Ex:

\[ R_1 = 1 \text{ k}\Omega \quad R_3 = 1.5 \text{ k}\Omega \]

\[ v_s = 12 \text{ V} \quad R_2 = 3 \text{ k}\Omega \quad i_s = 2 \text{ mA} \]

Find the Thevenin equivalent circuit at terminals a-b.

**SOL’N:** \( V_{Th} \) equals the voltage across the a, b terminals when nothing is connected from a to b.

Since no current flows in \( R_3 \) when we have nothing connected from a to b, there is no voltage drop across \( R_3 \). Thus, \( V_{Th} \) equals the voltage at the node above \( R_2 \) and \( i_s \). We could put a reference on the bottom of the circuit and label the top center node as \( V_{Th1} \) and we could use the node-v method to find \( V_{Th} \):

\[
\frac{V_{Th} - v_s}{R_1} + \frac{V_{Th} - i_s}{R_2} = 0 \text{ A}
\]

or

\[
V_{Th} \left( \frac{1}{R_1} + \frac{1}{R_2} \right) = \frac{v_s}{R_1} + i_s
\]

Multiplying both sides by \( R_1 R_2 \) gives

\[
V_{Th} \left( R_2 + R_1 \right) = v_s R_2 + i_s R_1 R_2
\]

or

\[
V_{Th} = \frac{v_s R_2 + i_s R_1 R_2}{R_1 + R_2} = \frac{36 \text{ k} + 6 \text{ k}}{4 \text{ k}} \text{ V} = 10.5 \text{ V}
\]
Another way to find \( V_{Th} \) is to use source transformations. \( V_S \) and \( R_1 \) on the left side are a Thevenin equivalent that we may transform into a Norton equivalent.

Our circuit now becomes the following:

Now we may combine current sources, and \( R_1 \) with \( R_2 \). Once again, we may ignore \( R_3 \).

By Ohm's law, \( V_{Th} = \left( \frac{V_S}{R_1} + i_S \right) R_1 || R_2 \)

or \( V_{Th} = \left( \frac{12V + 2mA}{1k\Omega} \right)(1k\Omega || 3k\Omega) = 14mA \cdot \frac{3\,k\,\Omega}{4} \)

or \( V_{Th} = 10.5V \)

To find \( R_{Th} \), we turn off the independent sources and look in from the a, b terminals.

\[ R_{Th} = R_3 + R_1 || R_2 \] (see diagram, below)
Note: The voltage source becomes a wire when turned off, and the current source becomes an open when turned off. That is, $0V = \text{wire}$, $0A = \text{open}$. 

\[ R_{TH} = R_3 + R_1 || R_2 \]