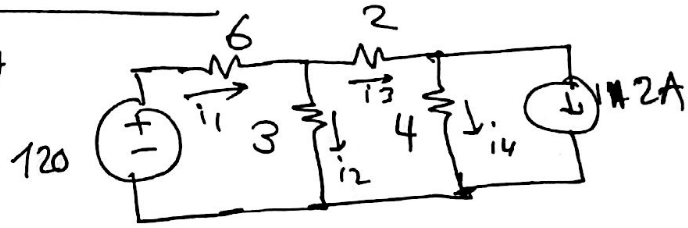
Lec(7)
Superposition

الفكرة هو التعامل مع independent sources على الإنفراد فقط [بحد أدنى 2 sources في الدائرة]

1. الغاء كل voltage sources واستبدالها بـ SC (سلكة $v=0$)
2. // // current // // // // O.C (سلك مقطوع $i=0$)

لو دائرة فيها مثلاً Vs و CS هلغي مرة Vs واحتفظ بالـ CS واحسب التيار او الجهد أو الـ Power المطلوب في الدائرة ثم الدرس نفس الكلام والغي الـ CS واحتفظ بالـ Vs واحسب نفس المطلوب وفي النهاية يكون i_t المطلوب هو i في حالة الغاء Vs + i في حالة الغاء CS وهكذا للباقي المطلوب

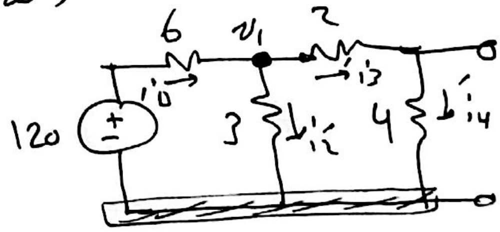
EX(1) Find i_1, i_2, i_3, i_4



Solution steps

1. deactivate 12A source (open circuit)

we can use here Nodal voltage



$\rightarrow \; i_3' = i_4'$

$\rightarrow \; i_1' = i_2' + i_3'$

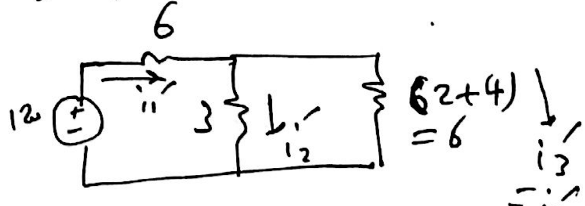
$$\frac{120 - v_1}{6} = \frac{v_1 - 0}{3} + \frac{v_1 - 0}{2+4} \rightarrow v_1 = 30V$$

$$i_1' = \frac{120 - v_1}{6} = 15A$$

$$i_2' = \frac{v_1}{3} = 10A$$

$$i_3' = i_4' = \frac{v_1}{6} = 5A$$

أو في حالة 2



$$i_1' = \frac{120}{R_t} = \frac{120}{6 + [3 \| 6]} = 15A$$

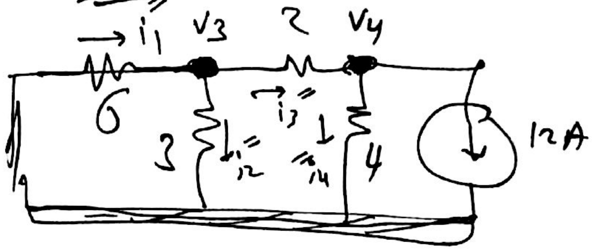
$$i_2' = \frac{15 \times 6}{3+6} = 10A$$

$$i_3' = i_4' = \frac{15 \times 3}{3+6} = 5A$$

Step 2

deactivate voltage source (S.C)

By (using Nodal voltage)



node ①: $i_1'' = i_2'' + i_3''$

$$\frac{V_3 - 0}{6} = \frac{V_3 - 0}{3} + \frac{V_3 - V_4}{2} \rightarrow \boxed{1}$$

node 2: $i_3'' = i_4'' + 12$

$$\frac{V_3 - V_4}{2} = \frac{V_4}{4} + 12 \rightarrow \boxed{2}$$

solving ① & 2 $\rightarrow$ $V_3 = -12$, $V_4 = -24$

$\therefore$ $i_1'' = 2A$, $i_2'' = -4A$, $i_3'' = 6A$, $i_4'' = -6A$

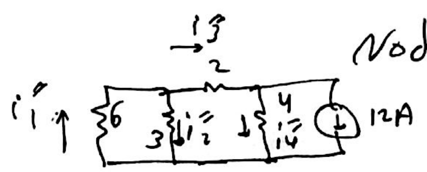
$\therefore$ Total currents for i_1, i_2, i_3, i_4 are

$\boxed{1}$ $i_1 = i_1' + i_1'' = 15 + 2 = 17A$

$i_2 = i_2' + i_2'' = 10 - 4 = 6A$

$i_3 = i_3' + i_3'' = 5 + 6 = 11A$

$i_4 = i_4' + i_4'' = 5 - 6 = -1A$



هناك حل آخر لـ i_1'' ، i_2'' / i_3'' ، i_4'' بدون Nodal

using current divider

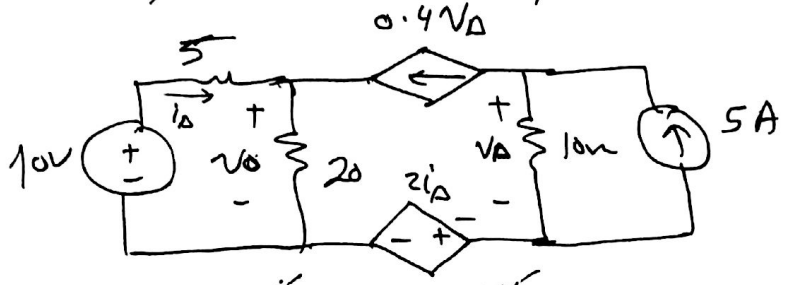
i_3''

(Solve it yourself)

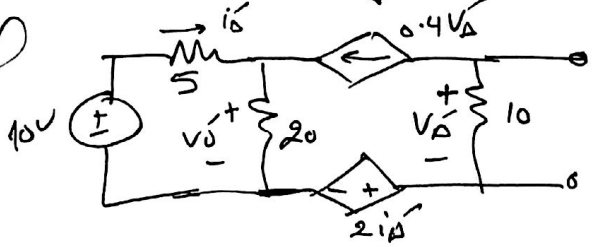
فى حاله الدائره فيها dependent (منجيش جنبها) اللى بيتغير فقط الـ independent

Dependent & independent (3) sources

EX(2) Use superposition to find v_o



SP



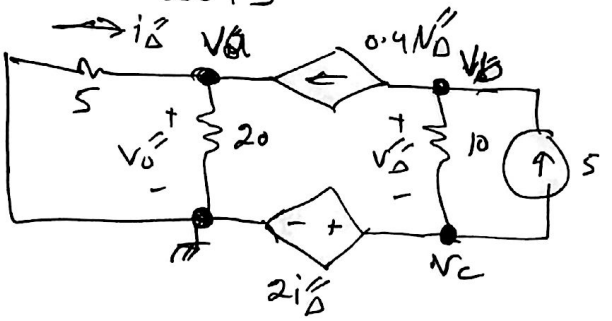
1

$$V_\Delta' = i' \times 10 = (-0.4V_\Delta')(10)$$

$$\therefore V_\Delta'(1+4) = 0 \quad \text{or} \quad V_\Delta' = 0$$

$$\therefore V_o' = \frac{10 \times 20}{20+5} = 8\,V$$

2



By node voltage

node a

$$\frac{V_a}{5} + \frac{V_a}{20} - (0.4V_\Delta'') = 0 \qquad V_a = V_o''$$

$$\therefore \boxed{5V_o'' = 8V_\Delta''} \quad (1)$$

node b

$$0.4V_\Delta'' + \frac{V_b - V_c}{10} - 5 = 0 \qquad (2i_\Delta'')$$

$$\therefore \boxed{4V_\Delta'' + V_b - 2i_\Delta'' = 50}$$

$$V_b - V_c = V_\Delta''$$

$$\therefore 5V_\Delta'' = 50 \quad \text{or} \quad V_\Delta'' = 10V$$

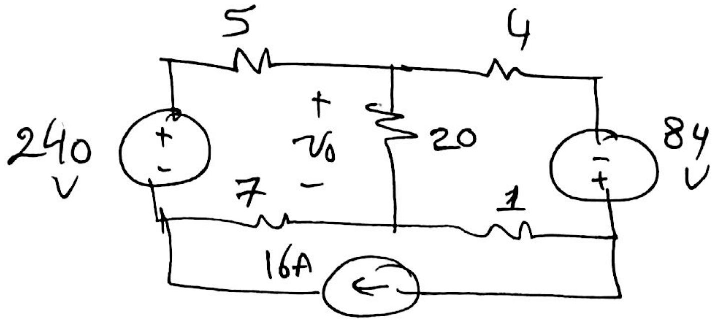
$$5V_o'' = 8V_\Delta = 80 \quad \therefore V_o'' = 16V$$

(1) is the same

$$\therefore V_{o\,total} = 16 + 8 = \boxed{24}\,V$$

Ex(3) مسائل (P4.93)

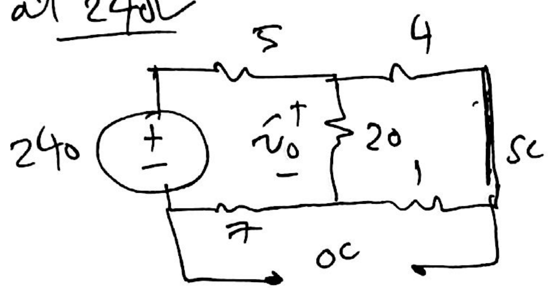
Find v_o using superposition



في حالة وجود اكثر من 2 source (مثال ٣) كل مرة نلغي 2 ونبقي 1

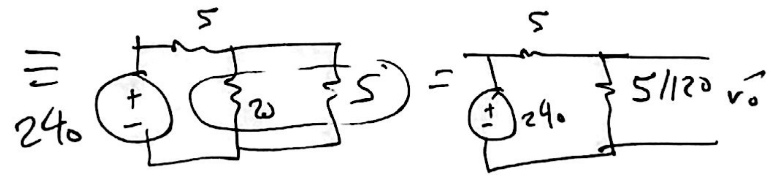
1- deactivate 84V & 16A

∴ at 240V

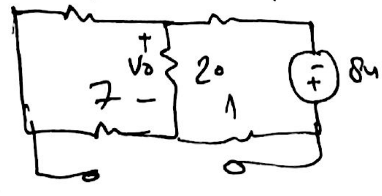


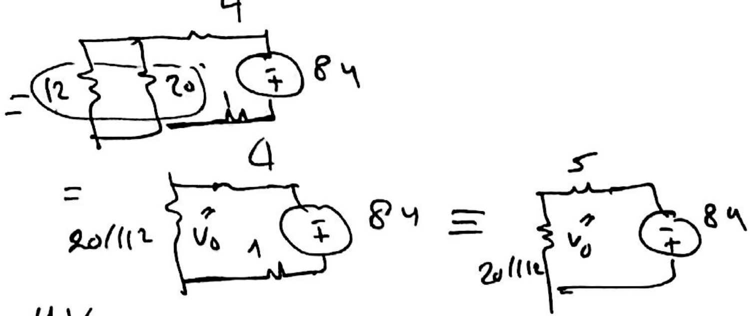
voltage divider

$$v_o' = \frac{240 \times [5//20]}{5 + [5//20]}$$



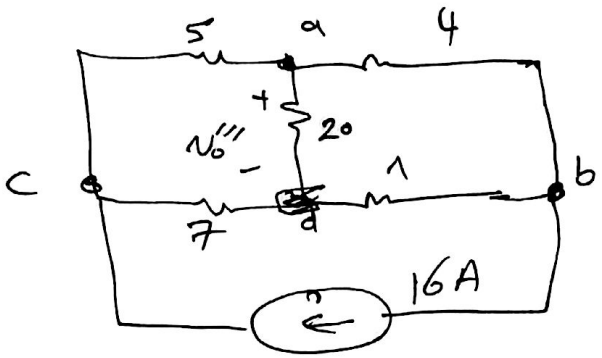
2- at 84V (deactivate 240V, 16A)





$$v_o'' = \frac{(-84) \times [12//20]}{5 + [12//20]} = -50.4\text{ V}$$

(3) at 16 A [deactivate 240 V, 84V]



use Node & let d Reference (V=0)

Node @ : $\frac{V_a}{20} + \frac{V_a - V_c}{5} + \frac{V_a - V_b}{4} = 0 \longrightarrow (1)$

$V_a\left[\frac{1}{20} + \frac{1}{5} + \frac{1}{4}\right] - \left[\frac{1}{4}\right]V_b - \left[\frac{1}{5}\right]V_c = 0$

Node ⑥ $\frac{V_b - V_a}{4} + \frac{V_b - 0}{1} + 16 = 0 \longrightarrow (2)$

$\left[-\frac{1}{4}\right]V_a + V_b\left[\frac{1}{4} + 1\right] + 16 = 0$

Node © $\frac{V_c - V_a}{5} + \frac{V_c - 0}{7} - 16 = 0 \longrightarrow (3)$

$\left[\frac{-1}{5}\right]V_a + 0\,[V_b] + \left[\frac{1}{5} + \frac{1}{7}\right]V_c - 16 = 0$

Solve by calculator ∴ $V_a = 18.4V$ نستخدم الآلة الحاسبة

$V_o''' = V_a - V_d = V_a = 18.4V$

∴ $V_{o\,total} = V_o' + V_o'' + V_o''' = 60 - 50.4 + 18.4 = 28V$

المسائل المطلوبة + مسائل الطالبة 4.91, 4.92, 4.93, 4.97

sec sec