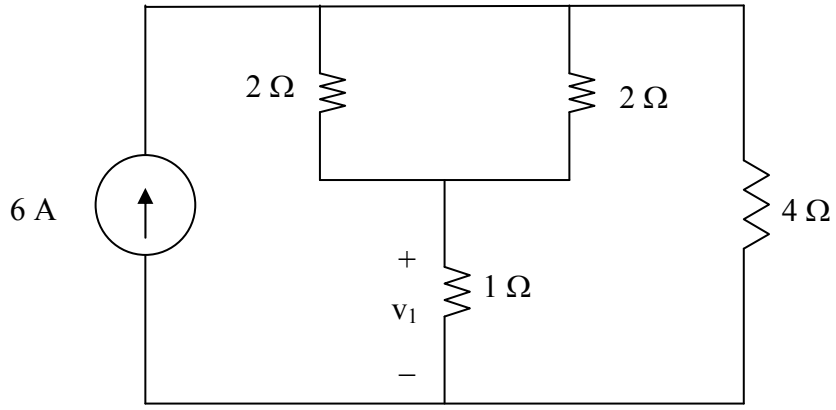
Boise State University
Electrical Engineering Department

EE 210: Circuits I

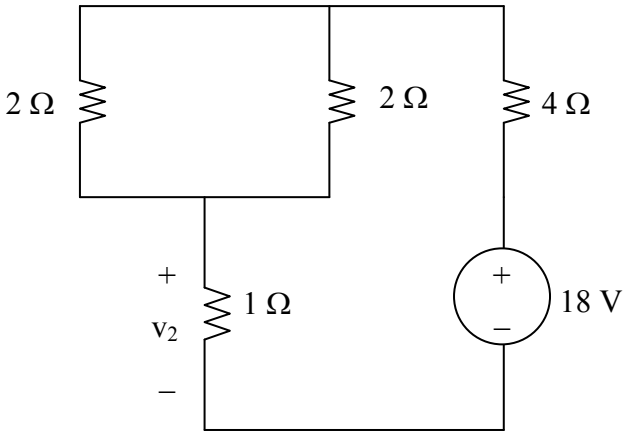
Solution 1

Let $v_o = v_1 + v_2$, where v_1 and v_2 are due to 6-A and 20-V sources respectively. We find v_1 using the circuit below.



$2//2 = 1\ \Omega$, $\quad v_1 = 1x\dfrac{4}{4+2}(6A) = 4\ V$

We find v_2 using the circuit below.

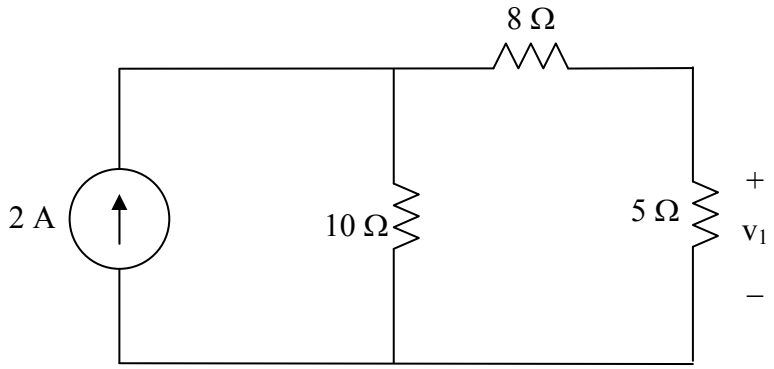


$$v_2 = \frac{1}{1+1+4}(18) = 3\ V$$

$$v_o = v_1 + v_2 = 4 + 3 = \underline{\mathbf{7\ V}}$$

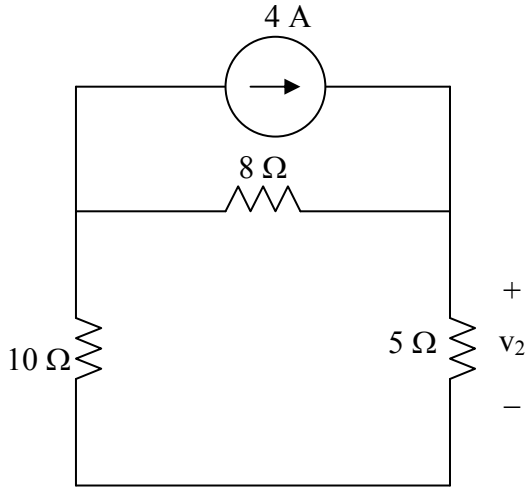
Solution 2

Let $v_o = v_1 + v_2 + v_3$, where v_1, v_2, and v_3 are due to the independent sources. To find v_1, consider the circuit below.



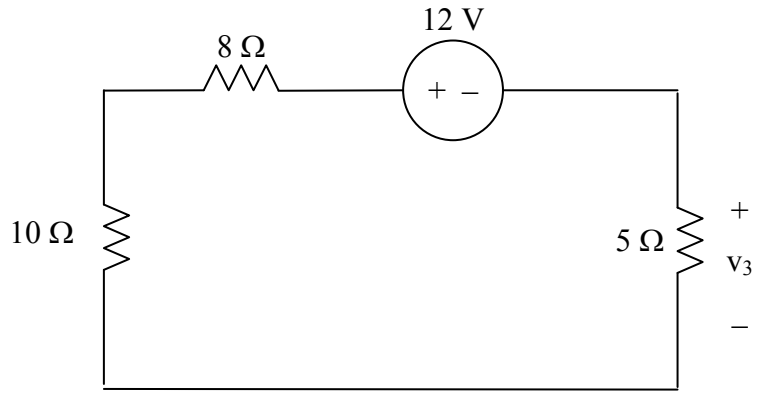
$$v_1 = 5x\frac{10}{10+8+5}x2 = 4.3478$$

To find v_2, consider the circuit below.



$$v_2 = 5x\frac{8}{8+10+5}x4 = 6.9565$$

To find v_3, consider the circuit below.

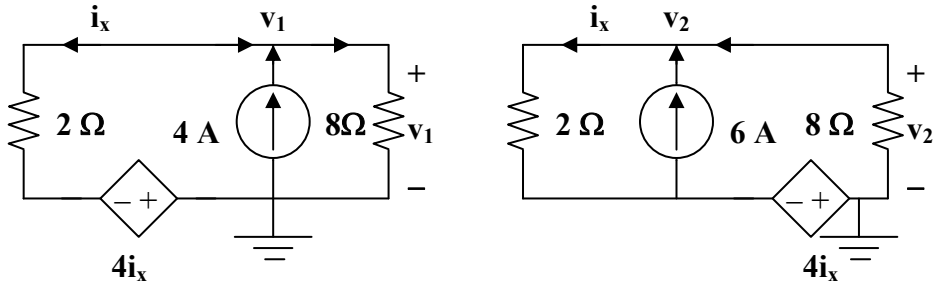


$$v_3 = -12\left(\frac{5}{5+10+8}\right) = -2.6087$$

$$v_o = v_1 + v_2 + v_3 = \underline{8.6956\ \text{V}} = \underline{\mathbf{8.696V}}.$$

Solution 3

Let $v_x = v_1 + v_2$, where v_1 and v_2 are due to the 4-A and 6-A sources respectively.



(a) **(b)**

To find v_1, consider the circuit in Fig. (a).

$$v_1/8 - 4 + (v_1 - (-4i_x))/2 = 0 \text{ or } (0.125+0.5)v_1 = 4 - 2i_x \text{ or } v_1 = 6.4 - 3.2i_x$$

But, $i_x = (v_1 - (-4i_x))/2$ or $i_x = -0.5v_1$. Thus,

$$v_1 = 6.4 + 3.2(0.5v_1), \text{ which leads to } v_1 = -6.4/0.6 = -10.667$$

To find v_2, consider the circuit shown in Fig. (b).

$$v_2/8 - 6 + (v_2 - (-4i_x))/2 = 0 \text{ or } v_2 + 3.2i_x = 9.6$$

But $i_x = -0.5v_2$. Therefore,

$$v_2 + 3.2(-0.5v_2) = 9.6 \text{ which leads to } v_2 = -16$$

Hence, $v_x = -10.667 - 16 = \underline{\mathbf{-26.67V}}$.

Checking,

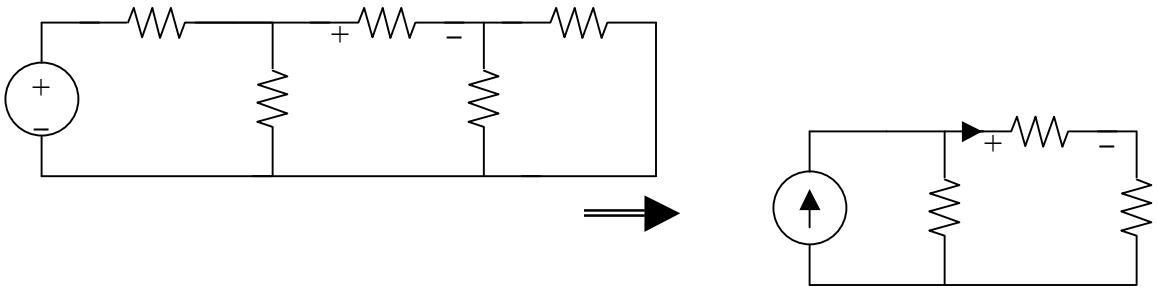
$$i_x = -0.5v_x = 13.333\text{A}$$

Now all we need to do now is sum the currents flowing out of the top node.

$$13.333 - 6 - 4 + (-26.67)/8 = 3.333 - 3.333 = 0$$

Solution 4

Let $v_x = v_{x1} + v_{x2} + v_{x3}$, where v_{x1},v_{x2}, and v_{x3} are due to the 90-V, 6-A, and 40-V sources. For v_{x1}, consider the circuit below.

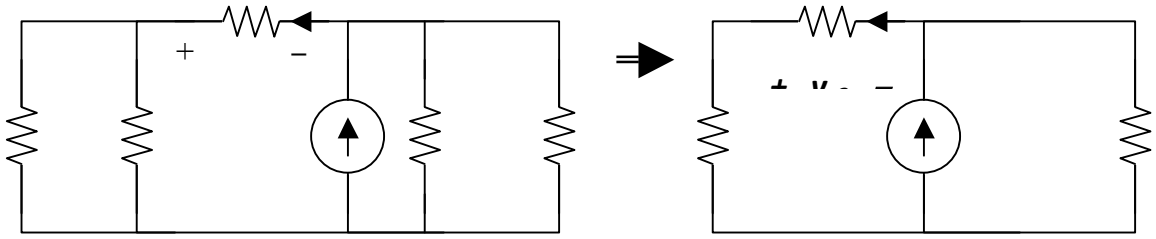


$$20||30 = 12 \text{ ohms}, \quad 60||30 = 20 \text{ ohms}$$

By using current division,

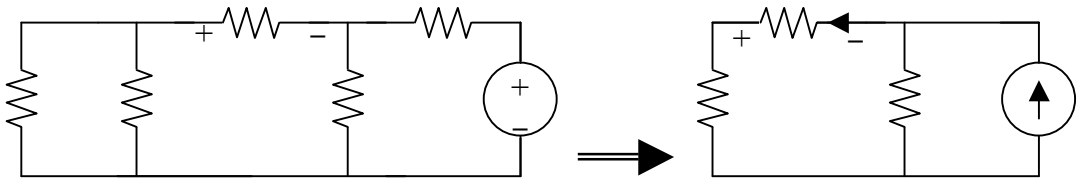
$$i_o = [20/(22 + 20)]3 = 60/42, \quad v_{x1} = 10i_o = 600/42 = 14.286 \text{ V}$$

For v_{x2}, consider the circuit below.



$$i_o' = [12/(12 + 30)]6 = 72/42, \quad v_{x2} = -10i_o' = -17.143 \text{ V}$$

For v_{x3}, consider the circuit below.



$$i_o'' = [12/(12 + 30)]2 = 24/42, \quad v_{x3} = -10i_o'' = -5.714 = [12/(12 + 30)]2 = 24/42, \quad v_{x3} = -10i_o'' = -5.714$$
$$= [12/(12 + 30)]2 = 24/42, \quad v_{x3} = -10i_o'' = -5.714$$
$$v_x = 14.286 - 17.143 - 5.714 = \underline{\mathbf{-8.571 \text{ V}}}$$