Homework 3

P2.3.5 Determine V_O by redrawing the ladder network of Figure 2.3.5 as a cascade of three voltage dividers.

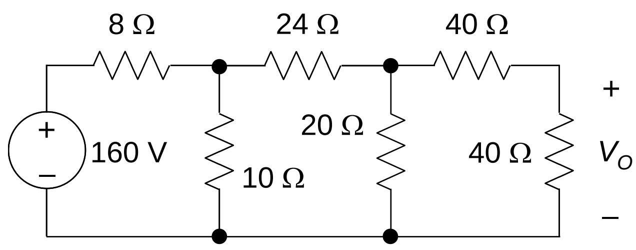
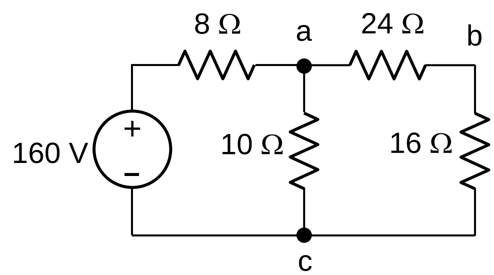


Figure P2.3.5

Solution P2.3.5

20||(40 + 40) = 16 Ω; 10||(24 + 16) = 8 Ω;



hence $V_{ac} = 160 \times \frac{8}{16} = 80$ V,

$V_{bc} = 80 \times \frac{16}{24+16} = 32$ V,

$V_O = 32 \times \frac{40}{80} = 16$ V.

P2.3.6 Determine I_O by redrawing the ladder network of Figure 2.3.6 as a cascade of three current dividers.

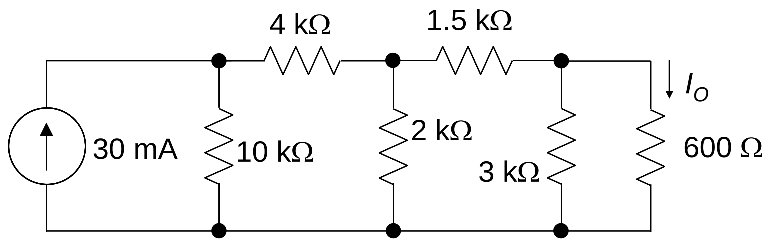


Figure P2.3.6

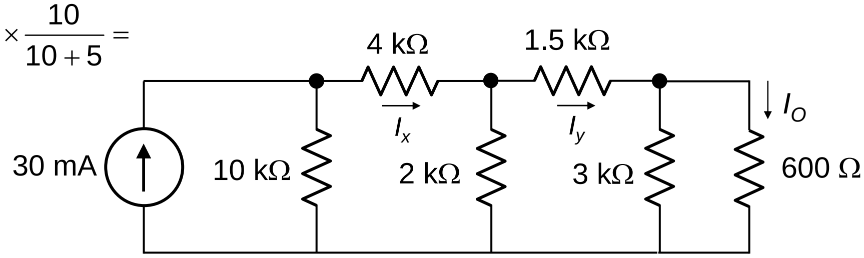
__Solution P2.3.6__

0.6||3 = 0.5 kΩ; (1.5 + 5) = 2kΩ;

from current division: $I_x = 30 \times \frac{10}{10+5} =$ 20 mA;

$I_y = 20 \times \frac{2}{2+2} = 10$ mA;

$I_O = 10 \times \frac{3}{3.6} = \frac{25}{3}$ m A.



P2.4.1 Determine V_O in Figure P2.4.1 using two methods: (a) applying KCL at node a and invoking KVL and Ohm's law; and (b) transforming the voltage source to an equivalent current source that is combined with the $4\,mA$ source.

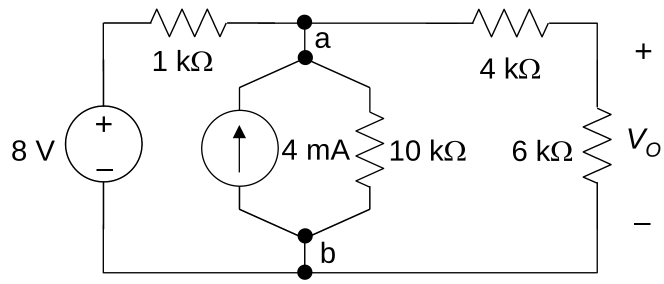


Figure P2.4.1

Solution P2.4.1

(a) $V_{ab} = \dfrac{10}{6}V_O$;

current flowing away from node a: $\dfrac{V_O}{6} + \dfrac{10}{6\times 10}V_O = \dfrac{V_O}{3}$ mA;

current flowing toward a: $4 + \dfrac{8 - \dfrac{10V_O}{6}}{1} = 12 - \dfrac{5V_O}{3}$.

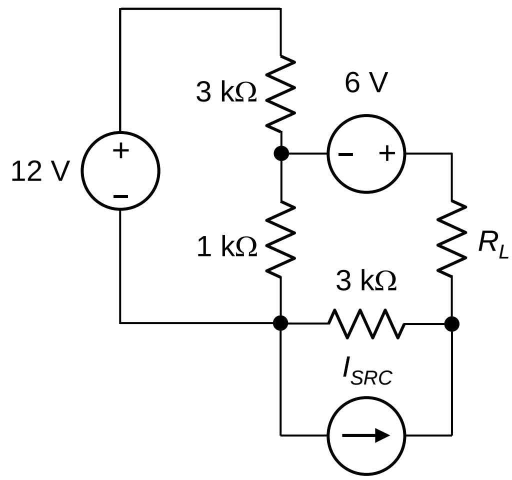
Hence, $12 - \dfrac{5V_O}{3} = \dfrac{V_O}{3}$, which gives $V_O = 6$ V.

(b) Voltage source in series with 1 kΩ is transformed to 8 mA source in parallel with 1 kΩ; total current is 12 mA;

total resistance is $1||10||10 = \dfrac{5}{6}$ kΩ;

$V_{ab} = 12\times\dfrac{5}{6} = 10$ V; $V_O = 10\times\dfrac{6}{10} = 6$ V.

P2.4.3 Determine I_{SRC} in Figure P2.4.3 so that no current flows in R_L.



Solution P2.4.3

When no current flows in R_L, the voltage across the 1 kΩ resistor is $12 \times \frac{1}{4} = 3$ V, and I_{SRC} flows in the 3 kΩ resistor.

The voltage across this resistor is then 3 + 6 = 9 V, so that $3I_{SRC} = 9$, and $I_{SRC} = 3$ mA.

P2.4.4 Determine V_O in Figure P2.4.4.

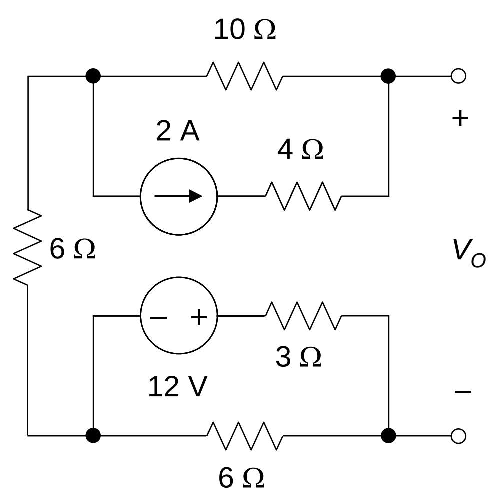


Figure P2.4.4

<u>Solution P2.4.4</u>

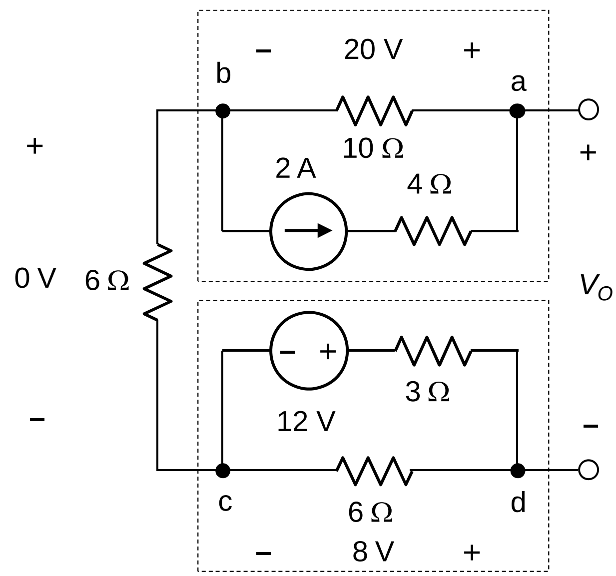
From KCL applied to the dashed rectangles, the current in the 6 Ω resistor is zero.

Hence, V_{ab} = 10×2 = 20 V;

$V_{dc} = 12 \times \frac{6}{9} = 8$ V;

Applying KVL srating at node d and going CW:

-8 + 0 + 20 – Vo = 0, which gives V_O = 12 V.



P2.4.5 Determine V_O in Figure P2.4.5, assuming $\alpha = 3$.

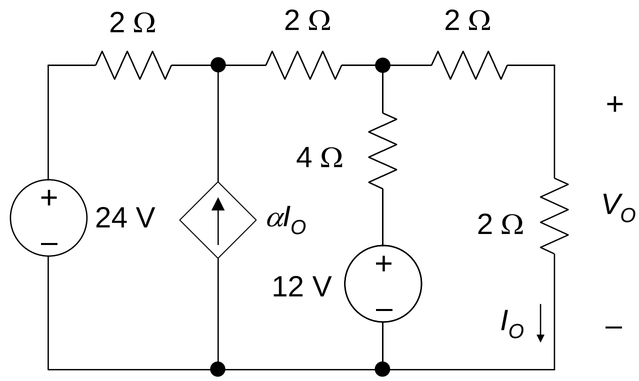
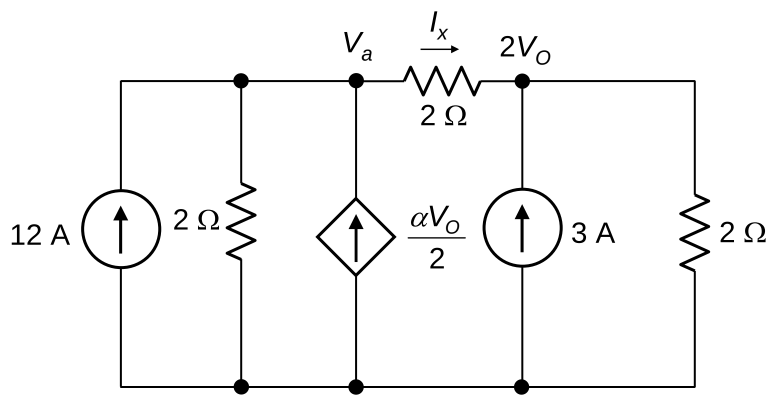


Figure P2.4.5

Solution P2.4.5



Since $I_O = \frac{V_O}{2}$, the dependent current source becomes $\frac{\alpha V_O}{2}$.

The 24 V source in series with 2 Ω is transformed to a 12 A source in parallel with 2 Ω. Similarly, the 12 V source in series with 4 Ω is transformed to a 3 A source in parallel with 4 Ω.

This resistor is then combined with the 4 Ω to give a resistance of 2 Ω in parallel with the 3A source.

The voltage of the upper RHS node is $2V_O$.

KCL for the node on the LHS gives: $12 + \frac{\alpha V_O}{2} = I_x + \frac{V_a}{2}$, where $\frac{V_a}{2}$ is the current that flows away from the node through the 2 Ω resistor.

KCL at the RHS node gives: $3 + I_x = \frac{2V_O}{2}$.

Substituting $I_x = \frac{V_a - 2V_O}{2}$ gives two equations in the two unknowns V_a and V_O:

$V_a - \left(1 + \frac{\alpha}{2}\right)V_O = 12$, and $V_a - 4V_O = -6$.

Eliminating V_a gives: $V_O = \frac{18}{3 - \alpha/2}$.

If $\alpha = 3$, $V_O = 12$ V. Note that if $\alpha = 6$, V_O is indeterminate.

P2.4.12 Find V_{SRC} , V_x, V_Y, I_{SRC}, and the current in each resistor in Figure. P2.4.12.

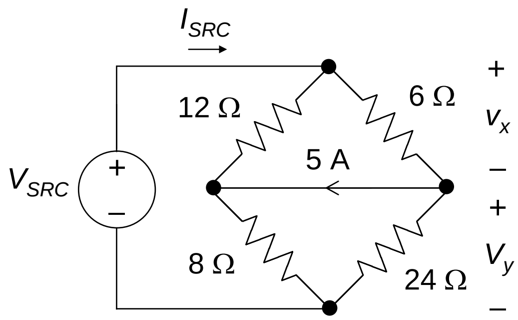
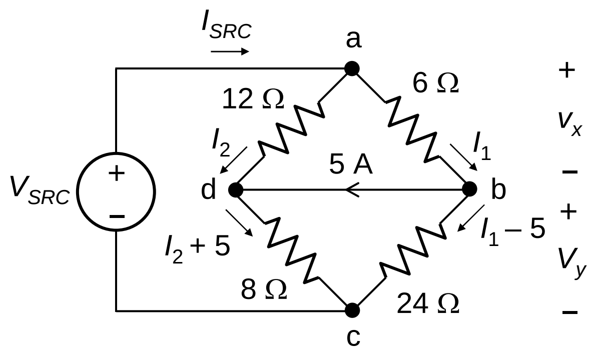


Figure P2.4.12

Solution P2.4.12



Let the current in the 6 Ω resistor be I_1;

from KCL at node b, the current in the 24 Ω resistor is $(I_1 - 5)$ A.

Similarly, if the current in the 12 Ω resistor is I_2, then from KCL at node d, the current in the 8 Ω resistor is $(I_2 + 5)$.

From KVL around mesh abd: $6I_1 = 12I_2$;

from KVL around mesh bcd: $24(I_1 - 5) = 8(I_2 + 5)$.

Solving for I_1 and I_2 gives: $I_1 = 8$ A and $I_2 = 4$ A.

From KCL at node a: $I_{SRC} = I_1 + I_2 = 12$ A;

$V_x = 6I_1 = 48$ V;

$V_y = 24(I_1 - 5) = 72$ V;

hence, $V_{SRC} = V_x + V_y = 120$ V.

It follows that $I_{6\Omega} = 8$ A, $I_{12\Omega} = 4$ A, $I_{24\Omega} = 3$ A, and $I_{8\Omega} = 9$ A.