pmatrix} V_{th} = \emptyset \\ I_N = \emptyset \end{pmatrix}$ → لأنو ماني Indep. source

- To find (R_{th}):

(using 1 volt-test)



$R_{th} = \frac{1V}{I_{test}}$

بنشيل ال dependent source وبيضل 1V-source

I_{test} →

* using mesh to find (I) →

① $-1.5i + 3i_x + 2i_x - 2i = \emptyset$

② $1 + 2i - 2i_x = \emptyset$

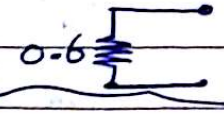
$I = \frac{-5}{3} A = -1.667$

$I_{test} = -i = 5/3 A$

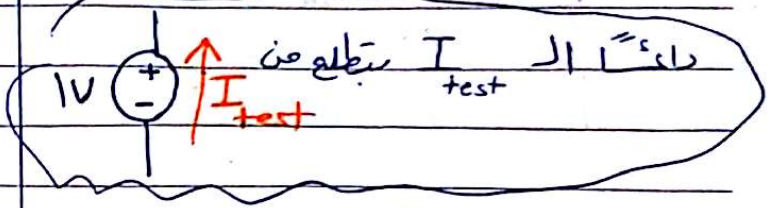
$= 1.67 A$

So, $R_{th} = \frac{1}{\frac{5}{3}} = 3/5 = 0.6 \Omega$

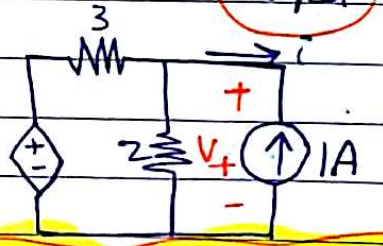
لو بدي أرسم ال (equivalent circuit)



$V_{th} = \emptyset$



* (current source) بحيث أنو مقدارها 1A مأطلع منو V_{test}



1volt-test الفكرة من ال

R_{th} بدل ال dep. source بضل ال

بس load ال شيلو

I_{test} بدل ← 1-volt voltage source

V_{test} بدل ← 1-A current source

R_{th} ← $\frac{1V}{I_{test}}$ ← I_{test} من

V_{th} ← V_{test} من ← R_{th} ← $\frac{V_{test}}{1A}$

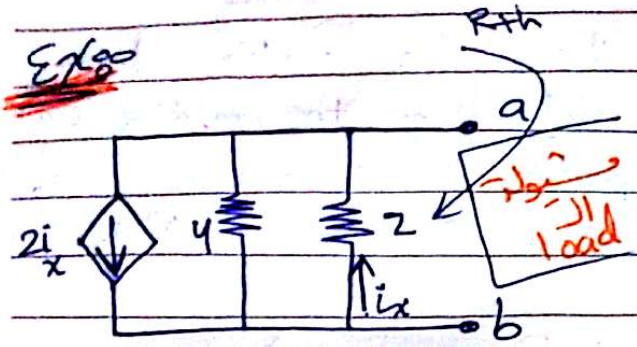
Five Apple

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Ex→

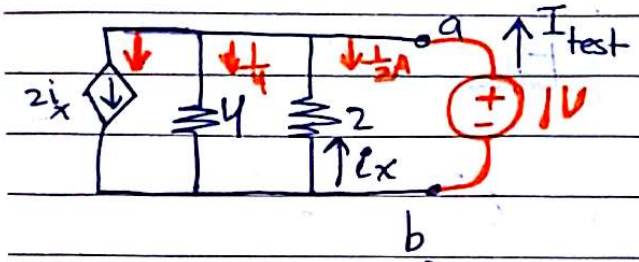
* Find (V_{th}) and (R_{th}) →

Ex∞



*Find V_{th}, I_N, R_{th} ?

→ use 1V- voltage source test



* using nodal to find (I_{test})

or

* KCL at node(a) →

$$I_{test} = \frac{1}{2} + \frac{1}{4} + 2i_x$$

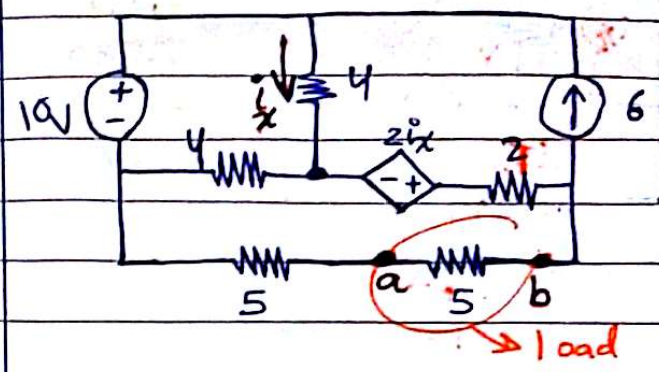
But $i_x = \frac{-1}{2}$

$$I_{test} = \frac{1}{2} + \frac{1}{4} + (-1) = -0.25 \text{ A}$$

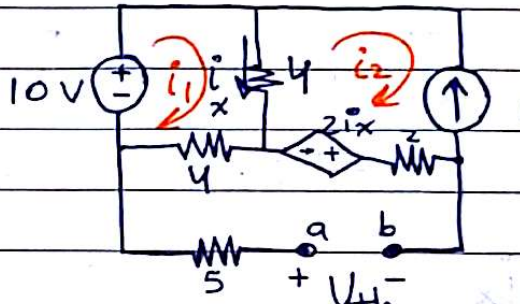
طبيعي $(I_{=1A})$ بس عكس الاتجاه

V_{test}

$$R_{th} = \frac{1}{-0.25} = -4\ \Omega$$



* (V_{th}) →



*KVL around (i_1) →

$$-10 + 4i_1 - 4i_2 + 4i_1 = 0 \quad (1)$$

*KVL around (i_2) →

$$-6 + 2i_2 + 2i_x + 4i_2 - 4i_1 = 0$$

$$i_1 = 0.5A$$

$$i_x = i_1 - i_2$$

* to find V_{th} →

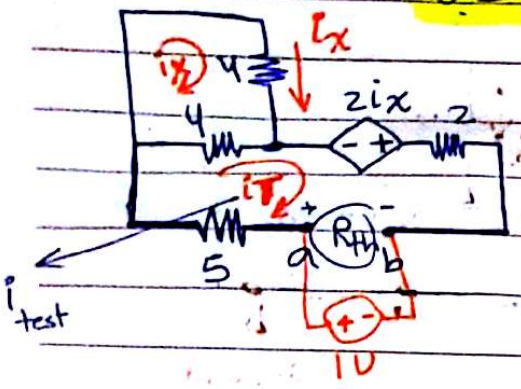
KVL around any loop ∴

$$-4i_1 - 2i_x - 2i_1 - V_{th} = 0$$

$$V_{th} = -10V$$

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* $(R_{th}) \rightarrow$ هاتفنم عن i_x بالبقية لكن هنا مختلف بالفرع ده



* using mesh analysis →

$$-2i_x + 7I_{test} - 1 + 4(I_{test} - i_x) = 0 \quad (1)$$

$$4i_x + 4i_x - 4i_{test} = 0 \quad (2)$$

$i_x = 0.125\ A$

$I_{test} = 0.125\ A$

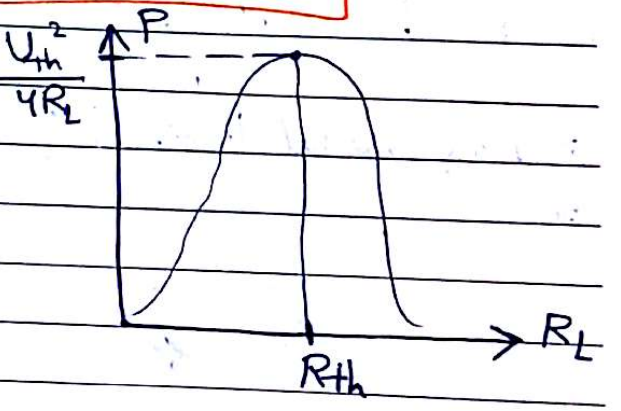
$$* R_{th} = \frac{1}{0.125} = 8\ \Omega$$

* The Value of R_L that will draw the maximum power from the rest of the CCT equals R_{th}

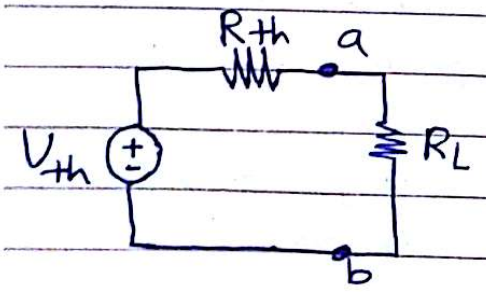
$$R_L = R_{th}$$

- The maximum power transfer to (R_L) is

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

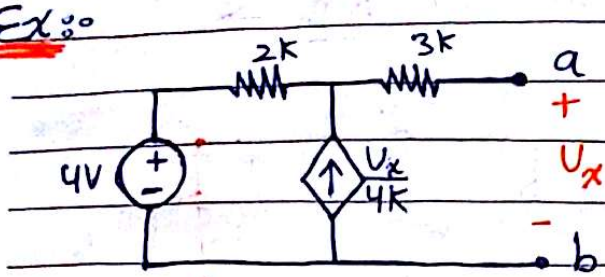


* Maximum power transform →



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Ex:-



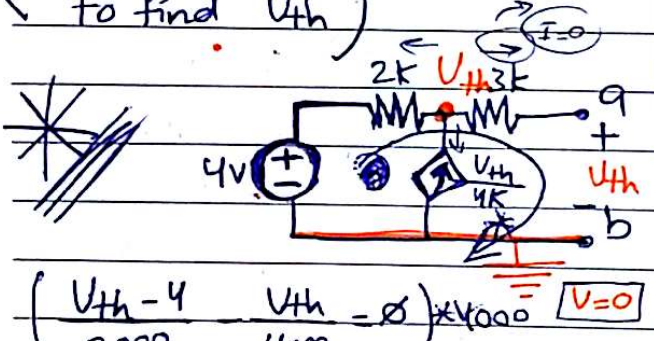
(*) Find I_N, U_{th}, R_{th} ?

(*) Find the max. power transferred to the load?

(*) Find the value of R_L at which the max. power is transferred?

→ $U_x = U_{th}$ (load already ∞)

(using nodal to find U_{th})



$\left(\frac{U_{th}-4}{2000} - \frac{U_{th}}{4000} = 0\right) * 4000$

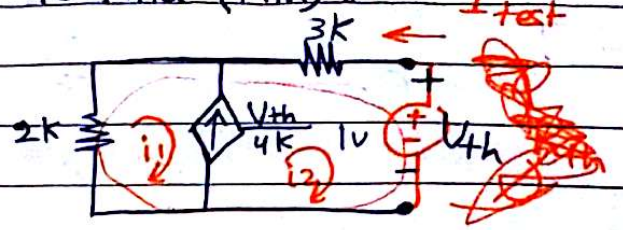
$U_{th} = 4$ V

or KVL around loop (2)

$-4 - 2k\left(\frac{U_{th}}{4k}\right) + 0 + U_{th} = 0$

$U_{th} = 4$ V

(*) to find (R_{th}) :-



(U_{th} = 1 volt

dep. current = $\frac{1}{4000}$)

- using mesh analysis →

$\frac{1}{4000} = i_2 - i_1$ ... (1)

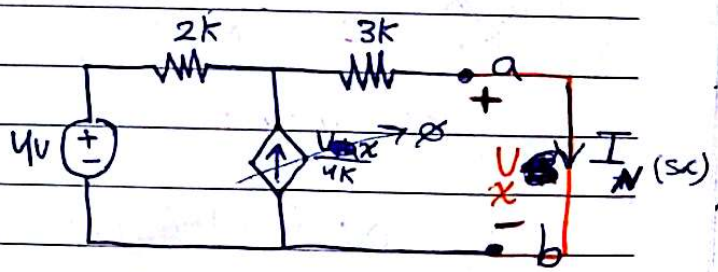
$2k(i_1) + 3k(i_2) + 1 = 0$ ... (2)

($I_2 = -0.1$ mA

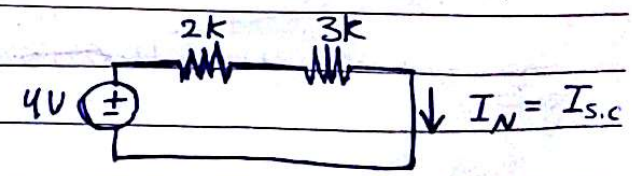
$I_{test} = 0.1$ mA)

→ $R_{th} = \frac{1}{I_{test}} = \frac{1}{0.1m} = 10$ kΩ

(*) To find (I_N) :-



$U_x = 0$



$I_N = \frac{4}{5k} = 0.8$ mA

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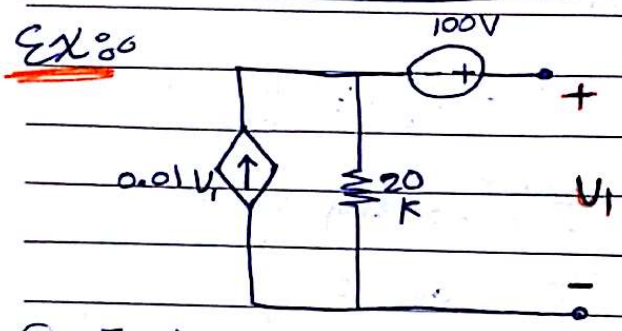
$* I_N = \frac{V_{th}}{R_{th}} = \frac{8}{10k} = \frac{4}{5k}$

$= 0.8\,m$

$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{(8)^2}{4(10k)} = 1.6\,mW$

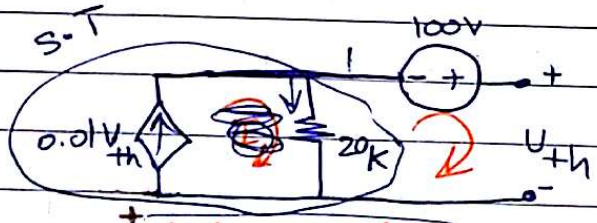
$* R_L = R_{th} = (10k)\,\Omega$

Ex:



① Find V_{th}, I_N, R_{th} ?

S.T



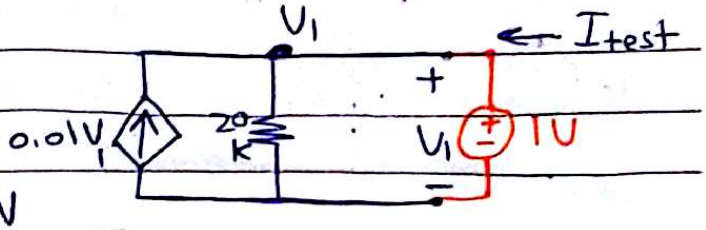
KVL around I

$V_{th} - 20K(0.01\,V_{th}) - 100 = 0$

$V_{th} = -502\,mV$

~~or use source transform~~

* to find R_{th} →



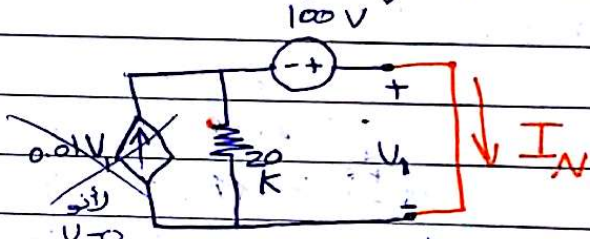
- using nodal analysis →

$-0.01 + \frac{1}{20K} - I_{test} = 0$

$I_{test} = -9.95\,mA$

$\rightarrow R_{th} = \frac{1}{-9.95} = -100.5\,m\Omega$

* to find (I_N) →



$V_1 = 0$

$V_1 = 0$

KVL

$I_N = \frac{100}{20k}\,A$

or $(-100) + (20K)\,I_N = 0$

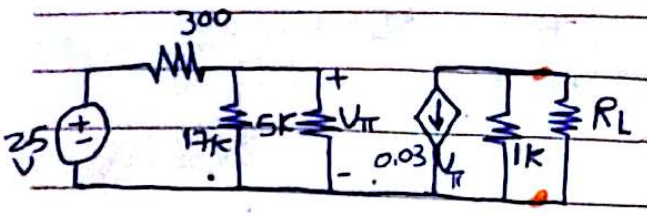
$I_N = \frac{100}{20k} = 5\,mA$

إذا شكينا بجهد وسالب بطبق KVL

أنا ما كاتبة عن أي دروس لطلاب
كان اهتمي للشرح الأصلية وطلبي

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Ex 8



① Find (R_L) so that the max. power is transferred to it?

② Find (P_{max}) ?

→ ① to find (V_{th}) :

← (R_L) ...

مطبق سالبة لأنها باتجاه معاكس

من (−) → (+)

$V_{th} = (-1k)(0.03\,V_\pi)$

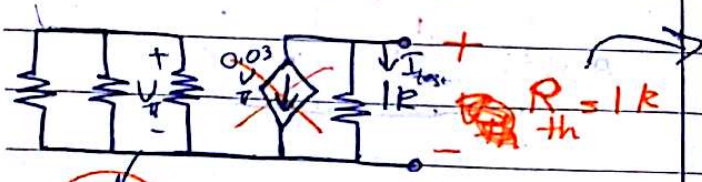
But V_π

* using voltage divider →

$$V_\pi = \frac{2.5\,(17k \,//\, 5k)}{(17k \,//\, 5k) + 300} = 2.32 \text{ volt}$$

$$V_{th} = -69.6 \text{ V}$$

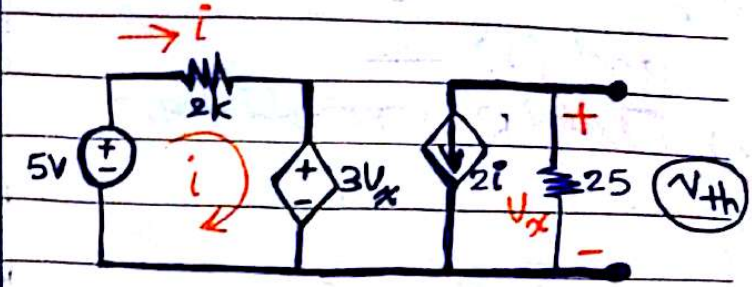
to find (R_{th}) :



$V_\pi = 0$ ← صفر لأنها independ. source

$$P_{max} = \frac{(-69.6)^2}{4(1k)} = 1.211 \text{ W}$$

Ex 8



* Find (V_{th}) and (R_{th}) ?

بدي أوجد (i) من اليمين على اليسار

* KVL around (i) :

$2000i + 3V_x = 5$

$V_x = V_{th}$

$V_{th} = 25(2i)$

$V_{th} = 50i$

$i = \frac{5 - 3V_{th}}{2000}$

$V_{th} = \frac{-5}{1000} + \frac{3V_{th}}{1000}$

$V_{th} = -0.125 + 0.075\,V_{th}$

$0.925\,V_{th} = -0.125$

$V_{th} = -0.135$

$I_{test} = \frac{(1)(10^3)}{10^3} = 10^{-3}$

$R_{th} = \frac{1}{10^{-3}} = 1 \text{ K}\Omega$

$\Rightarrow \#$

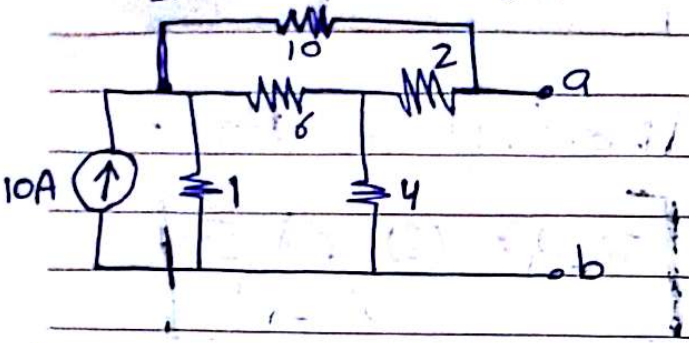
Five Apple

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①

Ex: Find (R_{eq}) (R_{th}) between (a) and (b) →

② Find (R_{eq}) ~~between~~ seen by the source?



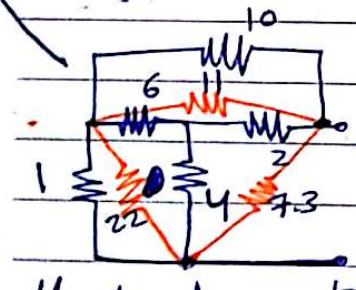
a) Seen by (a) and (b)?

→ ~~[illegible]~~

Indep. يُلغى (kill of) لأن

* to find (R_{eq}) seen by some source? كل

indep. Source يُلغى



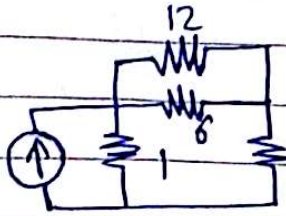
$10//11 = 5.24$ +
$1//22 = 0.95$
$\therefore 6.19//7.3$

$R_{eq} = 3.35\ \Omega$ a,b

Y ثم Δ

(W)

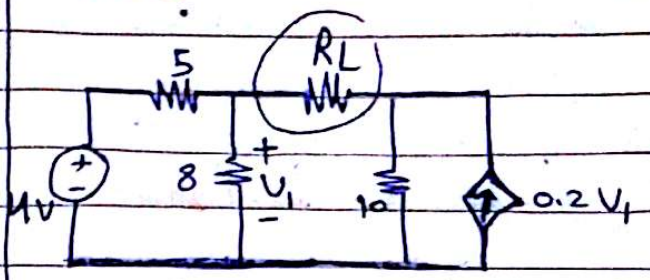
b



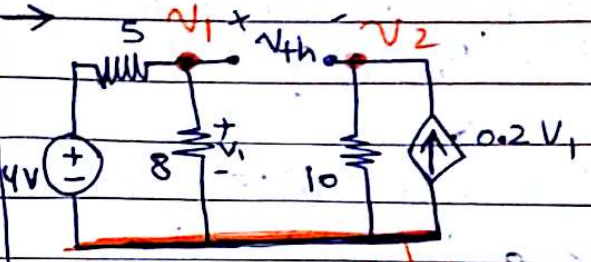
$R_{eq} = [12//6+4]//1$
$= [4+4]//1$
$= 8//1$

$R_{eq} = 0.88\ \Omega$

Ex: Find V_{th}, R_{th}, I_N?



→



nodal

V=0

* $\frac{V_1-4}{5} + \frac{V_1}{8} = 0$

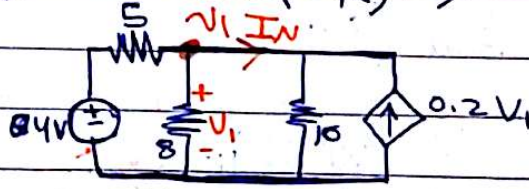
$V_1 = 2.46$

* $-0.2(2.46) + \frac{V_2}{10} = 0$

$V_2 = 4.92$

* $V_{th} = V_1 - V_2 = -2.46\ V$

→ to find (I_N) →



$\frac{V_1-4}{5} + \frac{V_1}{8} + \frac{V_1}{10} - 0.2V_1 = 0$

$V_1 = 3.55\ V$

$I_N = -\left(\frac{V_1-4}{5}\right) - \left(\frac{V_1}{8}\right) = -0.3555\ A$

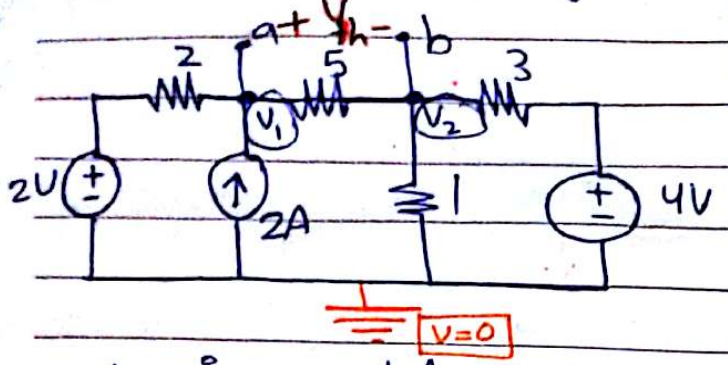
$R_{th} = 6.91875\ \Omega$

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Ex 8:

Find (V_{th}), (R_{th}), (I_N) between (a) and (b)?



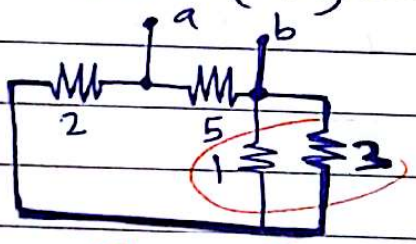
* using nodal analysis →

$V_1 = 1.74$

$V_2 = 1.097$

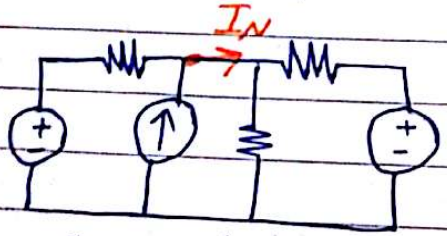
$V_{th} = V_1 - V_2 = 0.643$ volt

- To find (R_{th}):



$R_{th} = [(1 // 3) + 2] // 5$

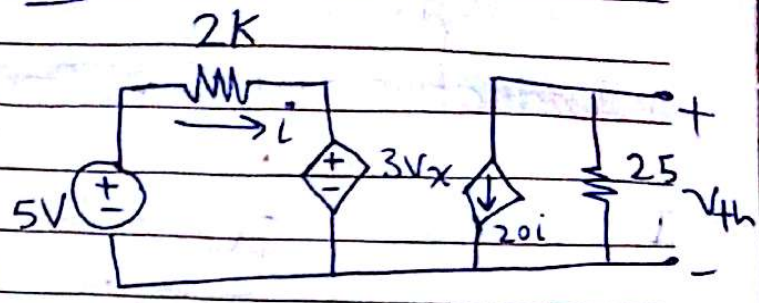
- to find (I_N):



using mesh analysis?

or $I_N = \frac{0.6}{1.77} = 0.34\,A$

Ex:



$V_{th} = -20\,i\,(25)$

to find (i) →

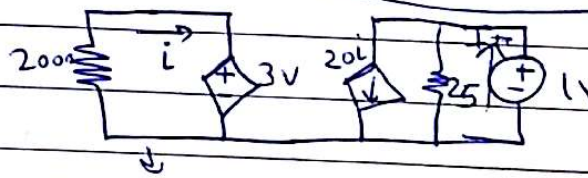
KVL

$2000i + 3V_{th} = 5$

$2000i + 3(-20(25)i) = 5$

$i = 0.01\,A$

$V_{th} = -5$ Volt



$2000i = -3$

$i = -1.5\,mA$

$I_{test} = \frac{1}{25} + \frac{2(-1.5)}{1000}$

$= 0.01\,A$

$R_{th} = \frac{1}{0.01} = 100\,\Omega$

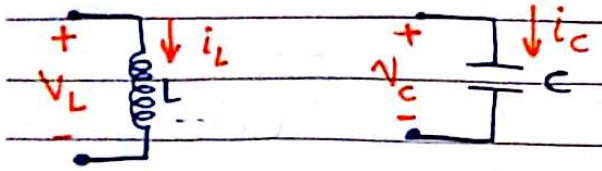
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Ch7

(Inductors and Capacitors)

(L) (C)

Inductors (L) **capacitor (C)**



(storage elements)

العلاقة:

$$V_L = L\frac{di_L}{dt} \qquad i_c = C\frac{dv_c}{dt}$$ AC source

لما أشتغل على DC:

$V_L = 0$ → s.c

$i_c = 0$ → o.c

DC source

AC

→ to find (i_L) :

$$i_L = \frac{1}{L}\int_{t_0}^{t} V_L(\tau)\,d\tau + i(t_0)$$

$P = V_L i_L$

→ to find (V_c) :

$$V_c = \frac{1}{C}\int_{t_0}^{t} i_c(\tau)\,d\tau + V(t_0)$$

$P = V_c i_c$

Inductors

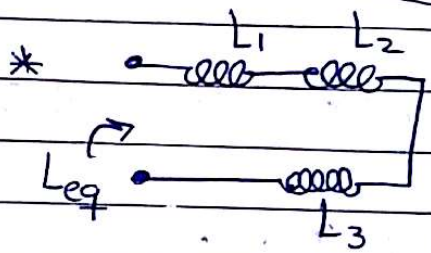
Energy stored in the inductor

$$W_L(t) = \frac{1}{2} L i_L^2(t)$$

Capacitor

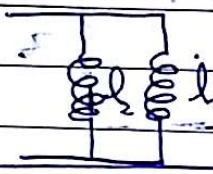
Energy stored in the capacitor

$$W_c(t) = \frac{1}{2} C V_c^2(t)$$

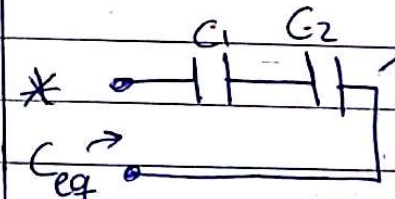


(توالي)

$$L_{eq} = L_1 + L_2 + L_3$$

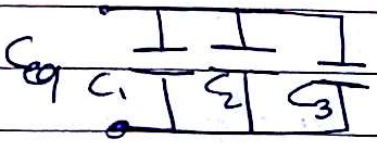


$$L_{eq} = \frac{L_1 L_2}{L_1 + L_2}$$



(توازي)

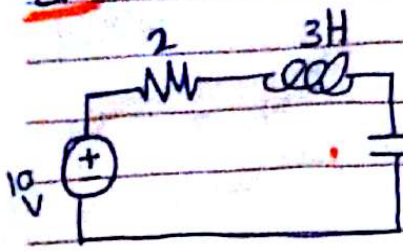
$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$



$$C_{eq} = C_1 + C_2 + C_3$$

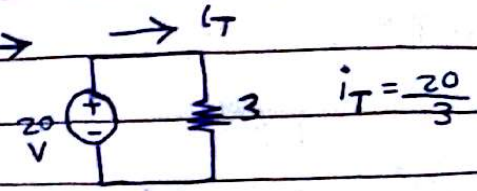
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Ex 80



$i = \frac{V}{2} = \frac{40}{12}$

or → i_T

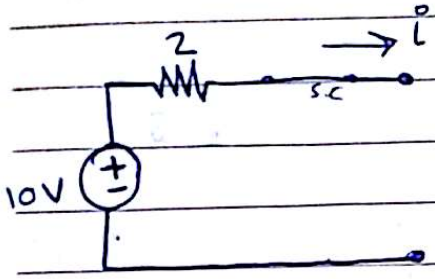


$i_T = \frac{20}{3}$

with C.D : $i = \frac{20}{6}$

دلتا اشتغل على الـ Source إذا كان AC أو DC

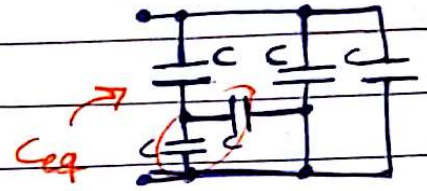
* Find (i) and (V) →



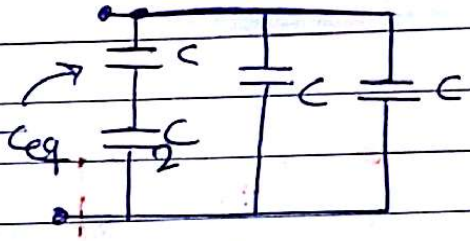
$i = \emptyset$

V = 10 volt

Ex 80



* if (C = 6 μf), find (Ceq)?



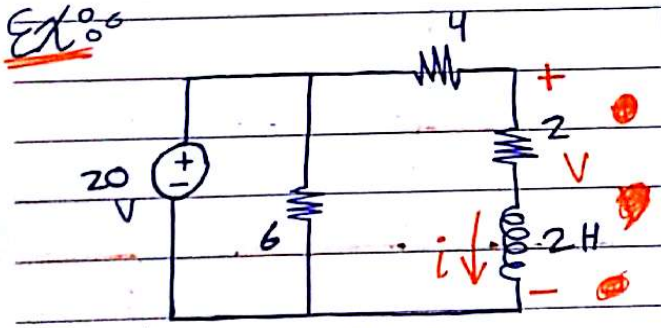
$C_{eq} = C + C + \left(\frac{2C^2}{3C}\right)$

$= 2C + \frac{2}{3}C$

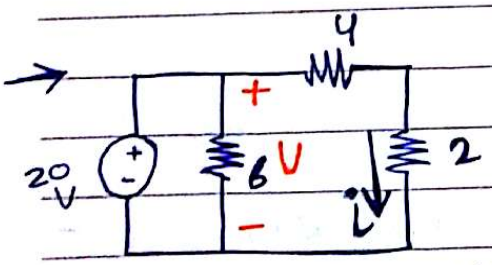
$= 2(6) + \frac{2}{3}(6)$

$C_{eq} = 16\ \mu f$

Ex 80



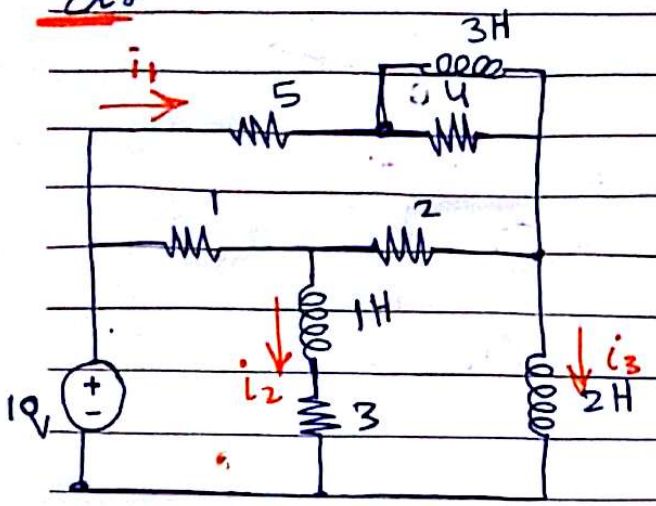
Find (i) and (V)?



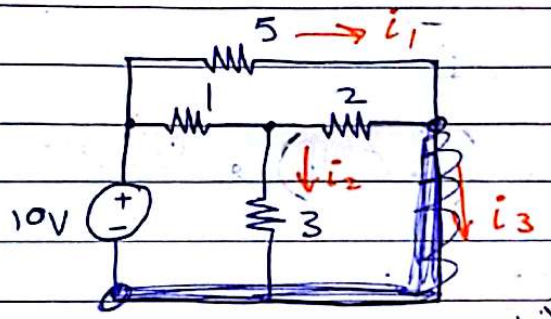
$V = \frac{20 * 2}{4+2} = \frac{40}{6}$

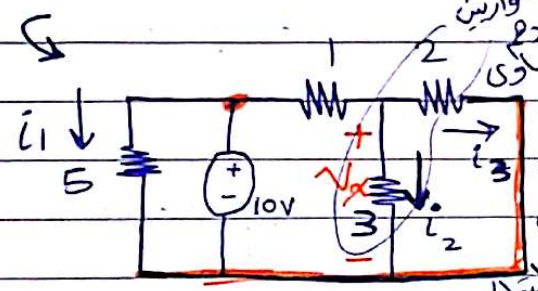
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Ex°8



* Find (i_1, i_2 and i_3)?





$i_1 = \frac{10}{5} = 2A$ ①

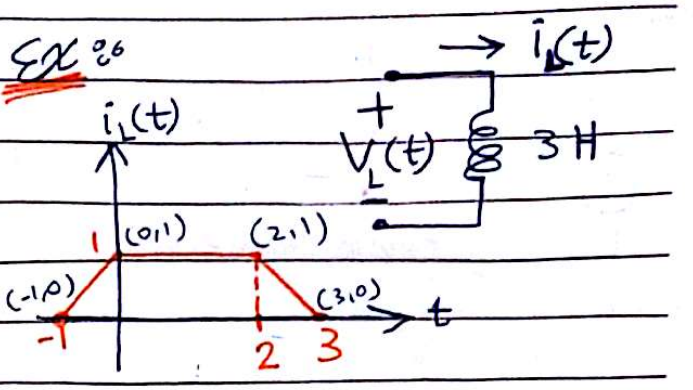
using VoD → $V_x = \frac{10 * (3//2)}{(3//2)+1} =$

$i_2 = \frac{V_x}{3} =$

$i_3 = \frac{V_x}{2} =$

or using mesh analysis

Ex°6

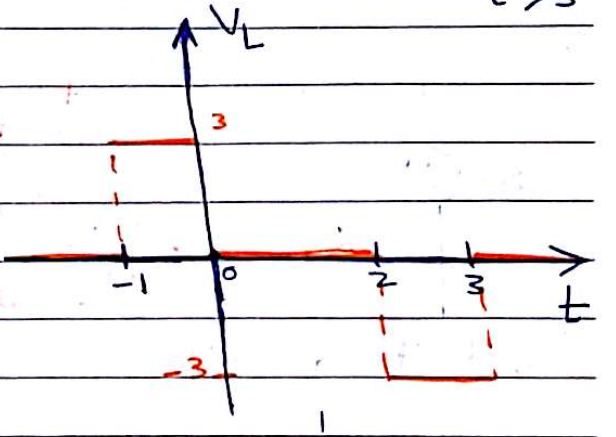


* Find the voltage (V_L) and Stretch it °o

→ $V_L(t) = L \frac{di}{dt} = 3 \frac{di}{dt}$

$= 3 \frac{\Delta i}{\Delta t}$

$V_L(t) =$ $\begin{cases} 0 & t<-1 \\ 3\left(\frac{1-0}{0-(-1)}\right) = 3 & -1<t<0 \\ 0 & 0<t<2 \\ 3\left(\frac{0-1}{3-2}\right) = -3 & 2<t<3 \\ 0 & t>3 \end{cases}$



* Find $V(1.5) = 0$

* $w(1.5) = \frac{1}{2} L i^2(1.5)$ (w: energy)

$= \frac{1}{2} * 3 * (1)^2 = \frac{3}{2}$ J

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ملاحظة

* دائماً التيار الماشي بالحث (continuous) فقط بالمكثف يكون continuous أما جميعها discontinuous

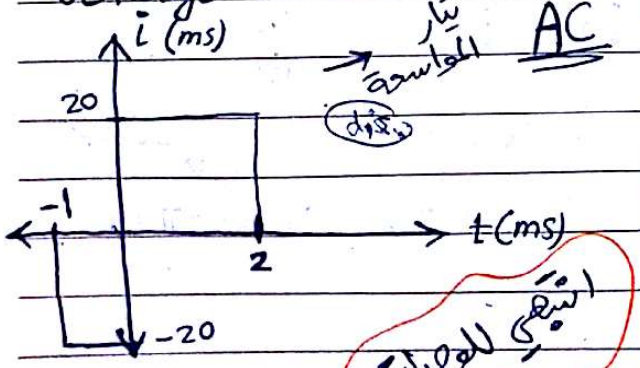
* بالحث $i(t_0^-) = i(t_0^-)$ اللحظة اللي سبقت لحظة اللحظة اللي بتليها (لكن بالسعة الجهد ما بيتساوى اللحظتين)

- The current (i_L) is con. $i_L(t_0^-) = i_L(t_0^+)$
- The voltage (V_L) is discon. $V(t_0^-) \neq V(t_0^+)$

بالحث

السعة بالعكس

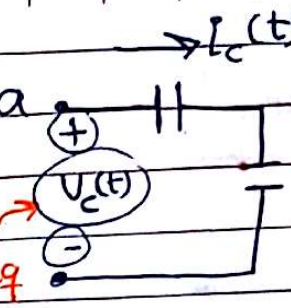
ex:: if (Ceq between a and b is .5 Hf and the current passing through it is represented below. Find and sketch the voltage ::



تيار الحواسة AC

discontinuous

الشكل للحواسة



* طبق $\left(i_c(t) = C\frac{dv_c}{dt}\right)$ لازم أعرف أناء أي حواسة ع أمتي.

$$V_c(t) = V_c(t_0) + \frac{1}{C}\int_{t_0}^{t} i_c(\tau)\,d\tau$$

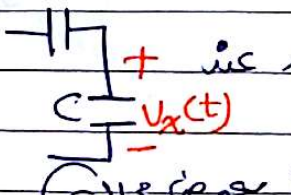
بطبق كل مرة لقانون

$$V_c(t) = \begin{cases} \varnothing + \int \varnothing \text{ (zero)} & t \leq -1 \\ \varnothing + \frac{1}{5\times10^{-6}}\int_{-1m}^{t} -20\times10^{-3}\,d\tau = -4000t - 4 & -1 \leq t \leq 0 \\ V(\varnothing) + \frac{1}{5\times10^{-6}}\int_{0}^{t} 20\times10^{-3}\,d\tau = 4000t - 4 & 0 \leq t \leq 2 \\ V(2) + \int \varnothing = 7996 & t \geq 2 \end{cases}$$

$t \geq 2$ ← لأنو جهد الحواسة بصفر con.

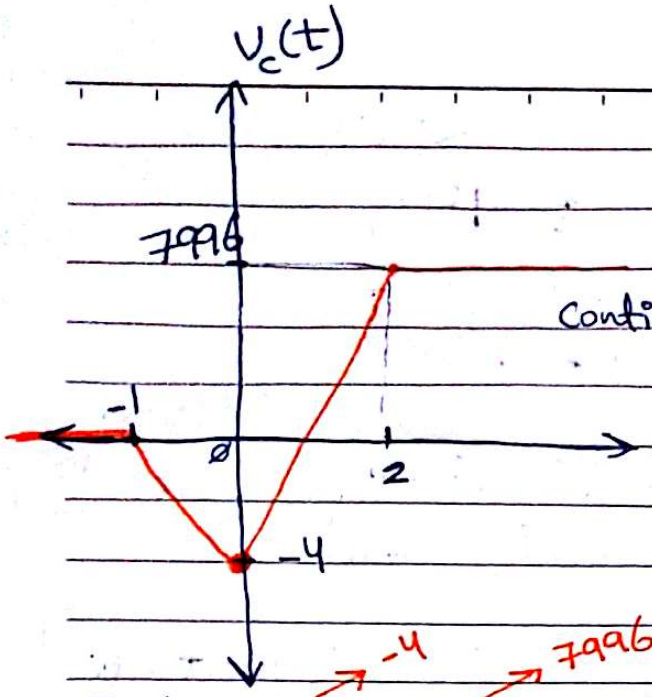
كل ما أوصل عند لحظة $(0 \leq t \leq 2)$ ← الـ initial بروح بعوض بالعلاقة اللي طالعة معي من الفترة اللي قبلها

لو كان طالب إكهد عند C



لبأي لحالة بعوض عل C بالحواسة اللي بعدها إكهد بـ حل التيار متساوي

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So, Find $V_c(0)$, $V(2)$, $W(0)$ $\xrightarrow{-4}$ $\xrightarrow{7996}$

$W(1)$

$\frac{1}{2}(5*10^{-6})(V_1^2)$

$V(1)$ كيف أوجد
لوجد الفترة من

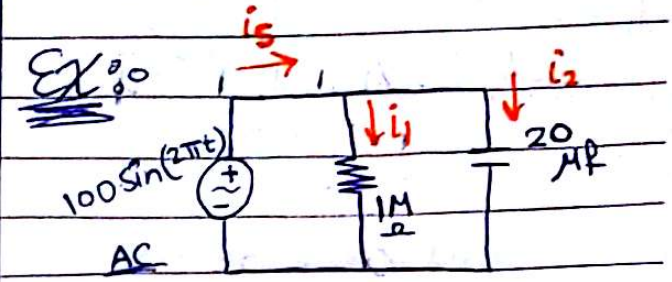
$0 \leq t \leq 2$

وبالمعادلة الى
فوق

$4000t - 4 \Big|_{t=1} = 3996$

وبعوض ① فيه
وبعوض الناتج في ال
(energy)

$W(0) = \frac{1}{2}(5*10^{-6})(-4)^2$



① Find i_1 , i_2 ② i_s at $(t=\frac{1}{3}s)$

③ energy stored in the capacitor at $(t=\frac{1}{12}s)$

④ max. energy stored in the capacitor

⑤ the time at which the max. energy stored in the capacitor is reached?

⑥ the energy dissipated in the resistor over the two intervals (charging and discharging)

① to find (i_1) 90

$i_1 = \frac{V}{R} = \frac{100\sin(2\pi t)}{1*10^6} = 10^{-4}\sin(2\pi t)$

$V = IR$
$V = L\frac{di}{dt}$
$i_c = C.\frac{dv}{dt}$

(i_2) $i_2 = C\frac{dv_c}{dt}$

$i_2 = (20*10^{-6})\frac{d(100\sin(2\pi t))}{dt}$

$i_2 = 4\pi*10^{-3}\cos(2\pi t)$

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(2)

$i_s(t) = i_1(t) + i_2(t)$

$t = \frac{1}{3}$ second

$i_s(\frac{1}{3}) = 10^{-4}\sin(2\pi\frac{1}{3}) + 4\pi\times10^{-3}\cos(2\pi\frac{1}{3})$

$= -6.2$ mA

$\pi = 180$

(3) $W = \frac{1}{2}C(V_c(\frac{1}{12}))^2$

$= \frac{1}{2}(20*10^{-6})(V_c(\frac{1}{12}))^2$

to find $V_c(\frac{1}{12})$

$V_c(\frac{1}{12}) = 100\sin 2\pi(\frac{1}{12}) = 50$

so $W = \frac{20*10^{-6}}{2}(50)^2 = 25$mJ

(4) $W(t) = \frac{1}{2}C(V(t))^2$

$= \frac{1}{2}(20*10^{-6})(100\sin 2\pi t)^2$

$= 0.1\sin^2(2\pi t)$

$W(t)_{max} = 0.1$ J

(minimum ما بتساوي صفر)

(5) at which the max. energy when

$\sin(2\pi t) = 1$

$2\pi t = \sin^{-1}(1)$

$2\pi t = \frac{\pi}{2}$

$t = \frac{1}{4}$ sec

(6) $P = \frac{dW}{dt}$

Energy (resistor) $= \int I^2R\,dt$

$2W_{max}$

$P\cdot dt$

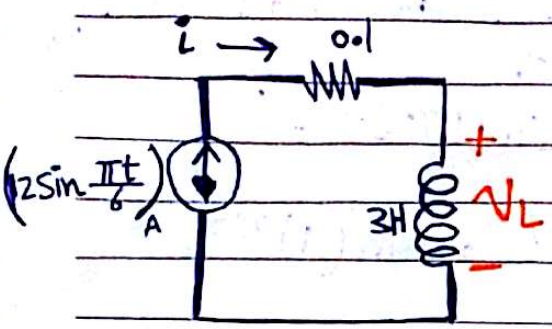
Energy dissipated over charging and discharging

$= \frac{-100}{2\pi}[\cos\pi - 1]$

$= 0.55$ J

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Ex:



* ① Find V_L
② $W_L(1)$
③ $W_{L_{max}}$
④ W_R during charging and discharging

① $V_L = L\cdot\frac{di_L}{dt}$

$V_L = (3)\frac{d}{dt}(12\sin\frac{\pi}{6}t)$

$V_L = 6\pi\cos(\frac{\pi}{6}t)$

② $W_L(1) = \frac{1}{2}L[i(1)]^2$

$\rightarrow \frac{1}{2}(3)[i(1)]^2 \rightarrow (12\sin\frac{\pi}{6})^2$

$= 54$ J

$\pi = 180°$

③ $W_{L_{max}} = \frac{1}{2}(3)(12\sin\frac{\pi t}{6})^2$

$= 216\sin^2(\frac{\pi t}{6})$

$= 216$

④ $W_R = \int i^2 R\cdot dt$

(time at which the energy is max.) $= \frac{1}{2}(W_{L_{max}})$

$= \int_0^{\square} (12\sin\frac{\pi t}{6})^2 (0.1)\,dt$

$= \int_0^{6} (12\sin\frac{\pi t}{6})^2 (0.1)\cdot dt$

$\sin(\frac{\pi t}{6}) = 1$

$\frac{\pi}{6}t = \sin^{-1}(1)$

$t = 3$ sec

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* Response of RL and RC - Circuit

- In DC source →

Inductors → (short circuit)

Capacitors → (open circuit)

- for any response :: (where x : V, I)

$$x(t) = x(t)_{natural} + x(t)_{forced}$$

(natural response) : (V, I) التي تعتمد في الدارة على المقاومة والمكثف

(forced response) : أي شيء يضاف للدارة (زي ما هو)

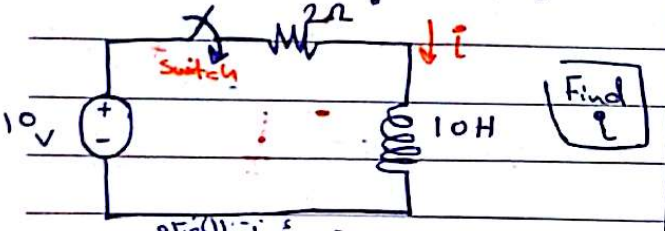
ممكن يكون عامل منع لل (response)

- يعني هاد اللي ما بيكون عندي (switch)

* After switching ($t > 0$)

[1] افترضت انو الـ switch صار عند $t = 0$

* مثلاً: أوجد التيار المار في المقاومة 2Ω بعد إغلاق المفتاح ($t \geq 0$)



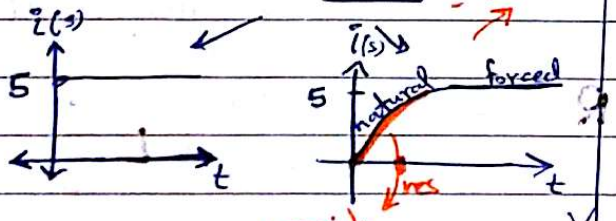
Find i

at: $t \geq 0$, find i ::

$t < 0$, $i = 0$

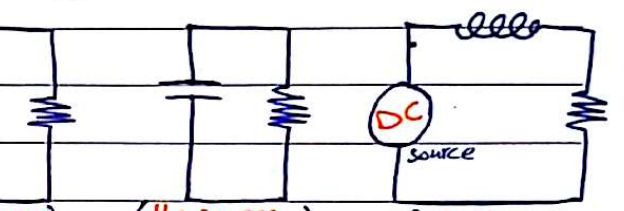
$t > 0$, $i = \frac{10}{2} = 5$

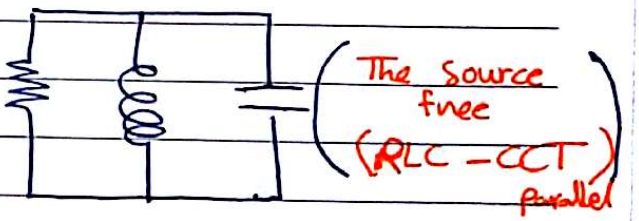
$i = 5$ (يعبر عن الشحن من البداية)



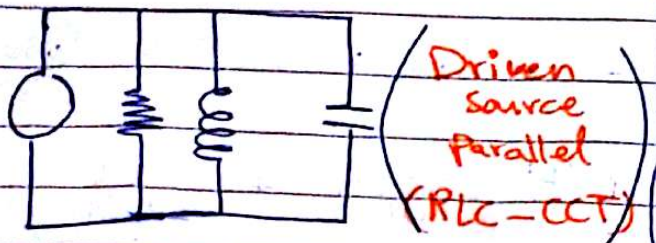
الفرق بين شو ما يعبر (5) والتيار (response) R_L , R_C

التيار اللي بيكون في الظروف الأولى (كيف يوصل لـ 5) سواء كان (Current) أو (Voltage) على (L / R / C)

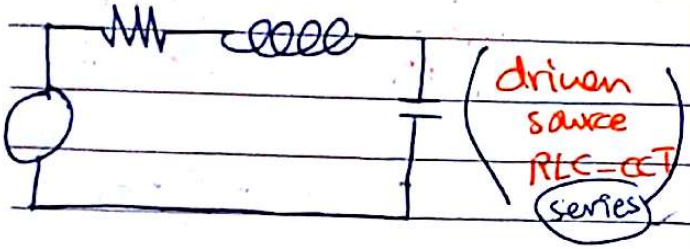




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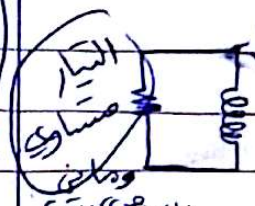
Driven source Parallel (RLC-CCT)



driven source RLC-CCT (series)

* كل دوائر الـ response كالها

1] free source RL CCT



البدائل مساوي وداخل source فاكره صفر

اذن (Source) في الـ

$$V_L + V_R = 0$$

$$L\frac{di}{dt} + IR = 0$$

$$i(t) = Ae^{-\frac{R}{L}t}$$

$i(t_{switching}^{+})$ ← $t>0$

Switch at $(t=0)$: $= i(0^+)\,e^{-\frac{R}{L}t}$

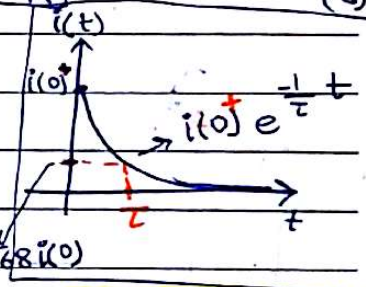
الطاقة التي كانت بالملف (الدائرة) أو (المنبع)

$$= i(0^+)\,e^{-\frac{1}{\tau}t}$$

where $\tau = \frac{L}{R}$: time constant (s)

$i(0^-)$: الطاقة التي تسبق الصفر

$i(0^+)$: الطاقة التي تكون بعد الصفر مباشرة



$$i(\tau) = i(0)\,e^{-1}$$

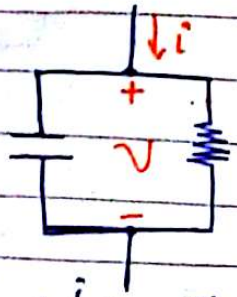
$$= 0.368\ i(0)$$

* After 5τ → the current reaches final value

(وشرط تكون صفر مسيرة عبر R وL بالسيركت)

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2. Free source RC Circuit →



$i_c + i_R = 0$

$C\frac{dv}{dt} + \frac{v}{R} = 0$ D.E

$v(t) = v(0^+)e^{\frac{-1}{RC}t}$

$= v(0^+)e^{-\frac{1}{\tau}t}$ ← response

where, $\tau = RC$

لما يكون عندك سيركت

$x(t) = x(0^+)e^{-\frac{1}{\tau}t}$

In general Free source → RC → $\tau = RC$

RL → τ → $\tau = \frac{L}{R}$

والإضافة بال

وإذا كان عندي driven source

$x(t) = [x(0^+) - x(\infty)]e^{-\frac{1}{\tau}dt} + x(\infty)$

3] Driven CCT (RL or RC)

response

$x(t) = x_{natural} + x_{forced}$

$= Ae^{-\frac{1}{\tau}t} + x(\infty)$

$x(t) = [x(0^+) - x(\infty)]e^{-\frac{1}{\tau}t} + x(\infty)$

response

response

(free source) $x(t) = x(0^+)e^{-\frac{1}{\tau}dt}$

RL → $\tau = \frac{L}{R}$ ، RC → $\tau = RC$

(driven source) $x(t) = [x(0^+) - x(\infty)]e^{-\frac{1}{\tau}dt} + x(\infty)$

natural: RL ، RC

forced: $x(\infty)$

حيث أن x تمثل علاقة إما التيار أو الجهد

إذا افترضنا أن لحظة الـ switching $t=0$ كانت عند الصفر

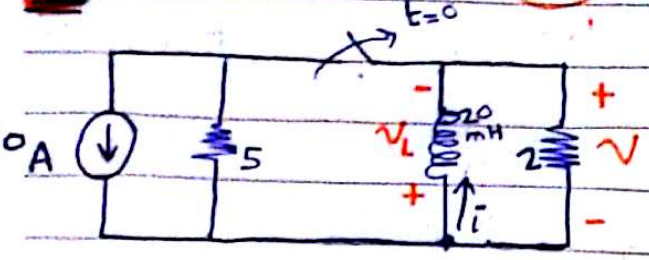
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* لما نفتح المفتاح صيرجع صفر كل شي من جهد وتيار وغيره ، لكن أنا ع بدرس كم كان لهذه اللحظة الصفر (لحظة الفتح) مباشرة وليس بعد أي فترة من طويلة سنشتغل على الـ response

* لما كان مسكر ، مثل الحث (أو الشغل بالكامل) وأيضاً مثل (short circuit) ولو كان مفتوح (open ckt)

Ex:-

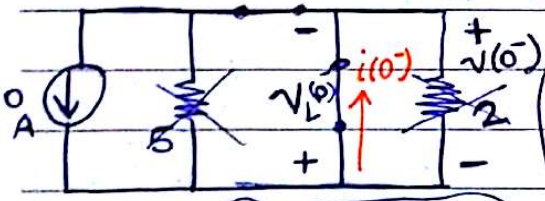


① Find $i(0^-)$ and $v_L(0^-)$?
② Find $i(0^+)$ and $v_L(0^+)$?
③ Find $i(300\mu)$ and $v(300\mu)$?
④ Find $v_L(0^+)$ and $v_L(200\mu)$?

→ كان مسكر الـ (switch) وبعدين فتح

* For → $t<0$ كان مسكر switch on

فبدي برسم السيركت



لما كان الـ switch مسكر شايف الحث (معه أكيد) كتير فاشش بالكامل

* $i(0^-) = i(0^+)$ (con.) لانه التيار بالحث

* $v_L(0^-) \neq v(0^-)$ (discon.) لانه جهد الحث

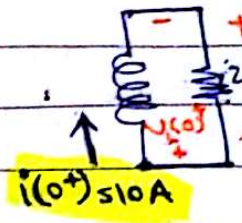
→ for $t<0$, $i = 10A$

$\therefore i(0^-) = i(0^+) = 10A$

$v_L(0^-) = 0$ ← (S.C)

$v(0^-) = 0$ ← لانها بالمقاومة

2 for $t>0$ (switch off)



free source

RL $x(t) = x(0^+)e^{-\frac{R}{L}t}$ response

$V_L(0^+) = RI(0^+)$

$= 2(10) = 20\ V$

$i(0^+) = i(0^-) = 10A$

(لقد استخدم أي معادلة بين هذين كلهة الـ (switching))

$v_L(0^+) = -20\ V$

3 $i(300\mu)$ = ؟

اذا طلبت قيمة أعلى من الـ switch كلهة الـ response كيف

$i(t) = i(0^+)\, e^{-\frac{1}{\tau}t}$

$= 10e^{-\frac{1}{\tau}t}$

But $\tau = \frac{L}{R} = \frac{20m}{2}$

$= 10m$

اذا كان كتير أكتر من A بطلع الـ eq واذا كان أكتر من L بطلع الـ eq

$\rightarrow i(t) = 10\, e^{-100t}$

$i(300\mu) = 10\, e^{-100(300\times10^{-6})}$

$= 9.7\ A$

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$v(t) = v(0^+) e^{-100t}$

$= 20\, e^{-100(300\mu)}$

$= 19.4$ Volt

or

$v(300\mu) = R\, i_{(300\mu)}$

$= 19.4$ V

dis. & Con. في حالة *

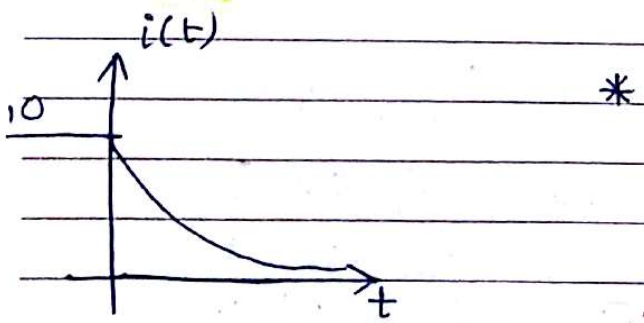
$x(0^-) = x(0^+)$

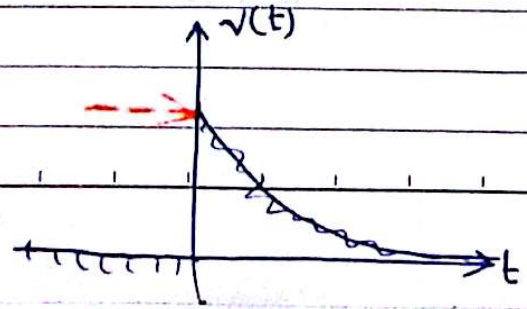
④

$v_L(0^+) = -20$ volt

$v_L = v_L(0^+) e^{-100t}$ $= -20e$

$\Rightarrow -19.6$ V





switching قبل من

⑤ Find the max. energy stored in the inductor?

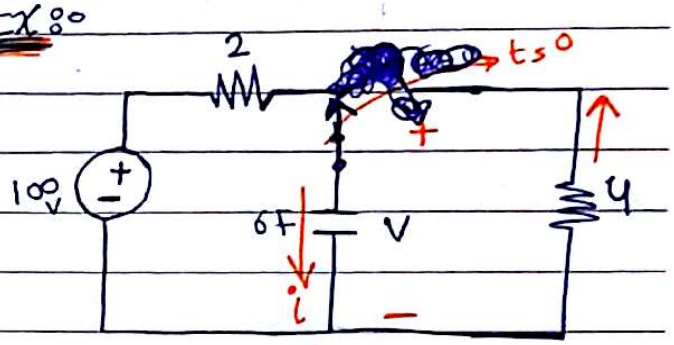
$W_{max} = \frac{1}{2} L\, i^2(0)$

لما كان مشحون بالكامل

$= \frac{1}{2} (20m) * (10)^2$

$= 1$ J

Ex:

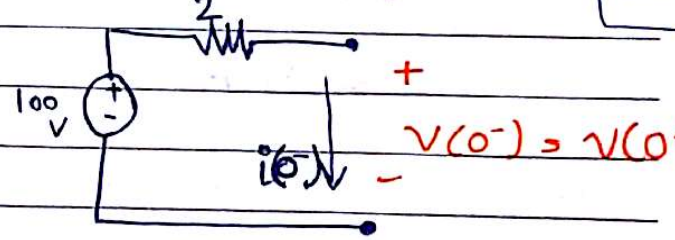


① Find $v(0^-)$, $i(0^-)$, $v(0^+)$ $i(0^+)$, $v(10m)$, $i(10m)$?

② Find max. energy dissipated in 4Ω resistor

③ Find energy dissipated in 4Ω at $t = 10m$

→ For $t<0$ الدائرة قبل ما تفتح



$v(0^-) = v(0^+)$

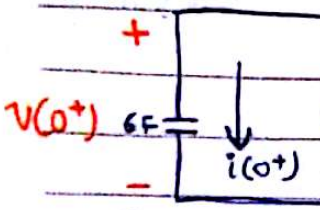
$i(0^-) = 0$

$v(0^-) = v(0^+) = 100$ V

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For $t>0$, الدائرة



$$i(0^+) = \frac{-100}{4}$$

$$= -25\ A$$

→ Find $v(t)$, for $t>0$, response طبيعي + قسري الكلي بالزمن t

* to find $v(10m)$ طبيعي response

$$v(t) = \underbrace{v(0^+)}_{100}\, e^{-\frac{1}{\tau}t} \quad \tau = RC = 4(6) = 24\ sec$$

$$= 100\, e^{-\frac{1}{24}t}, \quad t = 10m$$

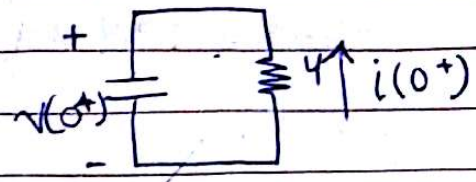
$$= 100V$$

$$i(t) = \underbrace{i(0^+)}_{-25}\, e^{\frac{-1}{24}t}, \quad t = 10m$$

$$= -25\ A$$

RC

② (max energy in the capacitor) تقدر عند



$$W_{max} = \frac{1}{2} C v^2(0^+)$$

$$= \frac{1}{2}(6)(100)^2$$

$$= 3\times10^4\ J$$

③ $W = \frac{1}{2} C v^2(10m)$

$$= \frac{1}{2}(6)(100)^2$$

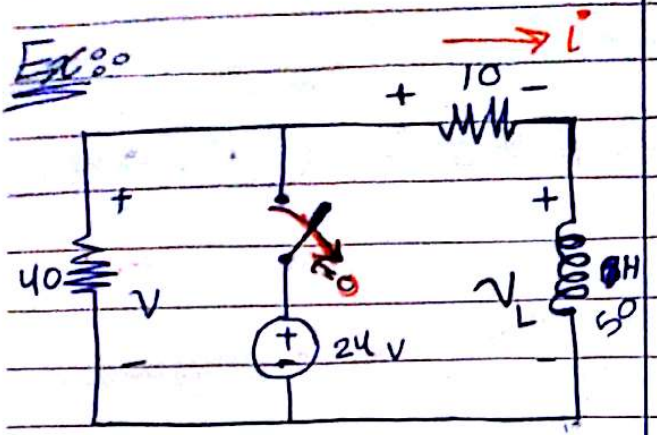
سؤال:

دائماً الـ W_{max} بيكون عند اللحظة اللي على عالية (Switching) سواء تفتح أو تغلق

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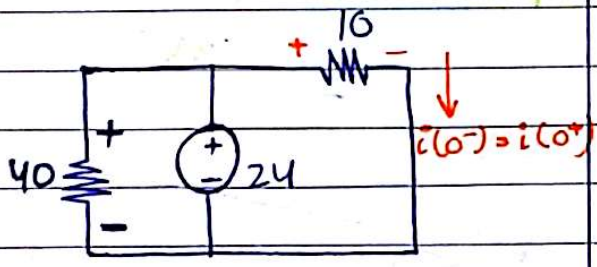
Ex:



Find $v(0^+)$, $v_L(0^+)$

$v(200ms)$, $v_L(200ms)$?

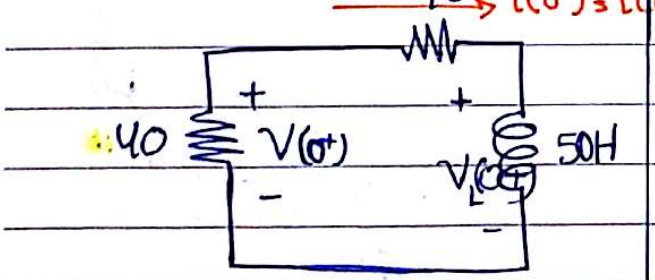
* For $t<0$ (أي شيء قبل الصفر) Continuous



* $i(0^-) = i(0^+) = \frac{24}{10} = 2.4\ A$

$v(0^-) = 24\ V$ (من الرسم)

→ for $t>0$

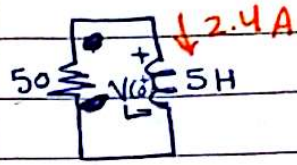


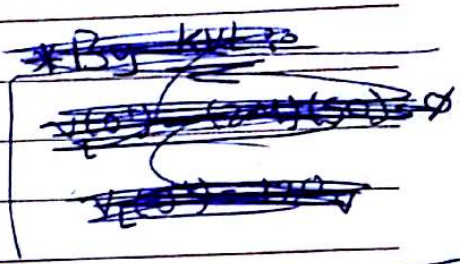
* بعد الخ (40Ω) ؟

$v(0^+) = -40\, i(0^+) = -40(2.4)$

$= -96$ Volt

$v_L(0^+) = -50(2.4) = -120\ V$





to find $v(t)$ at $t<0$?

$v(t) = v(0^+)\, e^{-\frac{1}{\tau}t}$

$R = 50$

$L = 5$

$= (-96)\, e^{-\frac{50}{5}t}$

$= -96\, e^{-0.2}$

$= -79\ V$

* $v_L(t) = v_L(0^+)\, e^{-t}$

$v_L(200ms) = -120\, e^{-(0.2)}$

$= -98.25\ V$

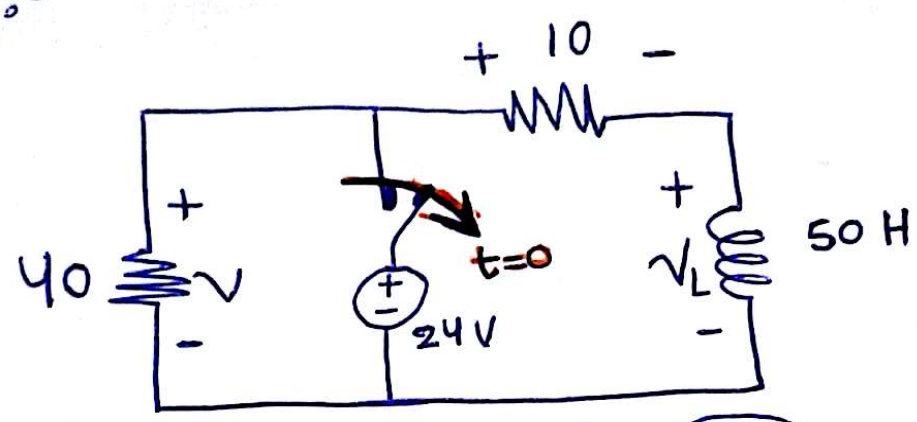
Five Apple

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$$W = \frac{1}{2}(6)\,v^2(10(10^{-3}))$$

$$= 3\left[v(0^+)\,e^{-\frac{1}{\tau}dt}\right]$$

Ex:



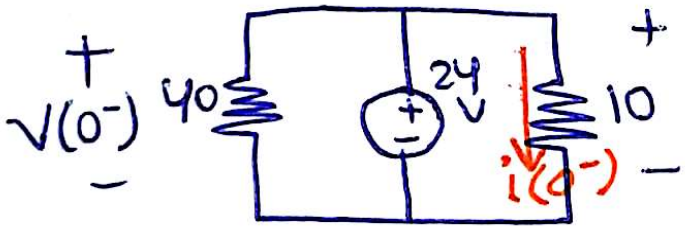
$v(0^+)$

$v_L(0^+)$

$v(200\,ms)$

$v_L(200\,ms)$

* For $(t<0)\rightarrow$

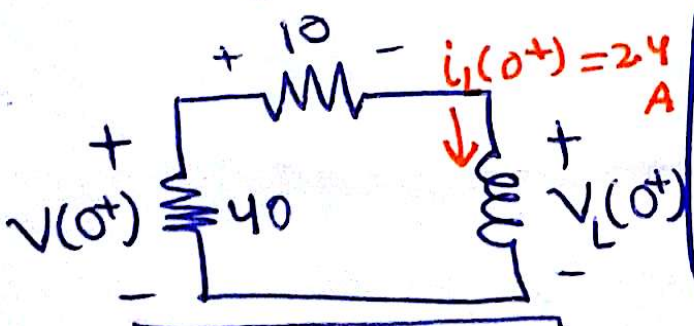


$v_L(0^-) = 0$

$$i(0^-) = i(0^+) = 2.4\,A$$

$v(0^-) = 24\,V$

For $(t > 0)\rightarrow$



RL - CCT

KVL

$10(2.4) + v_L(0^+) + 40(2.4) = 0$

$$v_L(0^+) = -120\,V$$

$$v(0^+) = \frac{(-120)(40)}{50}$$

$$v(0^+) = -96\,V$$

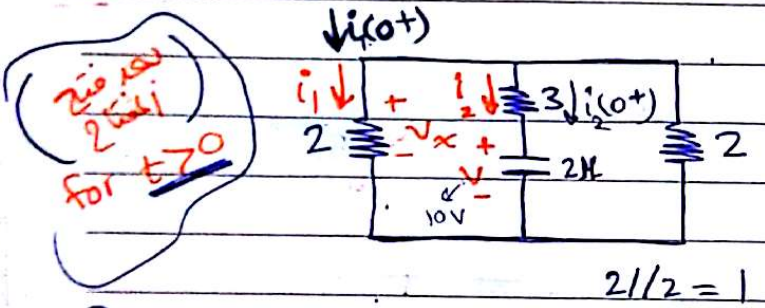
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Ex: The CCT shown below was connected to a DC source for along time. If $v(0^-) = 10\,V$, find :

1) $i_1(0^+)$, $i_2(0^+)$?

2) V for $t>0$?

3) i_1 for $t>0$?

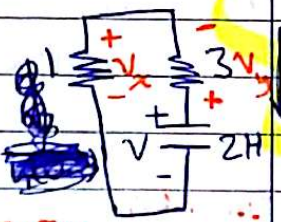


$2//2 = 1$

(1)

$\rightarrow v(0^+) = v(0^-) = 10V$

to find $i_1(0^+)$:



(using voltage divider)

$$v_x = \frac{10(1)}{1+3} = 2.5V$$

$$i_1(0^+) = \frac{2.5}{1}\,A = 1.25A$$

$\rightarrow$ to find $i_2(0^+) \Rightarrow$

voltage divider

$$v_y = \frac{-10(3)}{4} = \frac{-30}{4} = -7.5$$

$$\therefore i_2(0^+) = \frac{v_y}{3} = \frac{-7.5}{3}\,A = -2.5A$$

(2)

You can find $i_2(0^+)$ using :

$i_2(t) = C \frac{dv_c}{dt} \rightarrow v(t)$ response

$$v(t) = v(0^+)\, e^{-\frac{1}{\tau}t} = 10\, e^{-\frac{1}{8M}t}$$

$R_{eq} C = k\Omega(4)\,\mu F$

$= 8M$ second

(3)

$$i(t) = i_1(0^+)\, e^{-\frac{1}{\tau}t} = \frac{2.5}{2}\, e^{-\frac{1}{8M}t}$$

response

$q(t)$

$v(t)$

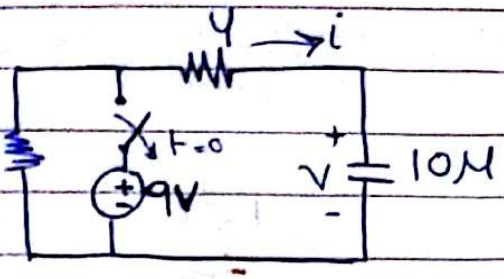
$i(0^+)$

$v(0^+)$

* لو بدي أوجد $i_1(t)$ بعطوني $(\tau = RC)$ وأنا R بدي (R_{eq})

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Ex:



*Find: 9V → 0 → 9 volt → $-\frac{9}{6}$

1) $v(0^-)$, $i(0^-)$, $v(0^+)$, $i(0^+)$

$v(200\,\mu s)$, $i(100\,\mu s)$?

$\tau = \frac{1}{60M}$

$v(t) = 9e^{-\frac{1}{\tau}t}$

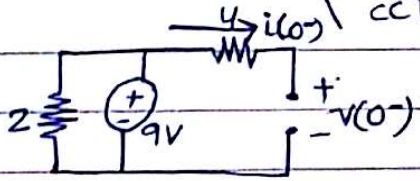
$i(t) = -\frac{9}{6}e^{-\frac{1}{\tau}t}$

→ for $t<0$, (قبل، أقل) كان مسكر



$v(0) = 0$ volt

لأن الدائرة مفتوحة (open ckt) فتصير

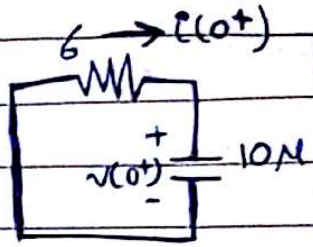


$i(0^-) = 0$

$v(0^-) = 9V = v(0^+)$

↳

*for $t>0$ (بعد، أكبر من)



$v(0^+) = 9V$

$i(0^+) = \frac{-9}{6} = -1.5\,A$

*the response so

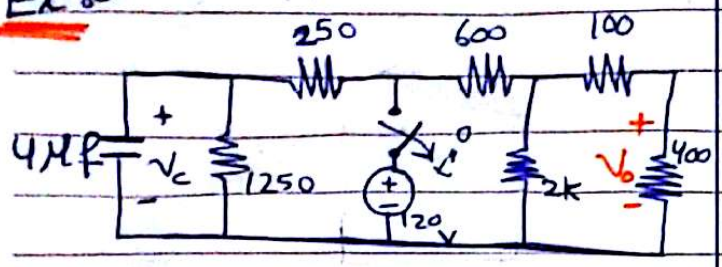
$v(t) = v(0^+)\,e^{\frac{-1}{RC}t}$

$v(t) = 9e^{\frac{-1}{60M}t}$ → $v(200ms) = 0.32$ V

$i(t) = i(0^+)\,e^{\frac{-1}{RC}t}$

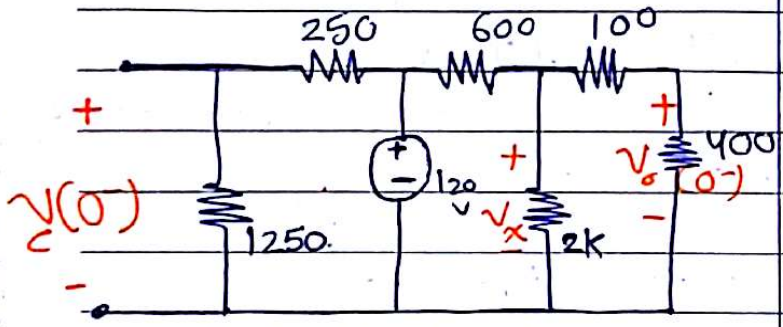
$i(t) = -1.5e^{\frac{-1}{60M}t}$ → $i(100\mu s) = -0.28$ A

Ex 8.0



* Find:
v_c and v_o at $t=0^-$, $t=0^+$, $t=1.3$ ms?

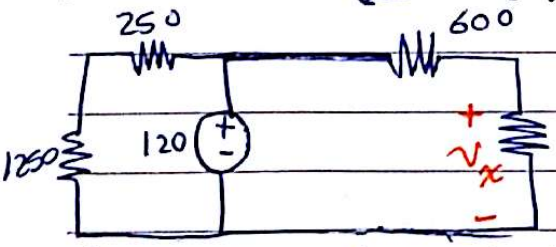
→ For $t<0$



* to find $v_c(0^-)$, using voltage divider?

$$v_c(0^+) = v_c(0^-) = \frac{(120)(1250)}{250+1250} = 100\ V$$

* to find $v_o(0^-)$:



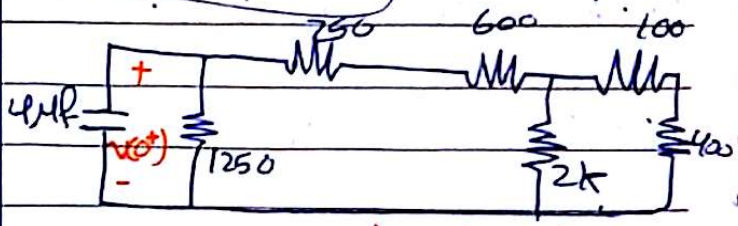
$= 400\ \Omega$

Also, using voltage divider →

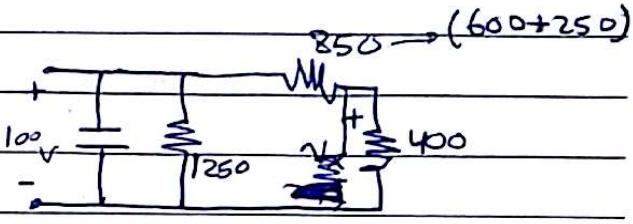
$$v_x = \frac{120(400)}{400+600} = 48 \text{ volt}$$

$$* \quad v_o(0^-) = \frac{400(v_x)}{500} = 38.4\ V$$

→ For $t>0$



$$v_c(0^+) = v_c(0^-) = 100\ V$$



using VoD →

$$v_x = \frac{400(400)}{400+850} = 32$$

$$v_o(0^+) = \frac{v_x(400)}{1000} = 25.6 \text{ volt}$$

→ to find τ:

$$\tau = R_{eq} C_{eq} \quad (4\mu F) = 2.5\times10^{-3}$$

$(400+850)//1250 = 625\ \Omega$

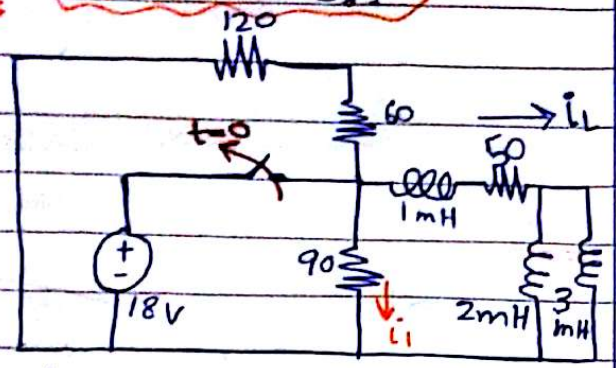
$$v_c(t) = 100\, e^{-400t}$$

$$v_o(t) = 256\, e^{-400t}$$

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تذكري انو ال driven و ال free هدول بيو ال switching و هول بيو ال response

Ex:



Find

① $i_1(0^-)$

② $i_1(0^+)$

③ $i_L(\infty)$

④ $i_1(100\mu s)$

After switching

$t > 0$

بعطيني ال driven

بعطيني ال free source CCT

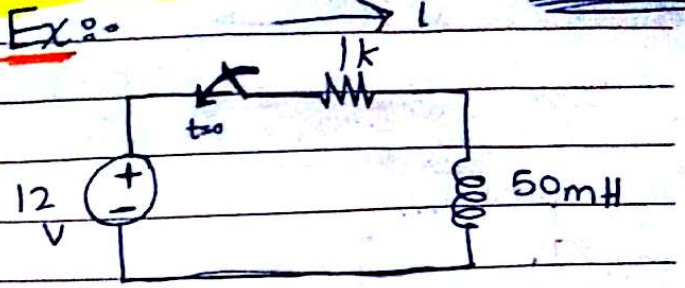
source بالكتير بدي اعمل تحليل لل

بدي اشوف ال

بالكامل

Driven

Ex:



① Find (i) for $t<0$ and $t>0$?

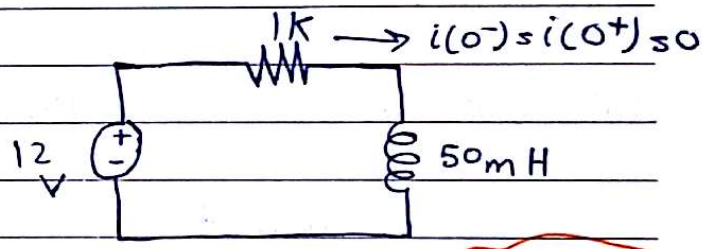
② $i(0^-)$, $i(0^+)$, $i(100\mu s)$?

$t<0$, $i(0^-) = 0$

$t>0$ ، لسه في شحن بالكامل

(لما يكون مفتوح و t>0 سكرتو الحث بيكون لسه مو مسكر)

(Driven CCT RL)



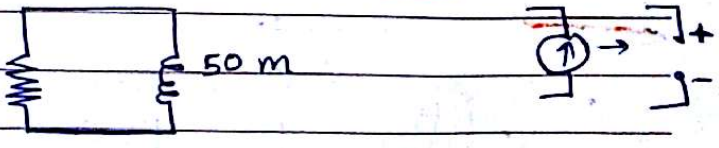
driven source

$$i(t) = [i(0^+) - i(\infty)]e^{\frac{-1}{\tau}t} + i(\infty)$$

$\tau = \frac{L}{R}$

(independent source) بالنوعين

بطفيهن أو بخلي كل R و L



$\tau = \frac{50m}{1k} = 50\mu$

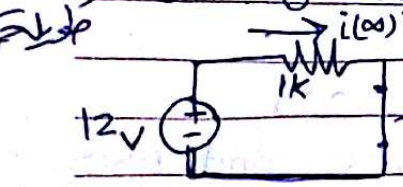
Five Apple

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(إيجاد ثابت الزمن)

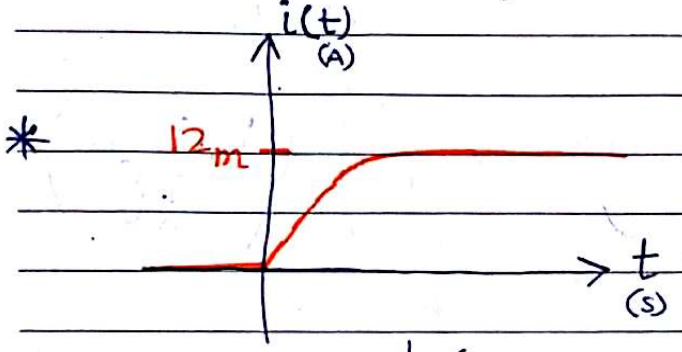
* to find $i(\infty)$ → (forced)

إيجاد بالتحليل الكامل بعد فترة زمنية طويلة



$$i(\infty) = \frac{12}{1k} = 12mA$$

$$i(t) = -12e^{\frac{-1}{50\mu}t} + 12\times10^{-3}$$

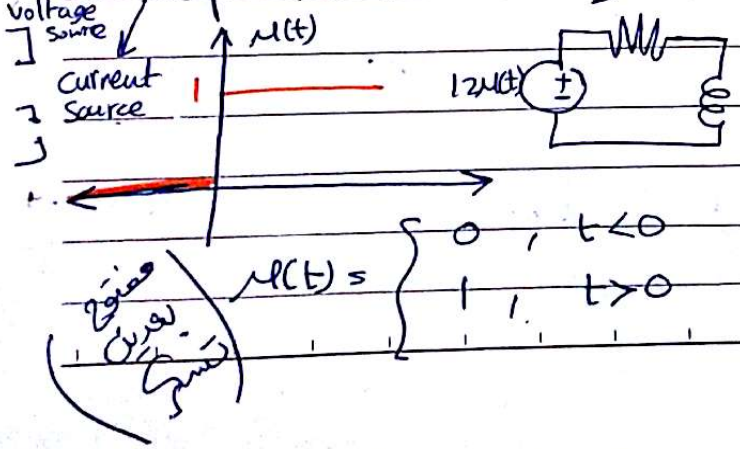


$$i(100\mu s) = -12e^{\frac{-1}{50\mu}(100\mu)} + 12\times10^{-3}$$

$$= 10.38 \text{ mA}$$

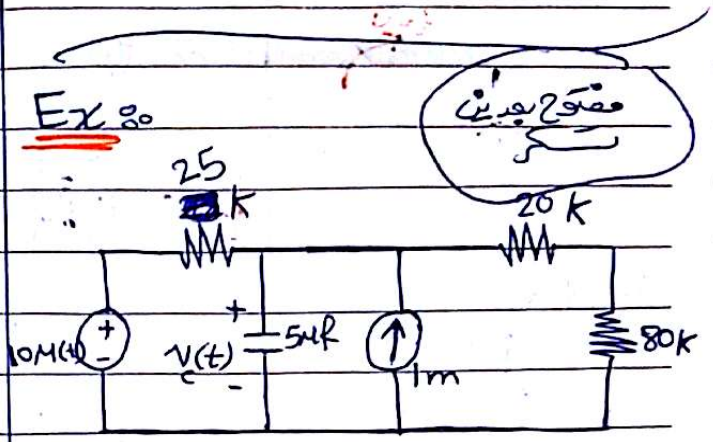
Note (switch) الـ ideal يكون بديل

Step function ← ε



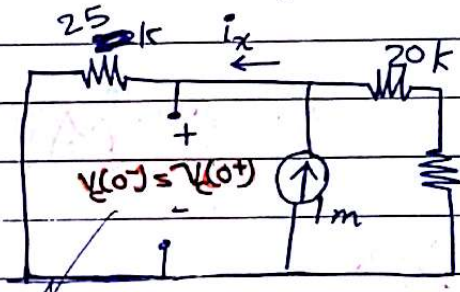
$$u(-t) = \begin{cases} 1, & t<0 \\ 0, & t>0 \end{cases}$$ (بعكس الفتح)

Ex:



Find $v_c(t)$ at $t=0^-, 0^+, \infty, 0.08$

* For $t<0$ →



saw it for along time (open CCT)

* using C.D →

$$i_x = \frac{1m(100k)}{100k+25k} = 0.8$$

$$v_c(0^-) = v_c(0^+) = 25k\, i_x$$

$$= 20 \text{ volt}$$

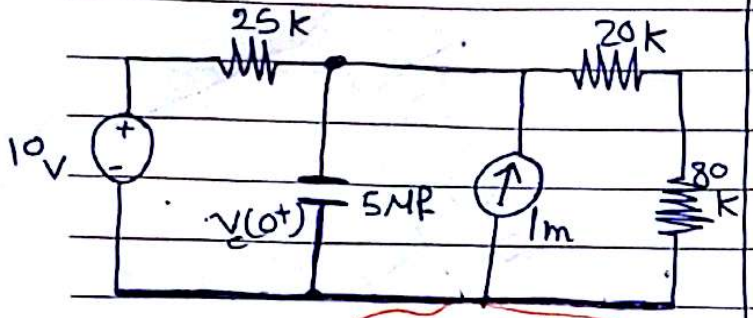
* independent ثابت زمني يا انو فيه مصادر بالسيكت لازم نطفي المصادر

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* For $t>0$

بعد ما انشئت الدائرة بالكامل

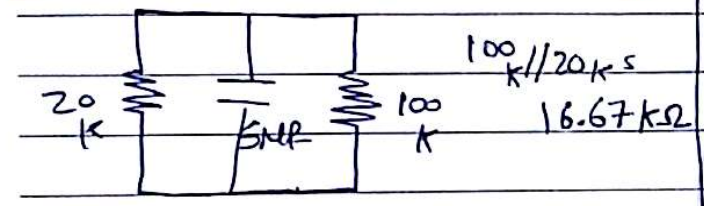
قبلها ←



$$v_c(t) = [v_c(0^+) - v_c(\infty)]e^{-\frac{t}{\tau}} + v_c(\infty)$$

$v_c(0^+) = 20$

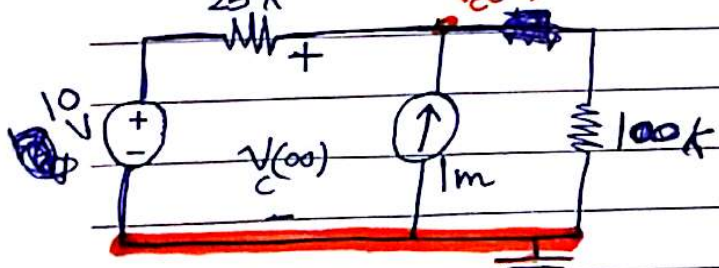
* to find τ → [turn off all indep sources] ← خلي الدائرة



$100k // 20k = 16.67 k\Omega$

$\tau = R_{eq} C_{eq} = 100_{(5)} (10^{-3}) = 0.1$

* to find $v_c(\infty)$ ⇒



using nodal analysis →

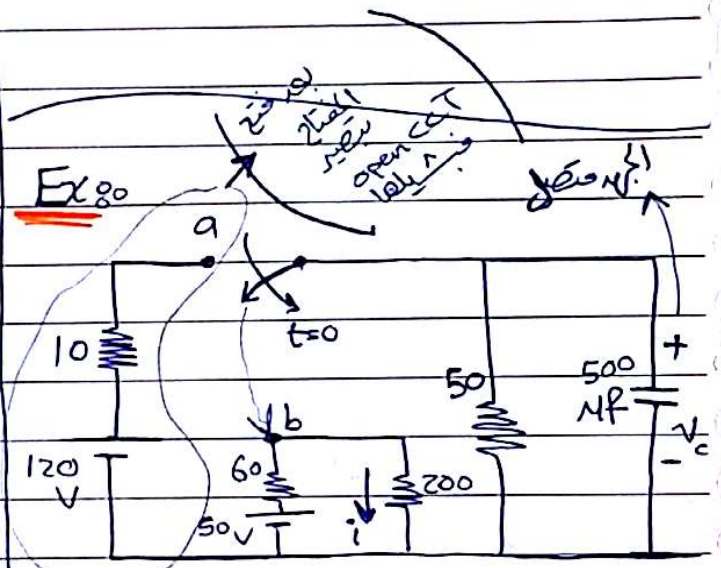
$$\frac{v_c(\infty) - 10}{25k} - 1m + \frac{v_c(\infty)}{100k} = 0$$

$v_c(\infty) = 28V$

$$v_c(t) = (20-28)e^{-0.012t} + 28$$

$v_c(0.8) =$

Ex ⇒



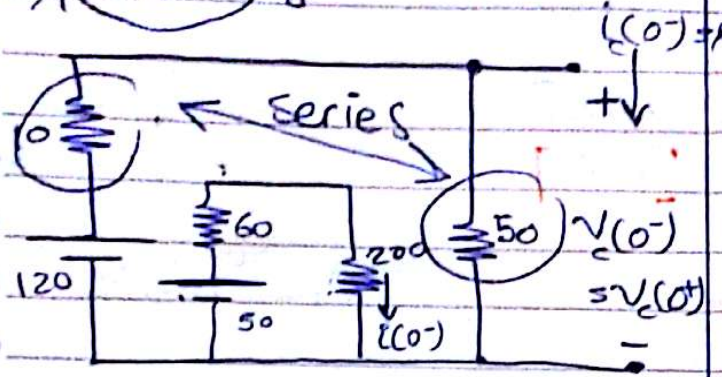
the switch was connected to the position (a) for a long time at $t=0$, the switch moved to (b) ⇒

Find $v_c(0^-)$, $v_c(0^+)$, $i(0^-)$, $i(0^+)$, $i_c(0^-)$, $i_c(0^+)$

$v_c(1\text{sec})$, $i(1\text{sec})$ ⇒

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* $t<0$:

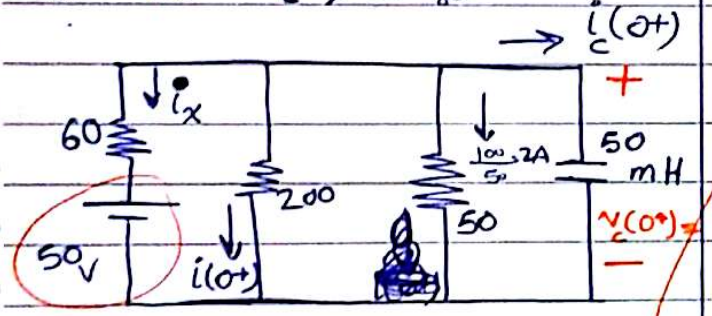


$$i(0^-) = \frac{50}{200} = 192.3\ mA$$

$$v_c(0^+) = v_c(0^-) = \frac{120\times 50}{50+10}$$

$$= \boxed{100V}$$

* for $t>0$:



after switching

driven → (response)

$$v_c(t) = [v_c(0^+) - v_c(\infty)]\, e^{-\frac{1}{\tau}t} + v_c(\infty)$$

$$i(t) = [i(0^+) - i(\infty)]\, e^{-\frac{1}{\tau}t} + i(\infty)$$

* $i_0(0^+) = \frac{v_c(0^+)}{200} = 0.5A$

$i_c(0^+) = i_x = \frac{100-50}{60} = \frac{5}{6}A$

ما سبق الحلول لأنو لسه ما انشحنت بالكامل

سبق حلها لما يمشي لفترة زمنية طويلة / $(t\to\infty)$ بتكون انشحنت بالكامل

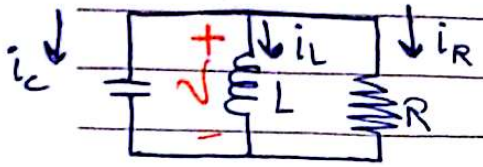
Sarah S. Abu-Sarah
mechatronics engineer

Five Apple

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* شو علاقة α بـ w وبعدين بنشوف response

* The Free source for parallel RLC - CCT:



$$i_L + i_R + i_C = 0$$

$$C\frac{dv_C}{dt} + \frac{v}{R} + \frac{1}{L}\int v\,dt = 0$$

$$s^2 + \frac{1}{RC}s + \frac{1}{LC} = 0$$

$$i \leftarrow x(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} \quad \text{(response)}$$

where

* $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - w_0^2}$

$\alpha = \frac{1}{2RC}$ (Neper frequency), $w_0 = \frac{1}{\sqrt{LC}}$ (resonant frequency)

* You need to find $x(0^+)$ and $\frac{dx}{dt}(0^+)$ // → to get A_1 & A_2

(switching) ; ab's is * ...

Cases:

response:

① $\alpha = w_0$, $s_1 \neq s_2$ → $A_1 e^{s_1 t} + A_2 e^{s_2 t}$ (overdamped)

② $\alpha = w_0$, $s_1 = s_2 = -\alpha$ → $A_1 e^{-\alpha t} + A_2 t e^{-\alpha t}$ (critically)

③ $\alpha < w_0$, s_1 and s_2 are complex no. → $A_1 e^{-\alpha t}\cos(w_d t) + A_2 e^{-\alpha t}\sin(w_d t)$ (rad)

when

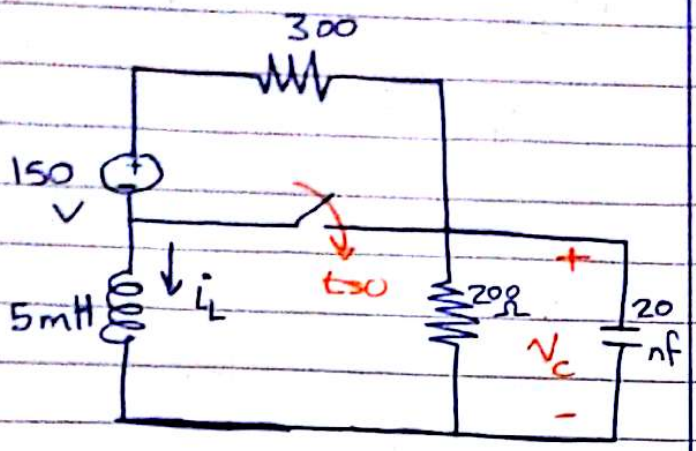
$w_d = \sqrt{w_0^2 - \alpha^2}$

(damped radian frequency)

Five Apple

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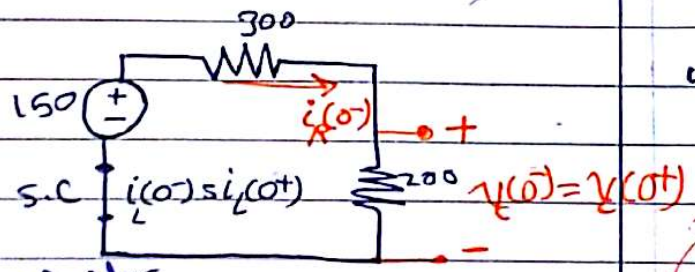
Ex :-



1) Find $v_c(0^-)$, $v_c(0^+)$, $i_L(0)$, $i_L(0^+)$, $i_R(0^-)$, $i_R(0^+)$?

2) Find $v_c(t)$ for $t>0$?

→ For $t<0$:



voltage divider

$$v_c(0^-) = v_c(0^+) = \frac{150 * 200}{500}$$

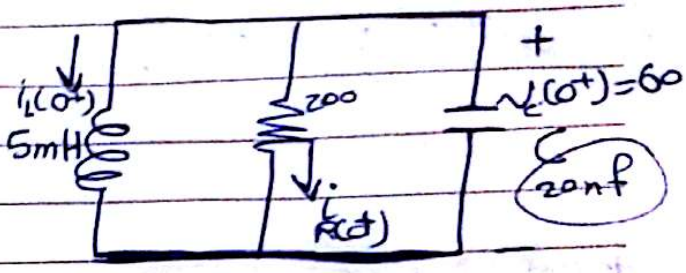
$$= 60V$$

$$i_L(0^-) = i_L(0^+) = \frac{-150}{500} = -0.3 \ A$$

$$i_R(0^-) = 0.3A \ (+ve)$$

$$= \frac{60}{200}$$

→ For $t>0$:-



$$i_L(0^+) = -0.3$$

$$i_R(0^+) = \frac{60}{200} = 0.3$$

$$v_c(0^+) = 60 \ V$$

* to find the response :-

$$\alpha = \frac{1}{2RC} = \frac{1}{2(200)(20 * 10^{-9})} = 125000$$

$$\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20*10^{-9} * 5*10^{-3}}} = 100\,000$$

$\alpha > \omega_o$

$$v_c(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

to find $S_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$

$$S_1 = -200000$$

$$S_2 = -50\,000$$

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$C \div i_C = C\frac{dv_c}{dt} \div C$

$v_c(t) = A_1 e^{-200000t} + A_2 e^{-500000t}$

* to find (A_1) and (A_2) :-

$v_c(0^+) = 60\ V$

$\frac{dv_c(0^+)}{dt} = \frac{i_C(0^+)}{C} = \frac{-i_L(0^+) - i_R(0^+)}{C}$

$= \frac{-0.3 - (-0.3)}{C}$

$= 0$

$v_c(0^+) = 60 = A_1 + A_2$ — (1)

$\frac{dv_c(0^+)}{dt} = -S_1 A_1 - S_2 A_2$

$\frac{dv_c(t)}{dt} = -200000 A_1 e^{-200000t} - 500000 A_2 e^{-500000t}$

* كيف أوجد A_1 و A_2 ←
$v_c(0^+)$ نطبق
و أكتب $\frac{dv_c(0^+)}{dt}$

$\frac{dv_c(0^+)}{dt} = 0 = -200000 A_1 - 500000 A_2$

$A_1 = 80\ V$

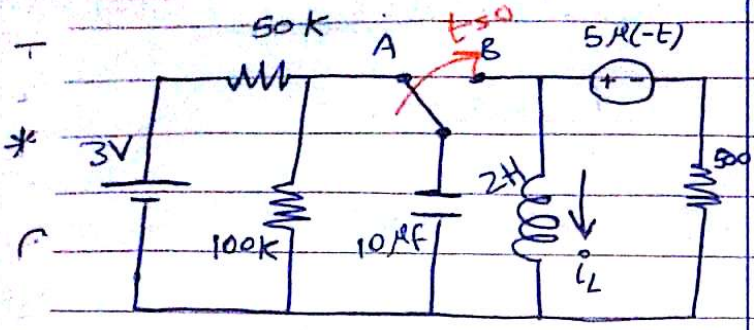
$A_2 = -20\ V$

$v_c(t) = 80 e^{-200000t} - 20 e^{-500000t}$

Five Apple

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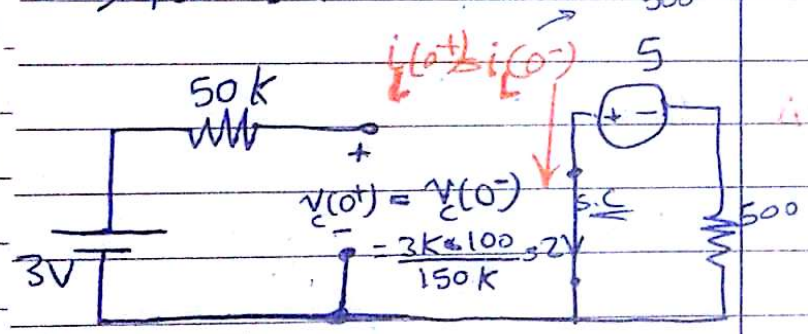
Ex 8.0 (i_L(0+) is 2 switches)



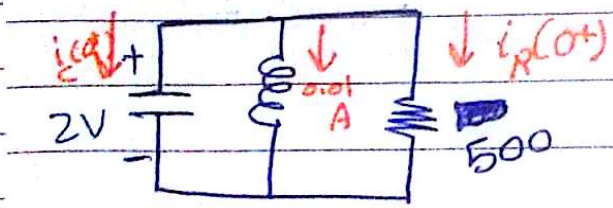
* the switch has been in position @ for a long time. It is moved to position B for t = 0

Find $v(0^-)$, $i_L(0^-)$, $\frac{dv(0^+)}{dt}$, $v(1ms)$?

→ For $t<0$ :: $= \frac{5}{500} = 0.01A$



→ For t>0 ::



→ $\frac{dv(0^+)}{dt} = \frac{i_c(0^+)}{C} = \frac{-i_L(0^+) - i_R(0^+)}{C}$

But $i_L(0^+) = 0.01$

$i_R(0^+) = \frac{2}{500} A$

$\frac{dv(0^+)}{dt} = -1400 V$

Using:

* $\alpha = 100$

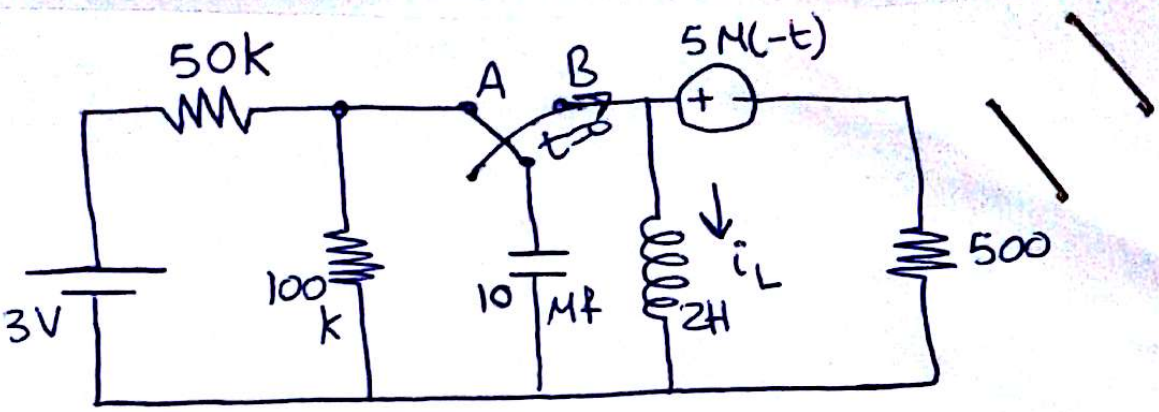
$W_0 = 223.6$

$\alpha < W_0$ underdamped (Complex)

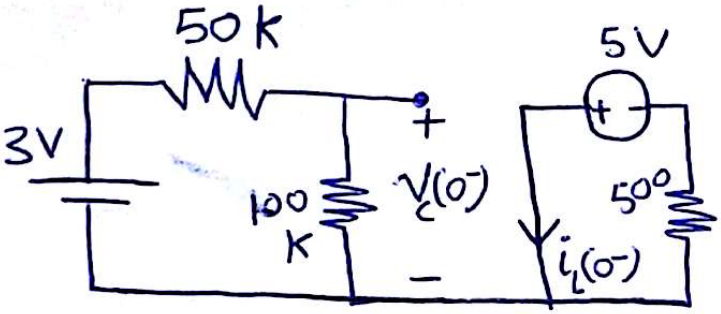
$W_d =$

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* For $t<0$ →



$v_c(0^-) = v_c(0^+)$

$i_L(0^-) = i_L(0^+)$

---

* $v_c(0^-) = \frac{3(100)(10^3)}{150(10^3)}$

$v_c(0^-) = v_c(0^+) = 2V$

$i_L(0^-) = i_L(0^+) = 0.01 A$

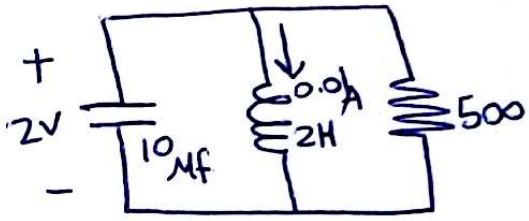
$\omega_o = 223.6$

$\alpha = 100$

$\alpha < \omega_o$

underclamped

For $t>0$ →



$$\frac{dv(0^+)}{dt} = \frac{i_c(0^+)}{C}$$

$$= \frac{-0.01 - 4(10^{-3})}{10(10^{-6})}$$

$$\frac{dv(0^+)}{dt} = -1400$$

$$v(t) = [A_1 \cos(\omega_d t) + A_2 \sin(\omega_d t)]\, e^{-\alpha t}$$

$\omega_d = 200$

$s_{1,2} = -100 \pm \sqrt{-1}\,\omega_d$

* to find (A_1) & (A_2) →

$A_1 = v_c(0^+) = 2$

$200 A_2 - 200 = -1400$

$A_2 = -6$

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$$v(t) = \left[2\cos(200t) - 6\sin(200t)\right] e^{-100t}$$

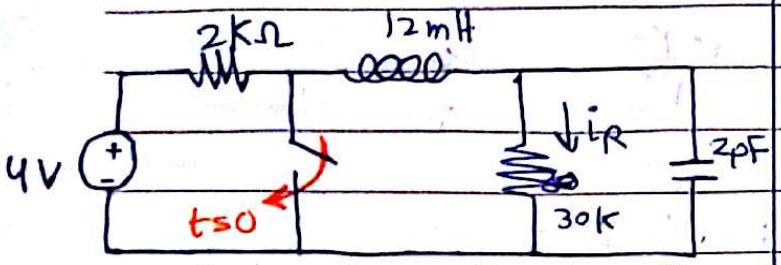
$$v(1(10^{-3})) = \left[2(0.98) - 6(0.198)\right] e^{-100(10^{-3})}$$

$$\boxed{v(10^{-3}) = 0.698\ \text{V}}$$

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$i^2 = -1$

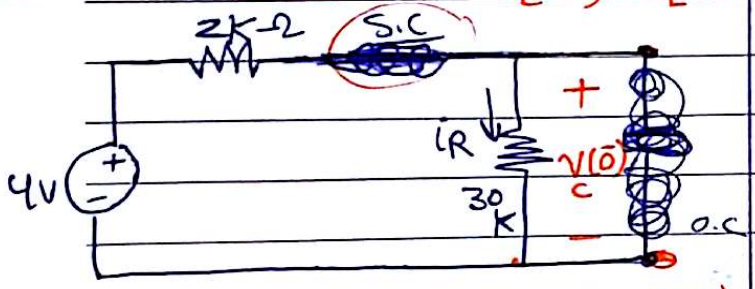
Ex 8:



* Find i_R for all values of time.

→

* For $t<0$



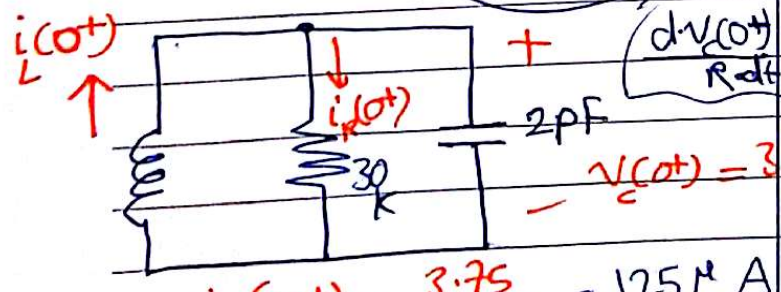
$\rightarrow i_L(0^+) = i_L(0^-)$

$= V_c(0^+)$

$i_L(0^-) = i_L(0^+) = \frac{4}{32}\,K = 125\,\mu A$

$V_c(0^-) = V_c(0^+) = \frac{4(30K)}{32K} = 3.75\,V$

For $t>0$



$\frac{i_L(0^+)}{R} = \frac{3.75}{30K} = 125\,\mu A$

to find the response find α and ω_o :-

$\alpha = \frac{1}{2RC} = 8.23 * 10^6$

$\omega_o = 6.455 * 10^6$

$\alpha > \omega_o$

$i_R(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

$s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$

$\rightarrow s_1 = -3.063 * 10^6$

$\rightarrow s_2 = -13.6 * 10^6$

* to find (A_1) and (A_2) :-

$i_R(0^+) = \frac{3.75}{30\,K}$

$\frac{di_R(0^+)}{dt} = \frac{1}{R}\frac{dV_L(0^+)}{dt}$

$= \frac{1}{R}\left[\frac{i_c(0^+)}{C}\right]$ → ϕ

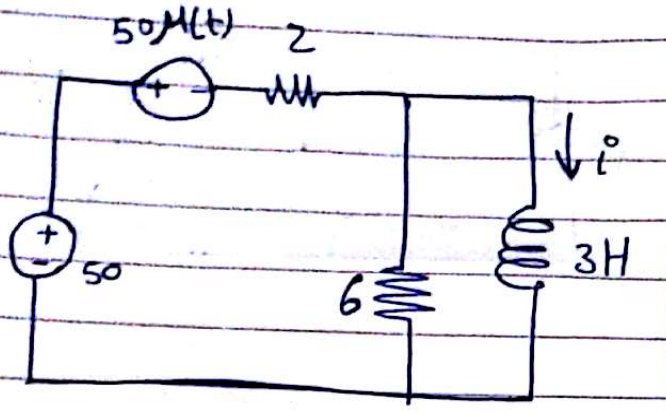
$= \frac{1}{RC}\left[-i_R(0^+) + i_L(0^+)\right]$

$\frac{dV_c(0^+)}{R\,dt} = di_R(0^+)$

Five Apple

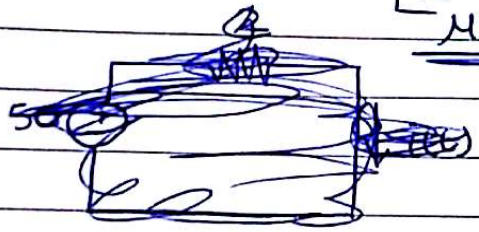
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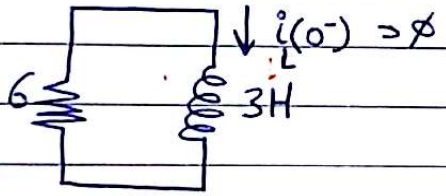
Ex 8o



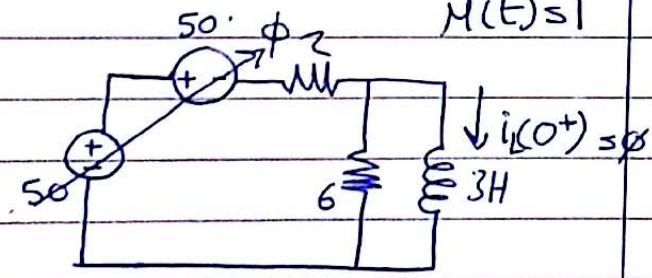
* Find i(t) for t>0 ?

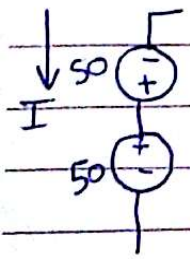
- For t<0 → [2 دوائر] M(t)=0





For t>0 (2 دائرة) M(t)=1

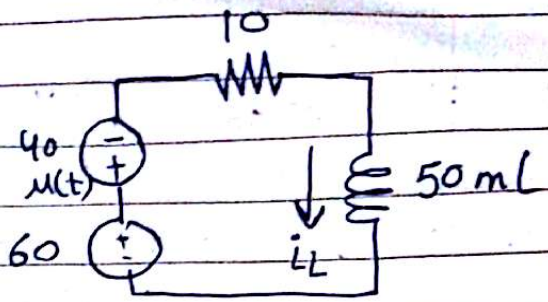




$-50 + 50 = 0$

$i(t) = i_L(0^+) e^{\frac{0}{\tau}} \int \frac{-1}{\tau} dt$

Ex 9o

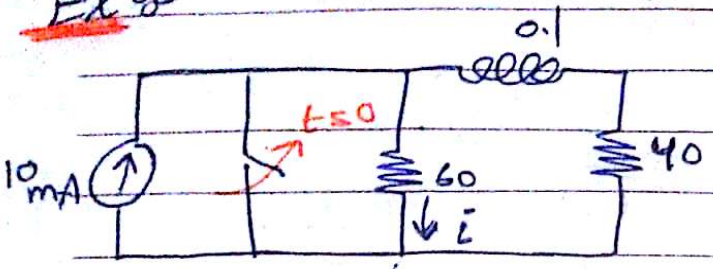


Find (i_L) and (V_L) at

t = 0⁻, 0⁺, ∞, 3ms ?

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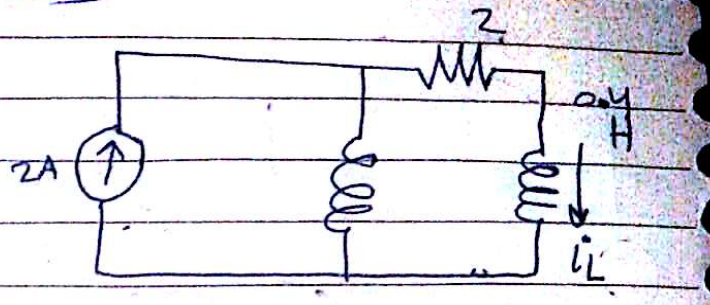
Ex 8



Find (i) at $t=0^-, 0^+, \infty$

1.5 μs ?

Ex 9



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