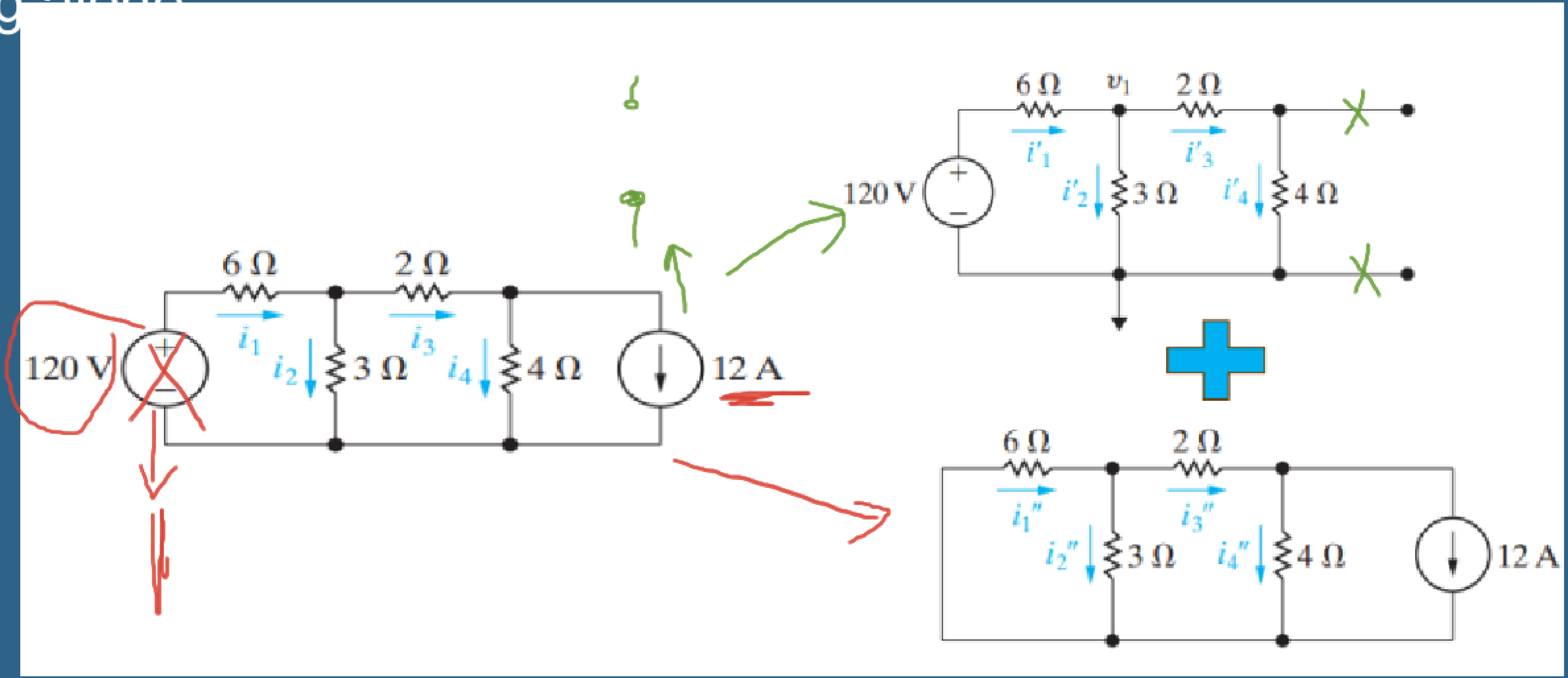
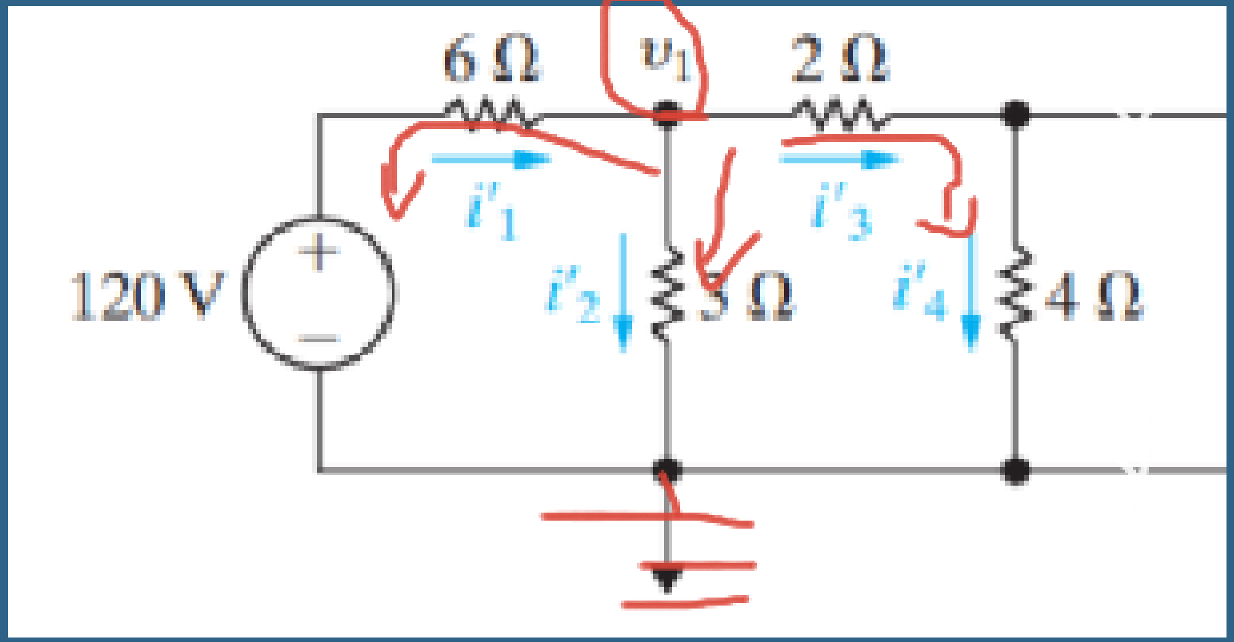
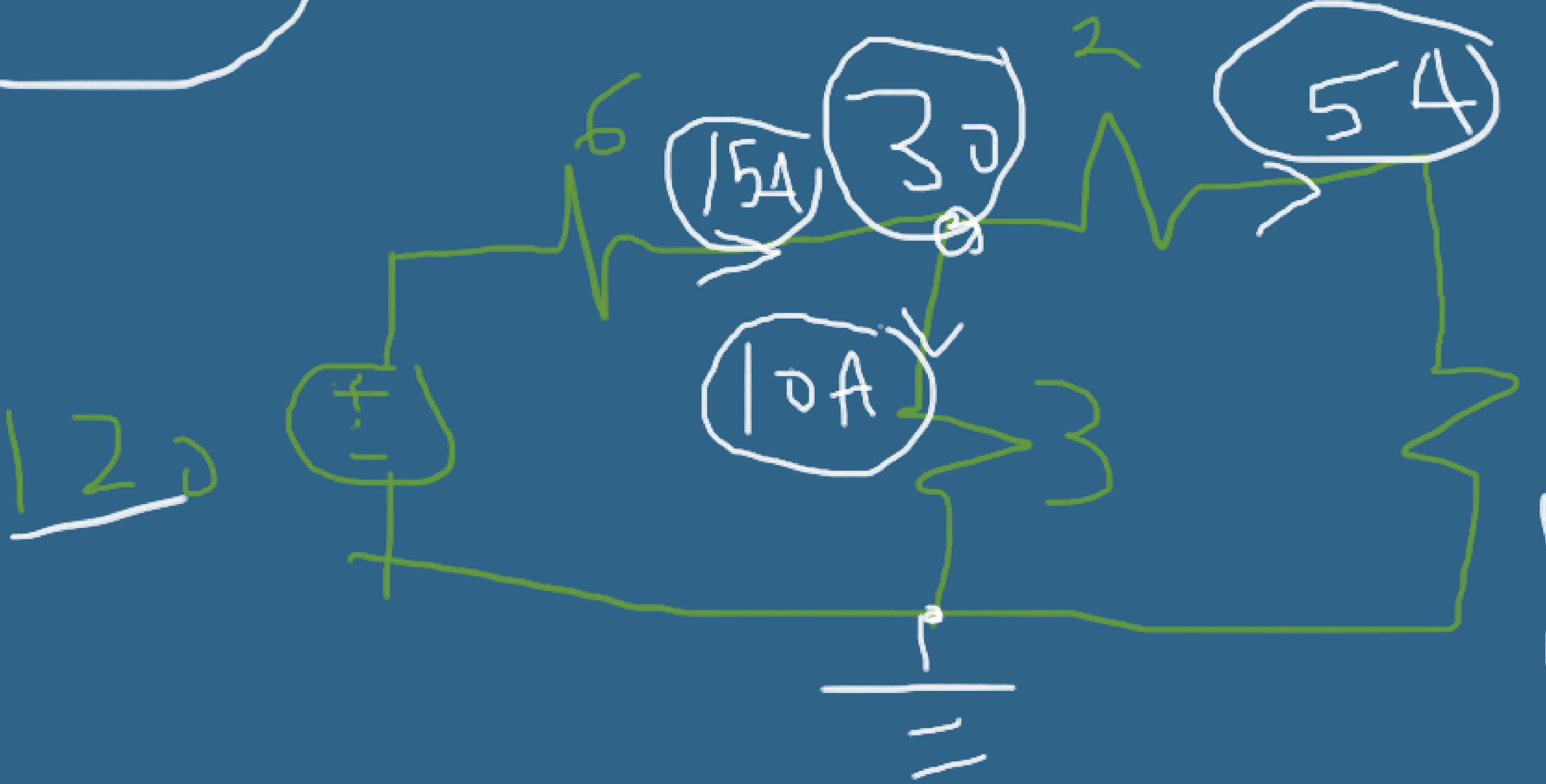
Superposition states that whenever a ~~linear system~~ is excited, or driven, by more than one ~~independent source~~ of energy, the ~~total response~~ is the ~~sum of the individual responses.~~
An individual response is the result of an ~~independent source~~ acting alone.



$$\frac{V_1 - 120}{6} + \frac{V_1 - 0}{3} + \frac{V_1 - 0}{6} = 0$$

$$V_1 = 30V$$



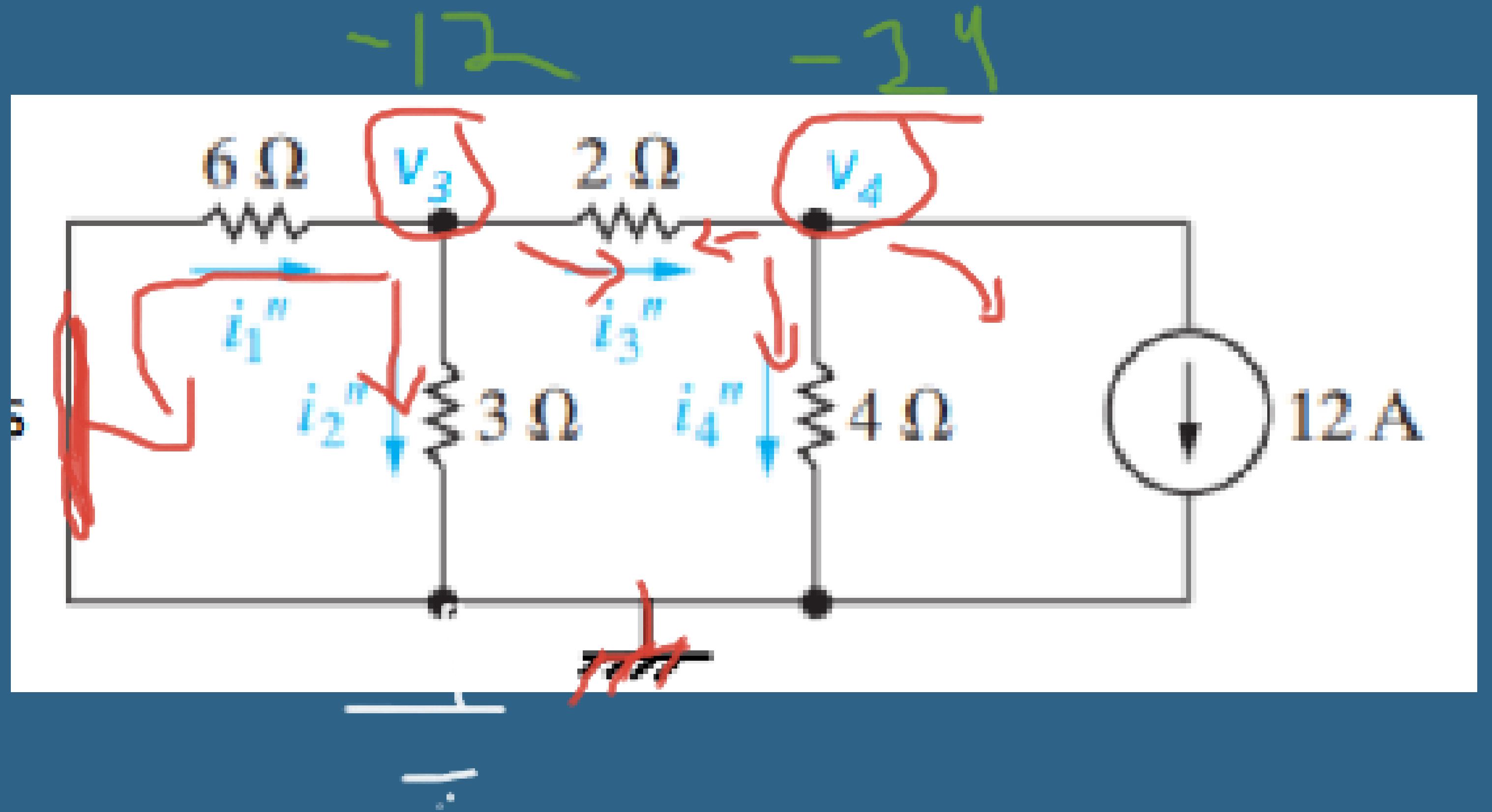


Due to 120V Voltage Src

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

$$\frac{V_4 - V_3}{2} + \frac{V_4 - 0}{4} + 12 = 0$$

$V_3 = -12$ $\boxed{V_4 = -24V}$

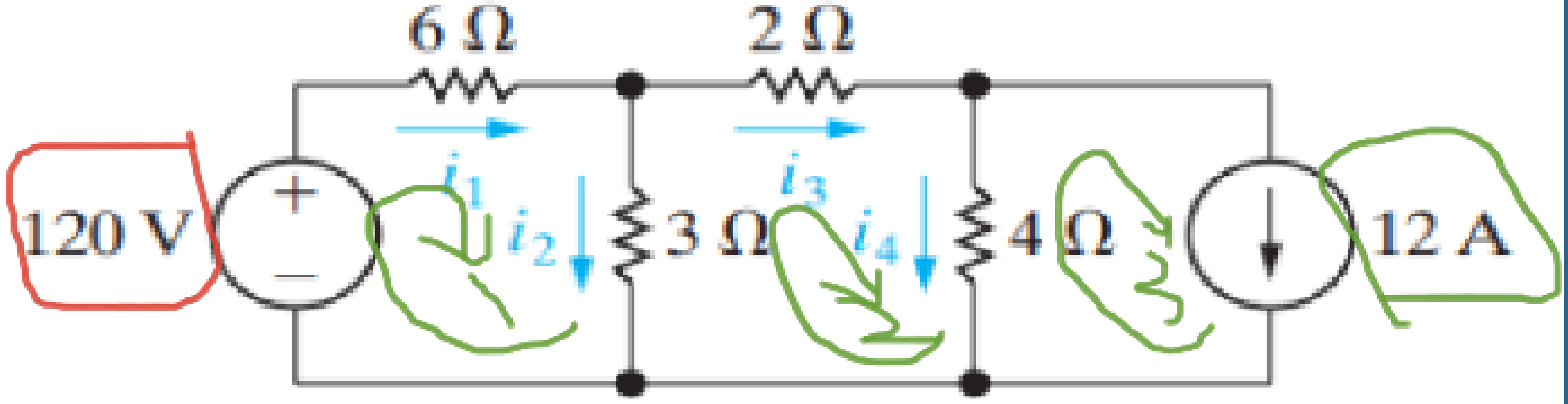


$$i_1 = i_1' + i_1'' = 15 + 2 = 17 \text{ A},$$

$$i_2 = i_2' + i_2'' = 10 - 4 = 6 \text{ A},$$

$$i_3 = i_3' + i_3'' = 5 + 6 = 11 \text{ A},$$

$$i_4 = i_4' + i_4'' = 5 - 6 = -1 \text{ A}.$$



Real-world applications (sensitivity Analysis)

- It is not possible to fabricate identical electrical components.

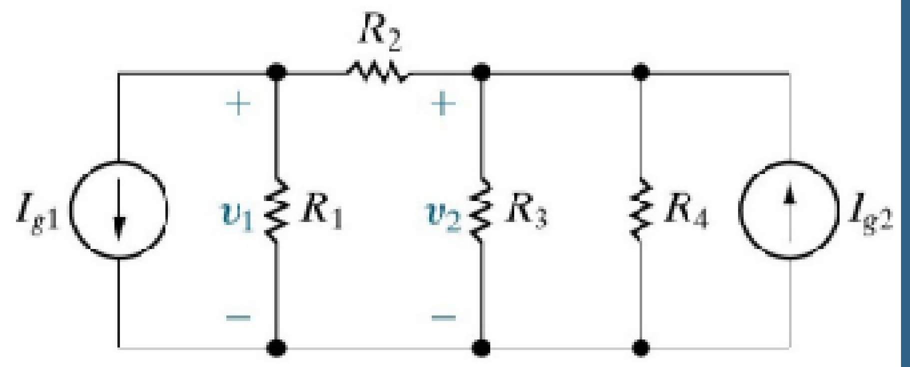
- For example, resistors produced from the same manufacturing process can vary in value by as much as 20%.

- Therefore, in creating an electrical system, the designer must consider the impact that component variation will have on the performance of the system.

- Sensitivity analysis permits the designer to calculate the impact of variations in the component values on the output of the system.

$$v_1 = \frac{R_1\{R_3R_4I_{g2} - [R_2(R_3 + R_4) + R_3R_4]I_{g1}\}}{(R_1 + R_2)(R_3 + R_4) + R_3R_4},$$

$$v_2 = \frac{R_3R_4[(R_1 + R_2)I_{g2} - R_1I_{g1}]}{(R_1 + R_2)(R_3 + R_4) + R_3R_4}.$$



$$\frac{dv_1}{dR_1} = \frac{[R_3R_4 + R_2(R_3 + R_4)]\{R_3R_4I_{g2} - [R_3R_4 + R_2(R_3 + R_4)]I_{g1}\}}{[(R_1 + R_2)(R_3 + R_4) + R_3R_4]^2}, \quad (4.47)$$

$$\frac{dv_2}{dR_1} = \frac{R_3R_4\{R_3R_4I_{g2} - [R_2(R_3 + R_4) + R_3R_4]I_{g1}\}}{[(R_1 + R_2)(R_3 + R_4) + R_3R_4]^2}. \quad (4.48)$$

Assume the nominal values of the components in the circuit in Fig. 4.74 are: $R_1 = 25\ \Omega$; $R_2 = 5\ \Omega$; $R_3 = 50\ \Omega$; $R_4 = 75\ \Omega$; $I_{g1} = 12$ A; and $I_{g2} = 16$ A. Use sensitivity analysis to predict the values of v_1 and v_2 if the value of R_1 is different by 10% from its nominal value.

$$v_1 = \frac{25\{3750(16) - [5(125) + 3750]12\}}{30(125) + 3750} = 25 \text{ V}$$

$$v_2 = \frac{3750[30(16) - 25(12)]}{30(125) + 3750} = 90 \text{ V}$$

$$\frac{dv_1}{dR_1} = \frac{[3750 + 5(125)] - \{3750(16) - [3750 + 5(125)]12\}}{[(30)(125) + 3750]^2}$$

$$= \frac{7}{12} \text{ V}/\Omega,$$

$\pm 1\Omega \rightarrow \pm \frac{7}{12}$ V

$$\frac{dv_2}{dR_1} = \frac{3750\{3750(16) - [5(125) + 3750]12\}]}{(7500)^2}$$

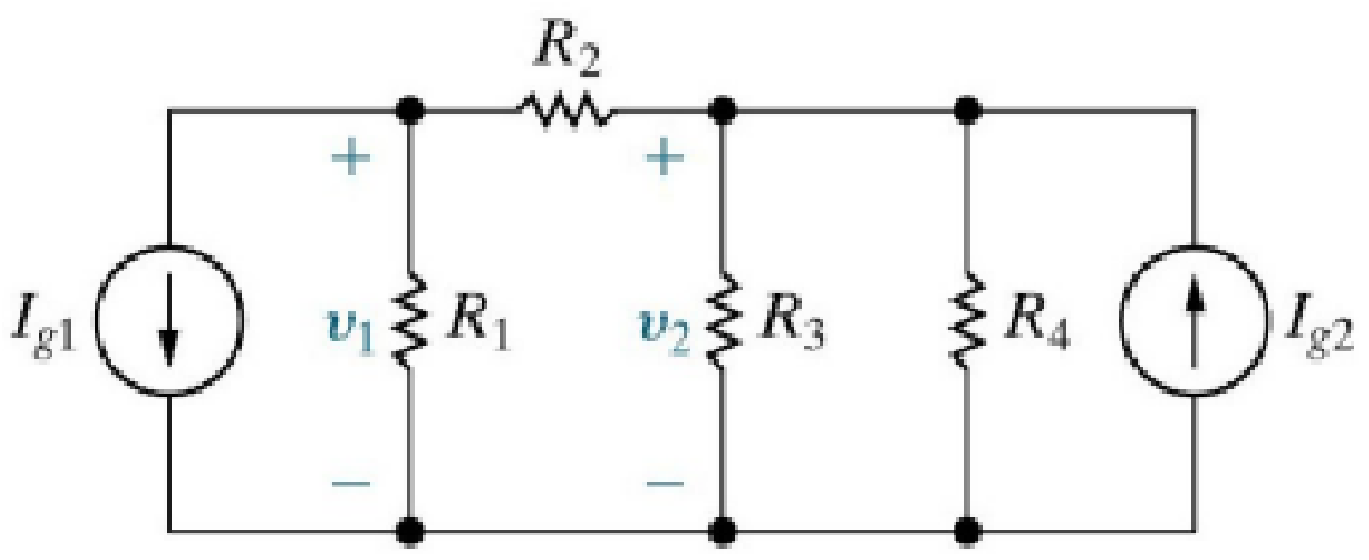
$$= 0.5 \text{ V}/\Omega.$$

that R_1 is 10% less than its nominal value, that is, $R_1 = 22.5\ \Omega$. Then $\Delta R_1 = -2.5\ \Omega$ and Eq. 4.51 predicts that Δv_1 will be

$$\Delta v_1 = \left(\frac{7}{12}\right)(-2.5) = \boxed{-1.4583 \text{ V.}} \quad v_1 = 25 - 1.4583 = \boxed{23.5417 \text{ V}}$$

$$\Delta v_2 = 0.5(-2.5) = -1.25 \text{ V},$$

$$v_2 = 90 - 1.25 = 88.75 \text{ V}.$$



$$v_1 = 23.4780 \text{ V},$$

$$v_2 = 88.6960 \text{ V}.$$

that for a 10% change in R_1, the percent error between the predicted and exact values of v_1 and v_2 is small. Specifically, the percent error in $v_1 = 0.2713\%$ and the percent error in $v_2 = 0.0676\%$.