Source Transformation

2013 October 15
Question from end of class

- Which circuit is more efficient when varying the power dissipated by the load resistor?

  Circuit 1  or  Circuit 2
So far, two ways to find $V_T$ and $R_T$

- **Theoretical Method:** Remove the load resistor. Calculate the open circuit voltage to find $V_T$. Then, calculate the equivalent resistance after turning off all voltage and current sources.

- **Experimental Method:** Replace the load resistor with a variable resistor (trim pot). When the resistance of the trim pot is very large (approaching $\infty \Omega$), the measured voltage across the trim pot is $V_T$. Decrease the resistance of the trim pot until the voltage across the trim pot is $\frac{1}{2} V_T$. The trim pot resistance is $R_T$. 
Source Transformation

- Convert sources and resistors from Thévenin and Norton equivalent circuits.
- Then combine sources when appropriate.
- Repeat until there is a single source, a equivalent resistor, and the load resistor.
Example 1
Transform $V_S$ into $I_N$

where:

$I_N = V_S / R_1$

$R_{T_1} = R_1$
Combine $R_T$ and $R_2$

where:

$$R_T = \left( \frac{1}{R_1} + \frac{1}{R_2} \right)^{-1}$$

$$= \frac{R_1 R_2}{R_1 + R_2}$$
Example 2
Solution 2

\[ I_{N_1} = \frac{V_{S_1}}{R_1} \]

\[ R_{T_1} = \left( \frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} \]

\[ = \frac{R_1 R_2}{R_1 + R_2} \]

where:

- \( I_{N_1} \) is the current through the transformer primary.
- \( V_{S_1} \) is the voltage source.
- \( R_1 \) and \( R_2 \) are the resistances in the circuit.
- \( R_{T_1} \) is the total resistance seen from the transformer primary.
- \( R_L \) is the load resistance.

The diagram shows a circuit with voltage sources \( V_{S_1} \) and \( V_{S_2} \), resistances \( R_1 \), \( R_2 \), and \( R_L \), and the current \( I_{N_1} \) flowing through the circuit.
Solution 2 continued

where:

\[ V_{T_1} = I_{N_1} R_1 \]

\[ R_{T_1} = \frac{R_1 R_2}{R_1 + R_2} \]

where:

\[ V_T = V_{T_1} - V_{S_2} \]

\[ R_T = R_{T_1} \]
Combining Sources

- Voltage sources in series are added together, taking into account the polarity of each source.

- Current sources in parallel are added together, taking into account the direction of current flow.