Network Theorems-4 (`EC_network_4.sqproj`)

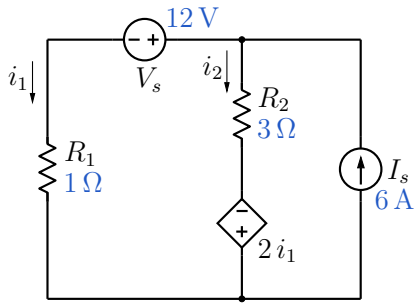

Figure 1: Superposition theorem example.

Question: For the circuit shown in Fig. 1,

(a) Find the current i_2 using superposition.

(b) Using the results of (a), find i_2 for $V_s = 8\,\text{V}$ and $I_s = 2\,\text{A}$.

Solution:

(a) We consider two cases: (i) only V_s active, (ii) only I_s active. In each case, we find i_2 and then add the two values to get the net value of i_2.

(i) Only V_s active: The current source I_s is deactivated (i.e., made equal to 0 A) in this case and is represented by an open circuit. The circuit then reduces to that shown in Fig. 2. KVL gives

$$R_1 i_1 + 2\,i_1 + R_2 i_1 + 12 = 0 \;\rightarrow\; i_1 = -2\,\text{A} \;\rightarrow\; i_2^{(1)} = 2\,\text{A}. \tag{1}$$

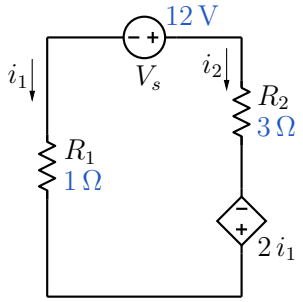

Figure 2: Circuit of Fig. 1 with I_s deactivated.

(ii) Only I_s active: The voltage source V_s is deactivated (i.e., made equal to 0 V) in this case and is represented by a short circuit. The circuit then reduces to that shown in Fig. 3. KCL at node A gives $i_2 = 6 - i_1$ which can be used to write the following KVL equation.

$$R_1 i_1 + 2\,i_1 - R_2(6 - i_1) = 0 \;\rightarrow\; i_1 = 3\,\text{A} \;\rightarrow\; i_2^{(2)} = 6 - 3 = 3\,\text{A}. \tag{2}$$

The net value of i_2 is therefore $i_2 = i_2^{(1)} + i_2^{(2)} = 5\,\text{A}$.

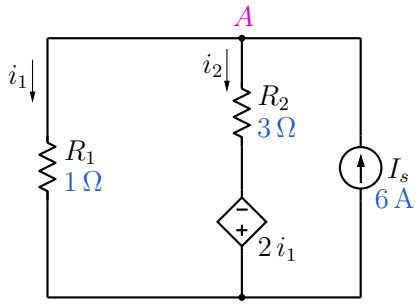

Figure 3: Circuit of Fig. 1 with V_s deactivated.

(b) In case (i) of part (a), since there is only one independent source in the circuit, we can write

$$i_2^{(1)} = k_1 V_s, \tag{3}$$

where $k_1 = \dfrac{2\,\text{A}}{12\,\text{V}} = \dfrac{1}{6}\,\text{℧}$.

Similarly, in case (ii) of part (a), we have

$$i_2^{(2)} = k_2 I_s, \tag{4}$$

where $k_2 = \dfrac{3\,\text{A}}{6\,\text{A}} = \dfrac{1}{2}$.

Using superposition, we have

$$i_2 = i_2^{(1)} + i_2^{(2)} = k_1 V_s + k_2 I_s = \left(\frac{1}{6}\,\text{℧}\right) \times V_s + \frac{1}{2} \times I_s. \tag{5}$$

Substituting $V_s = 2\,\text{V}$, $I_s = 2\,\text{A}$, we obtain

$$i_2 = \frac{1}{6} \times 8 + \frac{1}{2} \times 2 = 2.33\,\text{A}. \tag{6}$$

SequelApp Exercises:

1. For the circuit shown in Fig. 1, let $R_1 = 4\,\Omega$, with all other component values as shown in the figure.

   (i) Find the current i_2 using superposition.

   (ii) Using the results of (a), find i_2 for $V_s = 4\,\mathrm{V}$ and $I_s = 8\,\mathrm{A}$.

2. For the circuit shown in Fig. 1, find the value of R_1 which will give $i_2 = 5.4\,\mathrm{A}$, with all other component values as shown in the figure.

Verify your answers using SequelApp.