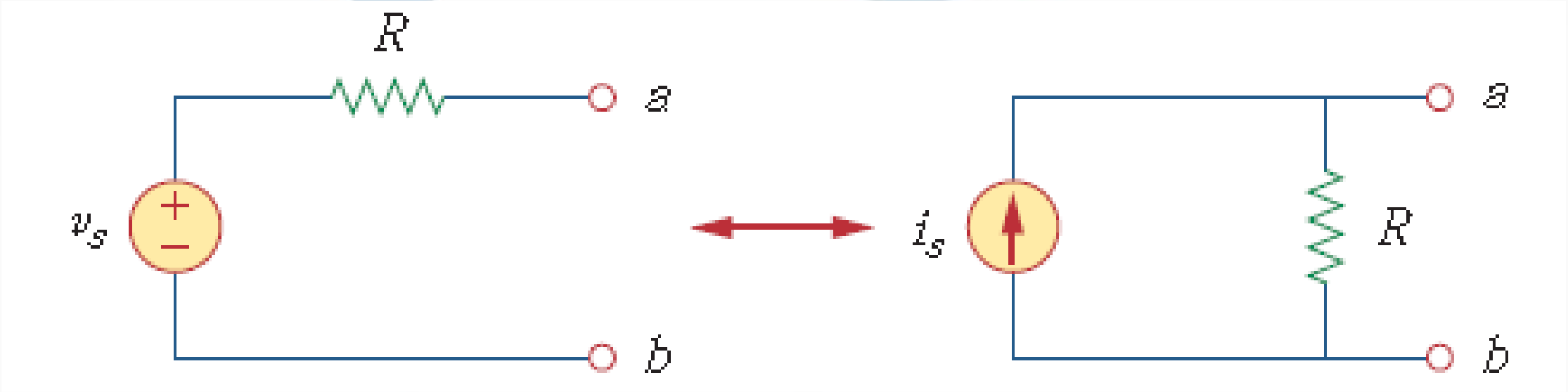
Source Transfomation

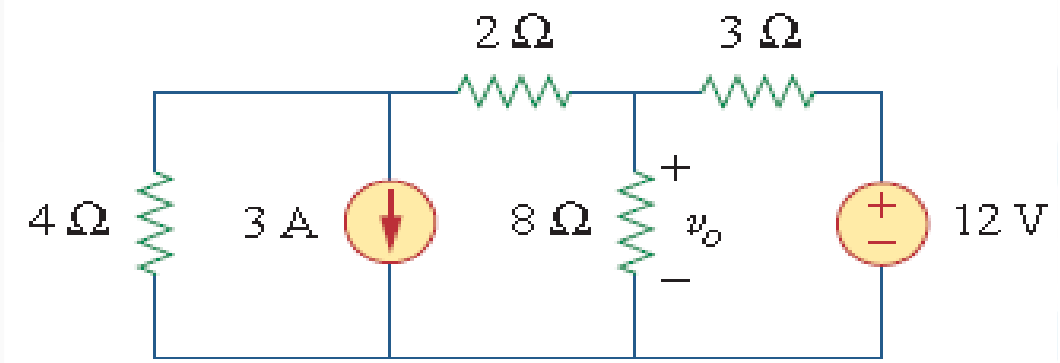


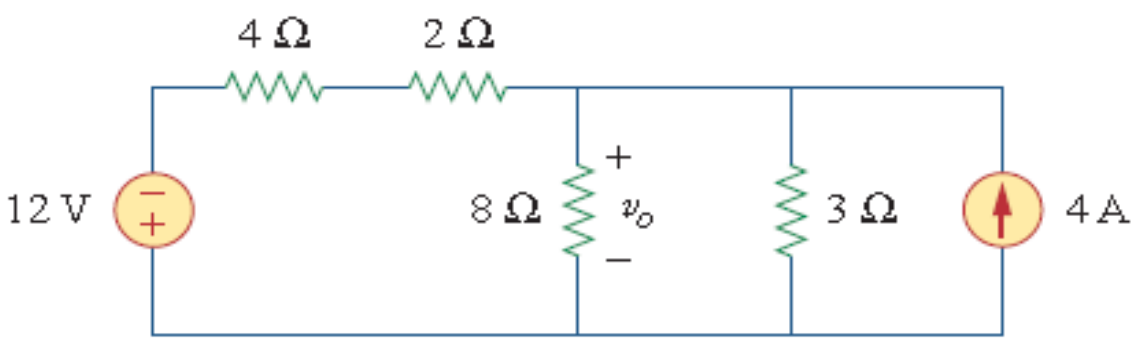
$$v_s = i_s R \qquad \text{or} \qquad i_s = \frac{v_s}{R}$$

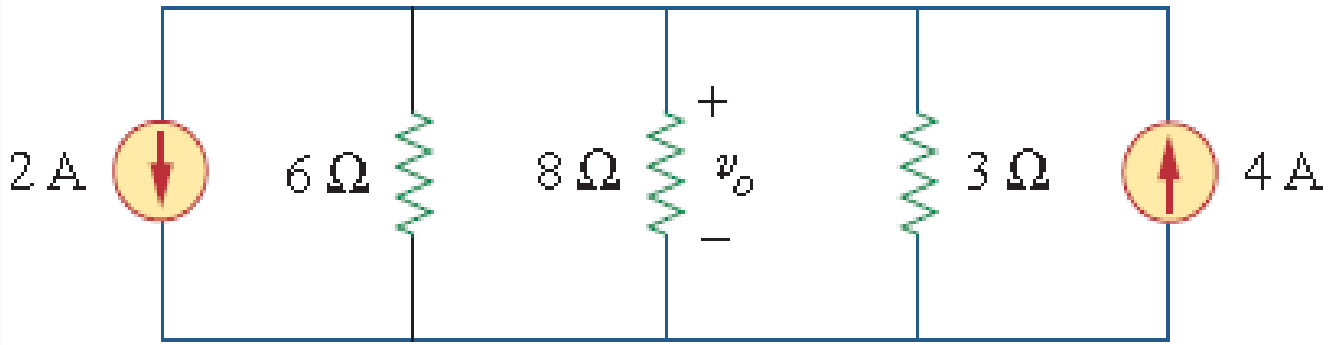
Robotics

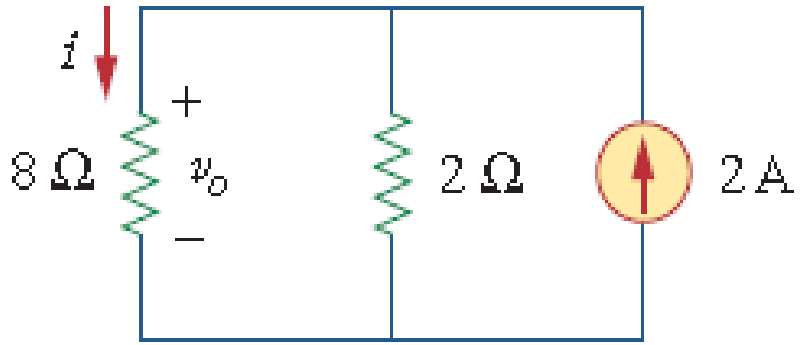
Robotics

Example Use source transformation to find v_o in the circuit of Fig.





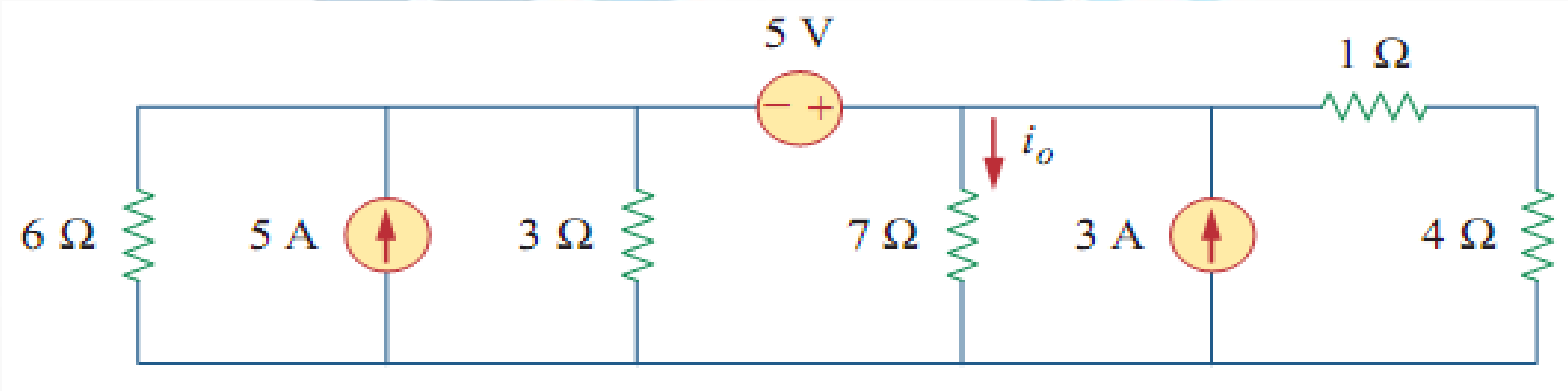




$$i = \frac{2}{2+8}(2) = 0.4\ \text{A}$$

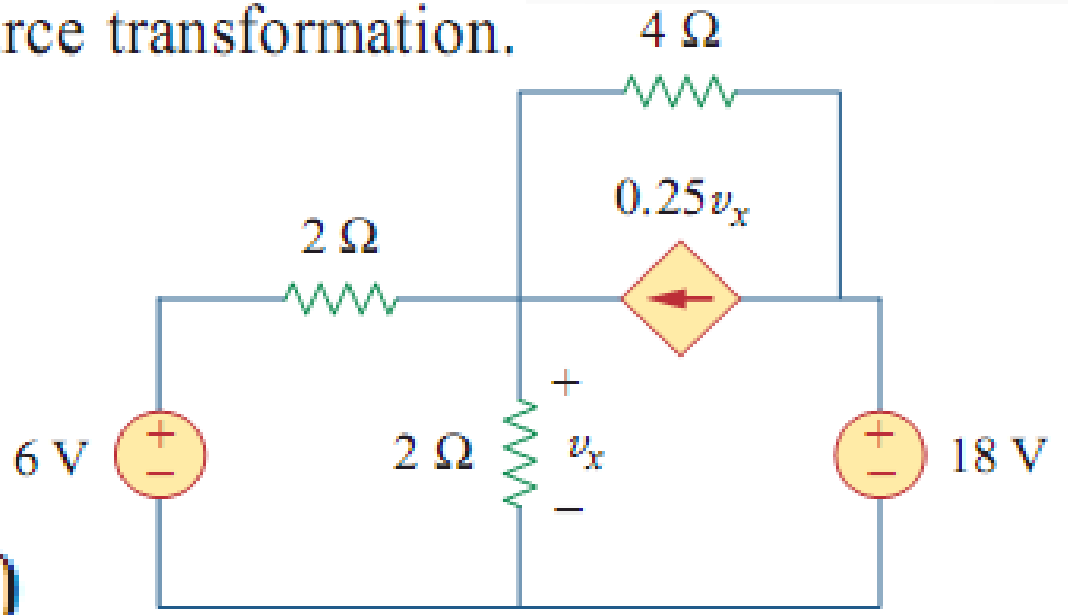
$$v_o = 8i = 8(0.4) = 3.2\ \text{V}$$

Practice Problem Find i_o in the circuit of Fig. using source transformation.

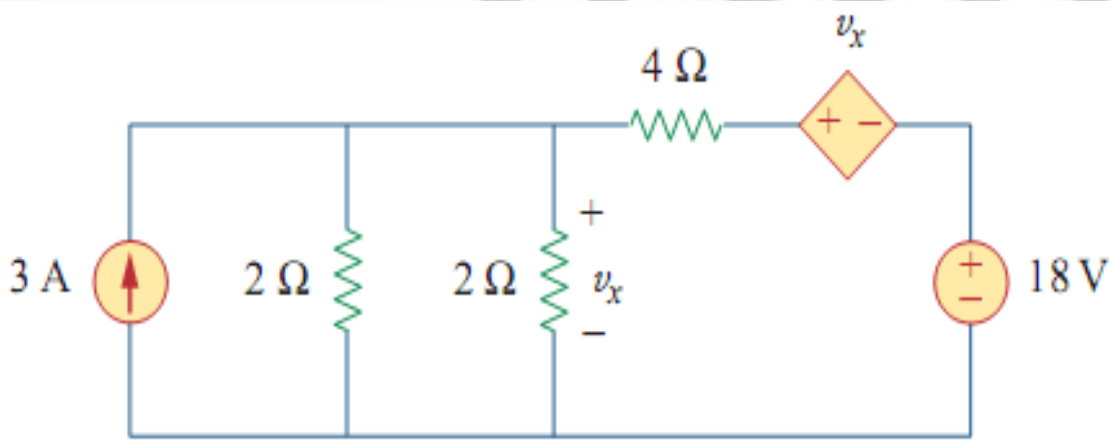


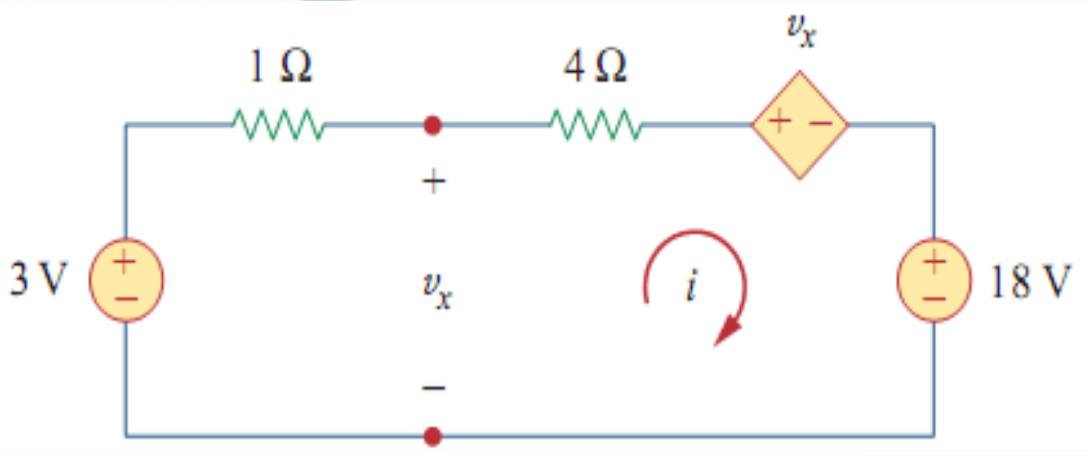
Answer: 1.78 A.

Example Find v_x in Fig. using source transformation.



$$-3 + 5i + v_x + 18 = 0$$





Applying KVL to the loop containing only the 3-V voltage source, the 1-Ω resistor, and v_x yields $-3 + 1i + v_x = 0 \quad \Rightarrow \quad v_x = 3 - i$

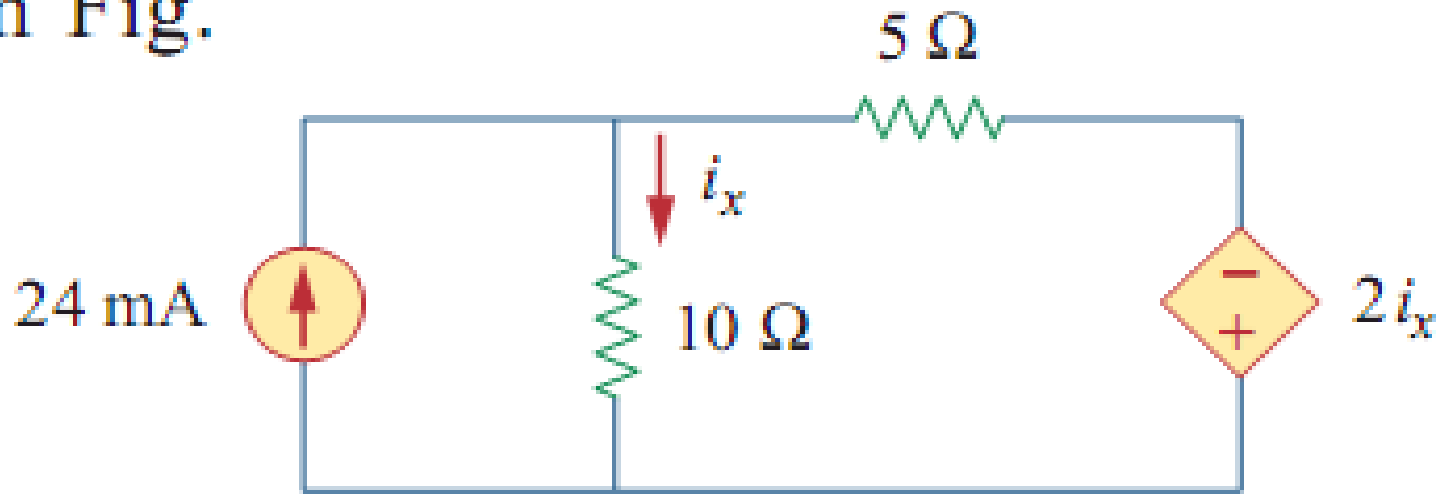
$$15 + 5i + 3 - i = 0 \quad \Rightarrow \quad i = -4.5 \text{ A}$$

$$-v_x + 4i + v_x + 18 = 0 \quad \Rightarrow \quad i = -4.5 \text{ A}$$

Thus, $v_x = 3 - i = 7.5$ V.

Practice Problem Use source transformation to find i_x in the circuit shown in Fig.

Answer: 7.056 mA.



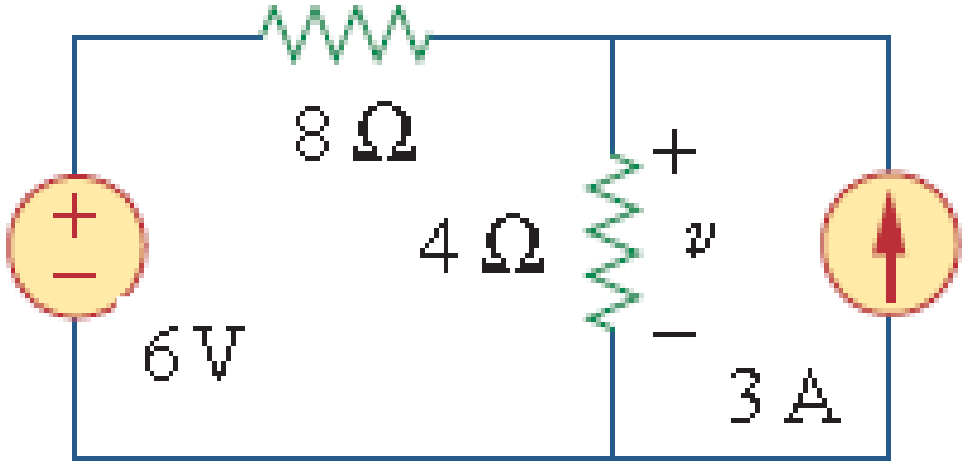
Superposition

Steps to Apply Superposition Principle:

1. Turn off all independent sources except one source. Find the output (voltage or current) due to that active source using the techniques covered in Chapters 2 and 3.
2. Repeat step 1 for each of the other independent sources.
3. Find the total contribution by adding algebraically all the contributions due to the independent sources.

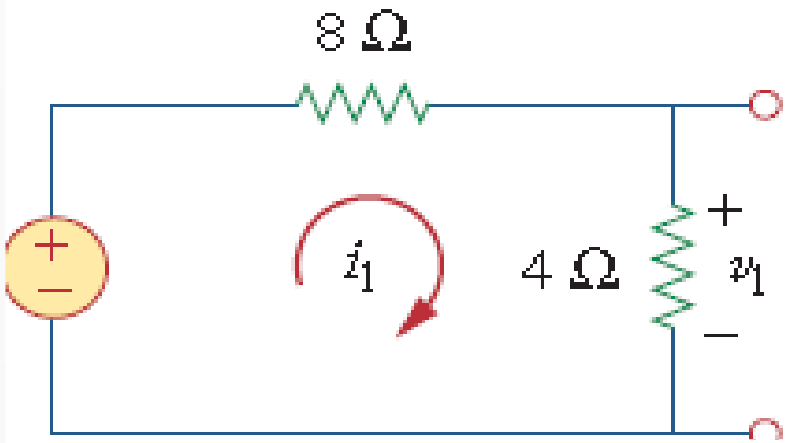
Example

Use the superposition theorem to find v in the circuit of Fig.

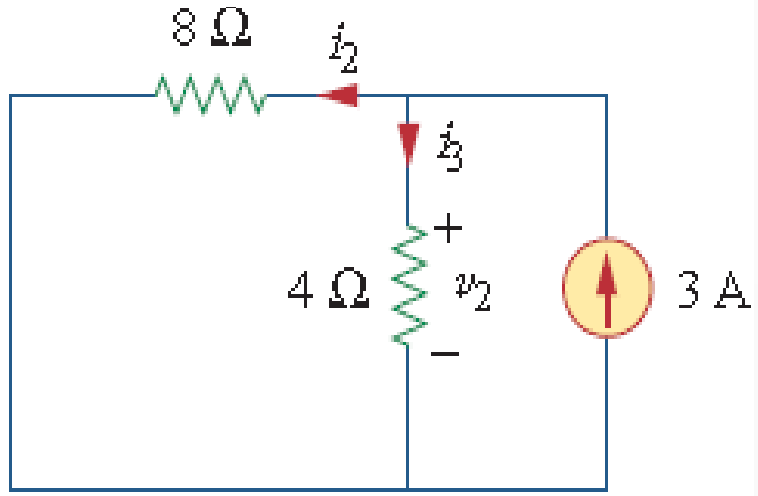


$$v_1 = \frac{4}{4+8}(6) = 2\,\text{V}$$

$$v_1 = 4i_1 = 2\,\text{V}$$



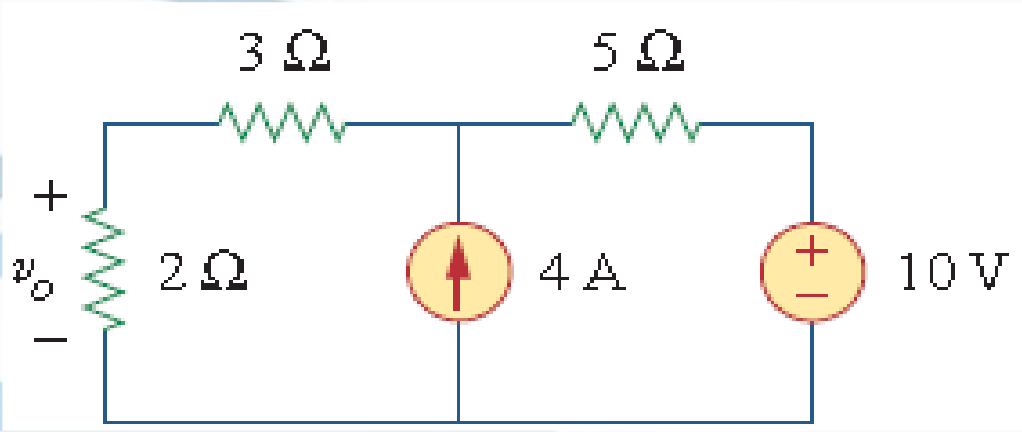
$$i_3 = \frac{8}{4+8}(3) = 2\,\text{A}$$



$$v_2 = 4i_3 = 8\,\text{V}$$

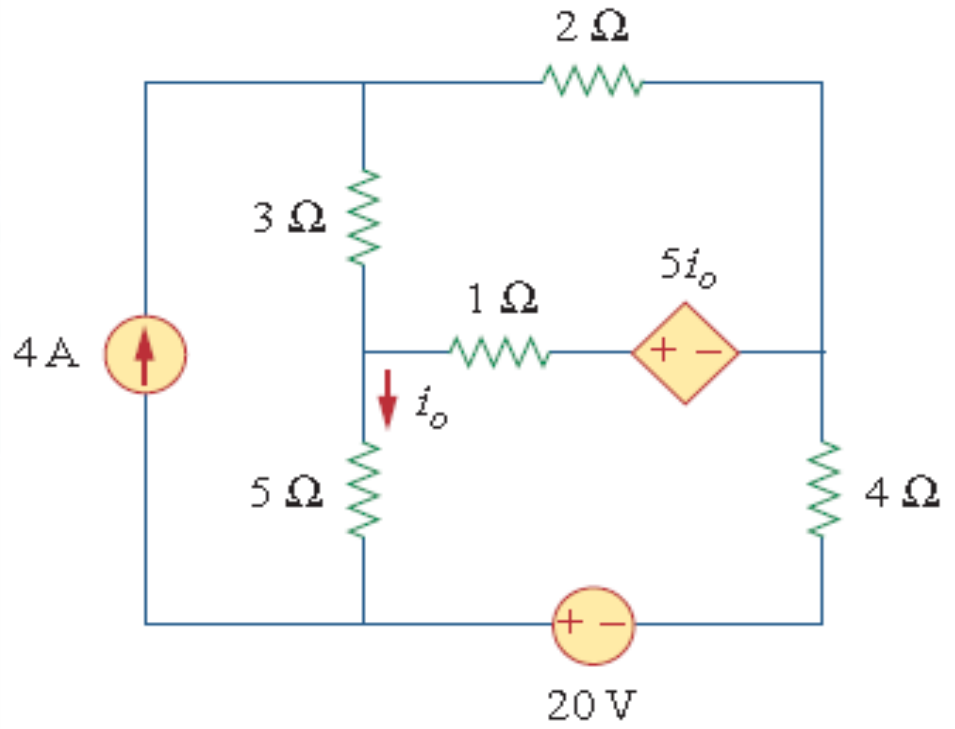
$$v = v_1 + v_2 = 2 + 8 = 10\,\text{V}$$

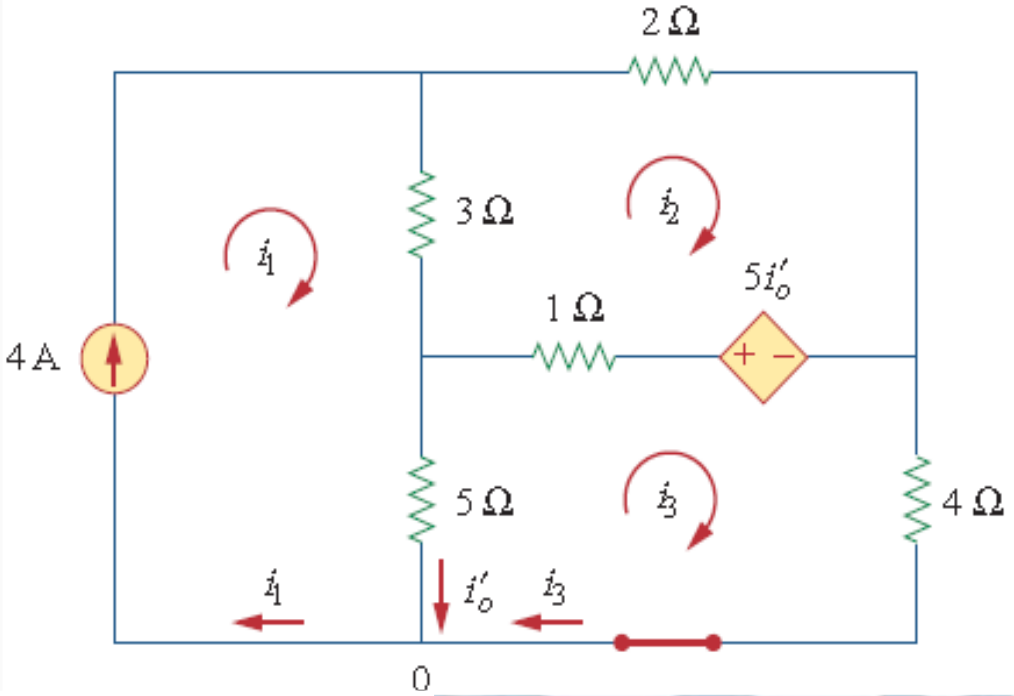
Practice Problem Using the superposition theorem, find v_o in the circuit of Fig.

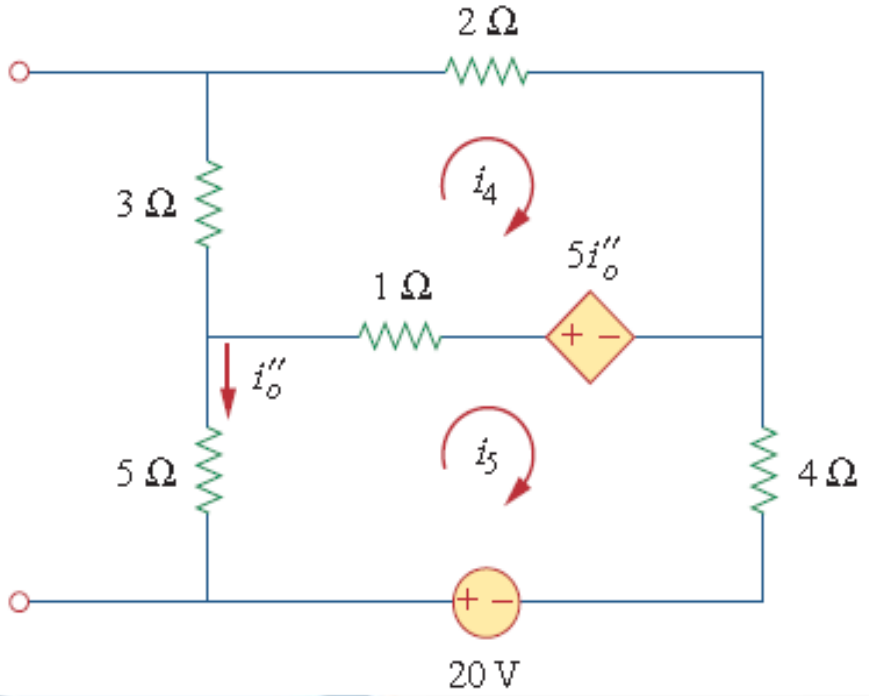


Answer: 6 V.

Example Find i_o in the circuit using superposition.







$$i_o = i'_o + i''_o \qquad i_1 = 4\ \text{A} \qquad \text{For loop 2,}\quad -3i_1 + 6i_2 - 1i_3 - 5i'_o = 0$$

$$\text{For loop 3,}\quad -5i_1 - 1i_2 + 10i_3 + 5i'_o = 0 \qquad \text{But at node 0,}\quad i_3 = i_1 - i'_o = 4 - i'_o$$

$$3i_2 - 2i'_o = 8$$

$$i_2 + 5i'_o = 20$$

$$i'_o = \frac{52}{17}\ \text{A}$$

$$\text{For loop 4,}\quad 6i_4 - i_5 - 5i''_o = 0$$

$$\text{and for loop 5,}\quad -i_4 + 10i_5 - 20 + 5i''_o = 0$$

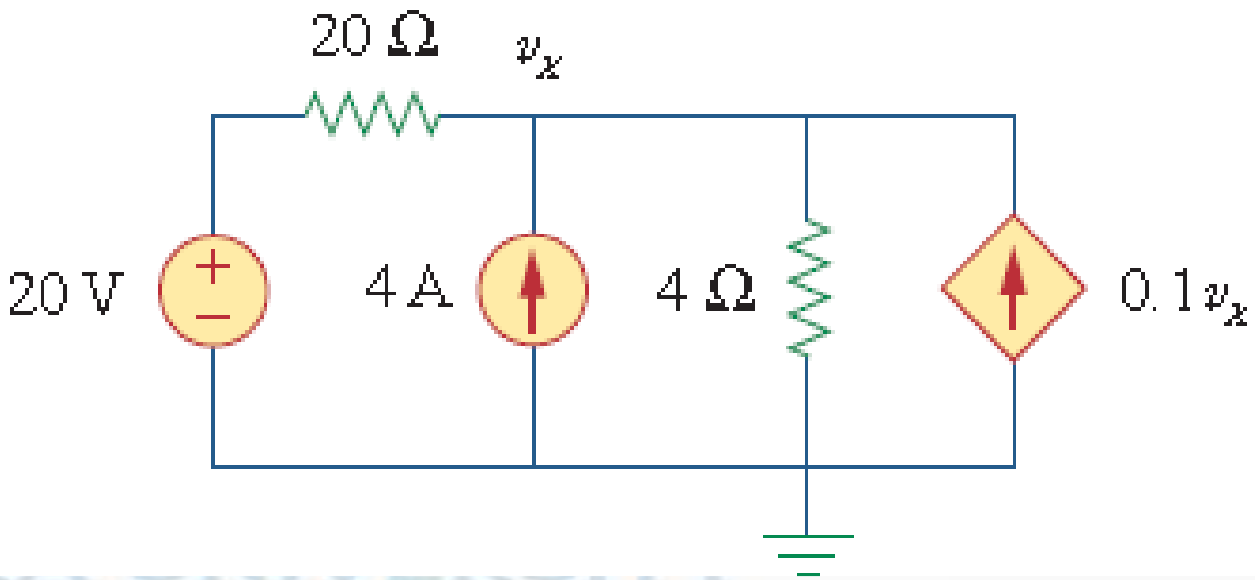
$$6i_4 - 4i_o'' = 0$$
$$i_4 + 5i_o'' = -20$$

$$i_o'' = -\frac{60}{17}\,\text{A}$$

$$i_o = -\frac{8}{17} = -0.4706\,\text{A}$$

Practice Problem

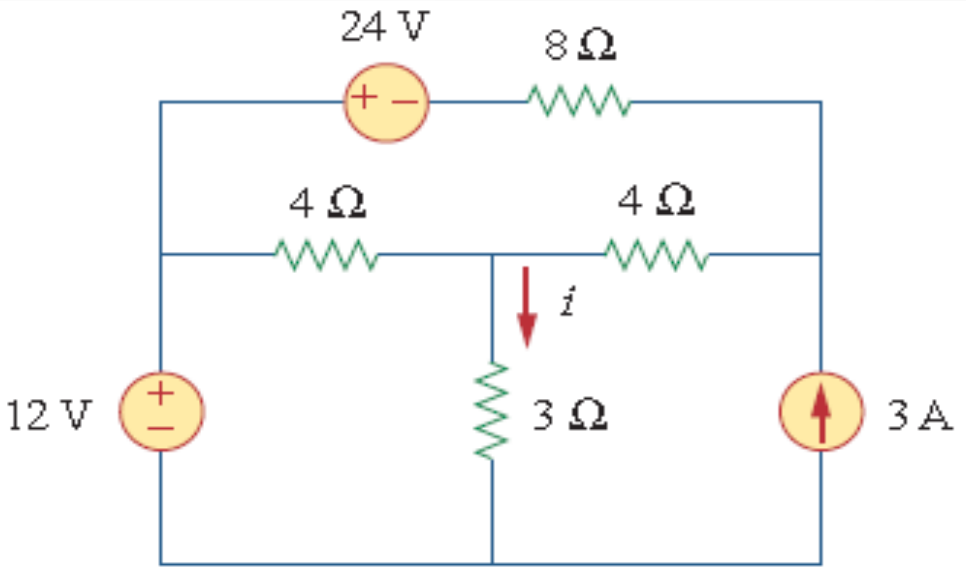
Use superposition to find v_x in the circuit of Fig.

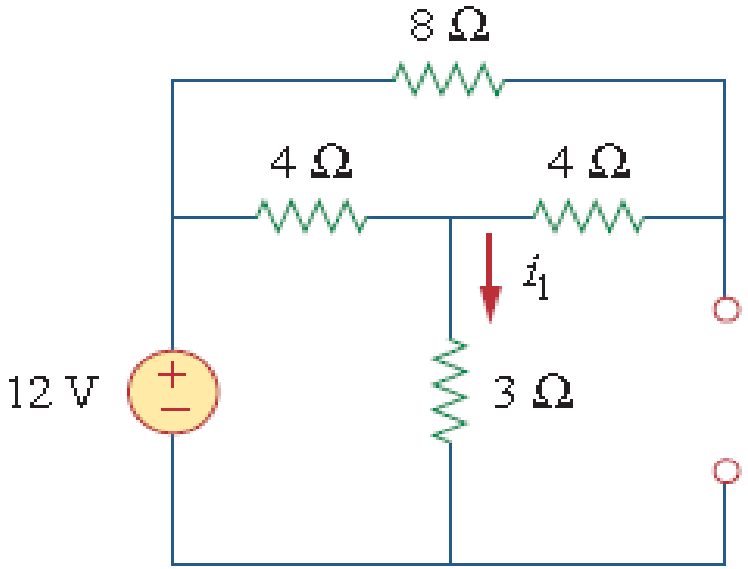


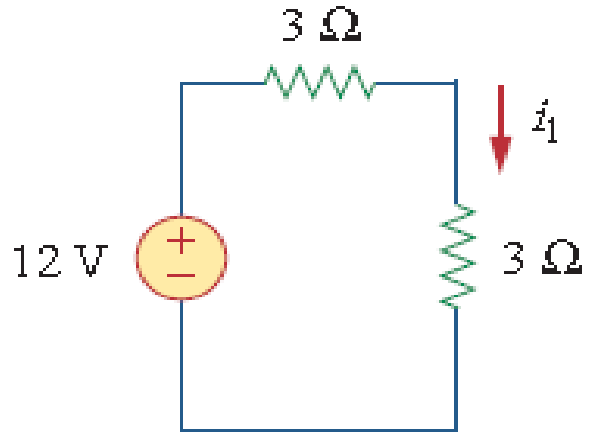
Answer: $v_x = 25$ V.

Example use the superposition theorem to

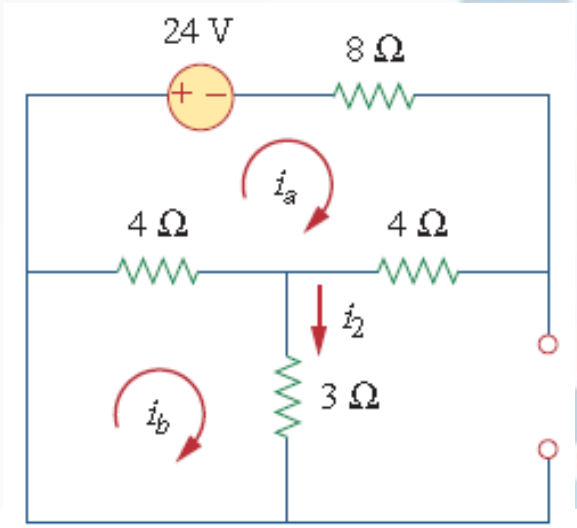
$$i = i_1 + i_2 + i_3$$







$$i_1 = \frac{12}{6} = 2\ \text{A}$$

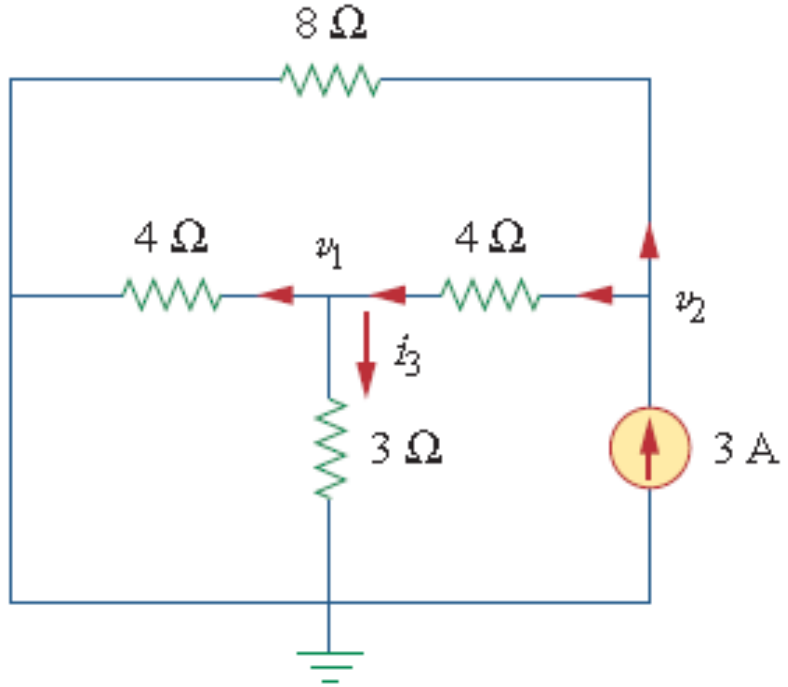


$$16i_a - 4i_b + 24 = 0 \quad \Rightarrow \quad 4i_a - i_b = -6$$

$$7i_b - 4i_a = 0 \quad \Rightarrow \quad i_a = \frac{7}{4}i_b$$

$$i_2 = i_b = -1$$

$$3 = \frac{v_2}{8} + \frac{v_2 - v_1}{4} \quad \Rightarrow \quad 24 = 3v_2 - 2v_1$$



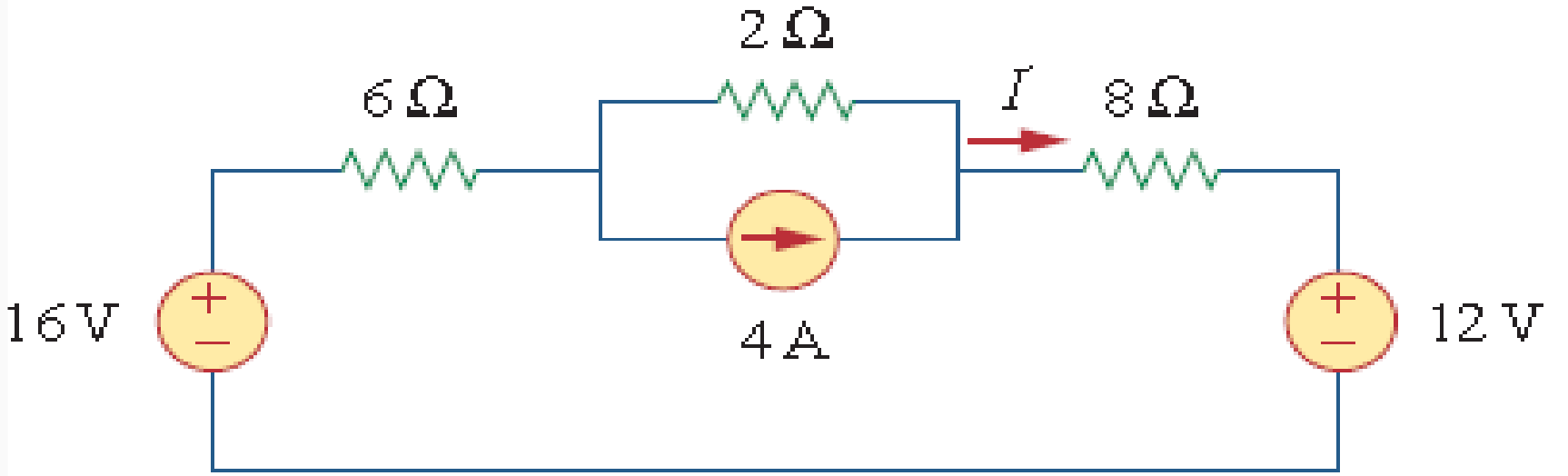
$$\frac{v_2 - v_1}{4} = \frac{v_1}{4} + \frac{v_1}{3} \quad \Rightarrow \quad v_2 = \frac{10}{3}v_1$$

$$i_3 = \frac{v_1}{3} = 1\ \text{A}$$

$$i = i_1 + i_2 + i_3 = 2 - 1 + 1 = 2\ \text{A}$$

Practice Problem

Find I in the circuit of Fig. using the superposition principle.



Answer: 0.75 A.