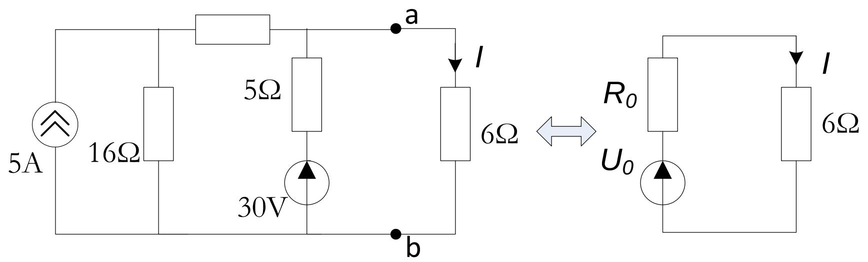
Thevenin's Theorem

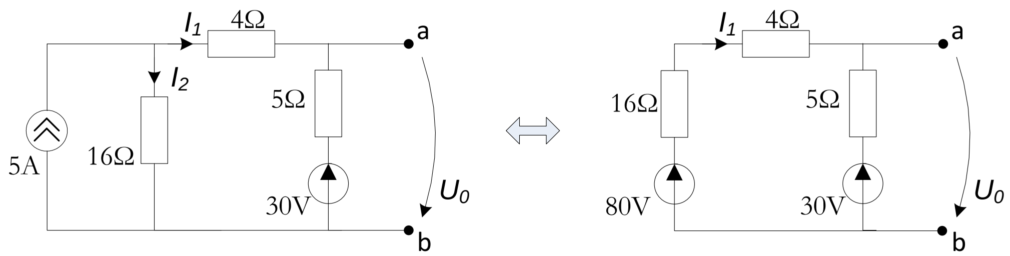
Example 2.7.1. Determine the Thevenin equivalent circuit (R_0, U_0), viewed by the 6Ωs resistance (terminals a and b) for the circuit below. Find the current I through the 6Ωs resistance.



Example 2.7.1.

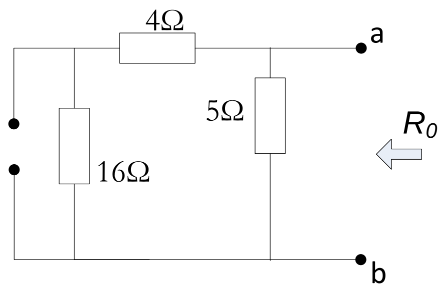
Solution:

The open-circuit voltage, U_0, is the voltage between the terminals a and b by detaching the 6Ω's resistance. For the circuit below, using KL, we have $I_1 + I_2 = 5$, $(4+5)\cdot I_1 - 16\cdot I_2 = -30$, *from where solving for I_1 and I_2, we get I_1=2A and I_2=3A. Thus,* $U_0 = 5\cdot I_1 + 30 = 40\ (V)$. *Another way to calculate the current I_1 is by using the source transformation theorem. The equivalent circuit is obtained in figure b), for which* $(16+4+5)\cdot I_1 = 80 - 30$, *and I_1=2A.*



a) b)

To calculate the equivalent resistance R_0 of the remaining circuit, regarding the terminals a and b, we have to suppress the two sources. The passive circuit is drawn below, for which $R_0 = \frac{(16+4)\cdot 5}{16+4+5} = 4(\Omega)$.

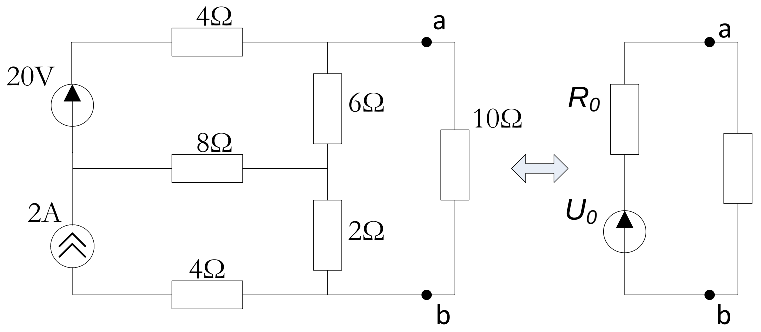


The remaining deactivated circuit used for the calculus of the R_0

According to the Thevenin's theorem, from the equivalent circuit, the desired current is:

$$I = \frac{U_0}{R + R_0} = \frac{40}{6+4} = 4\ (A).$$

Example 2.7.2. Determine the Thevenin equivalent circuit (R_0, U_0), viewed by the 10Ωs resistance (terminals a and b) for the circuit below. Find the current I through the 10Ωs resistance.



Example 2.7.2.

Solution:

The open-circuit voltage, U_0, is the voltage between the terminals a and b by detaching the 10Ω's resistance. For the circuit below, using KL, we have $I_1 + I_2 = 2$, $(4+6)\cdot I_1 - 8\cdot I_2 = 20$, from where solving for I_1 and I_2, we get I_1=2A and I_2=0A. Thus, $U_0 = 6\cdot I_1 + 2\cdot 2 = 16\ (V)$.

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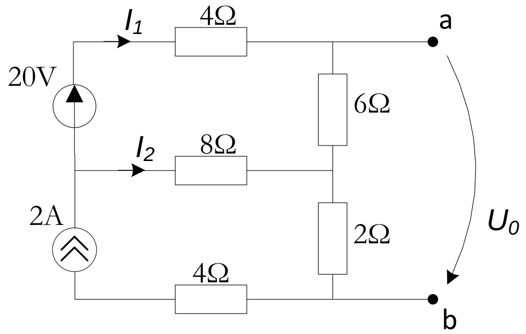
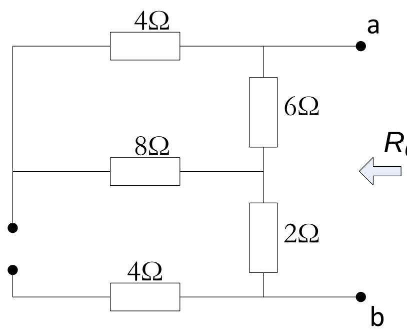
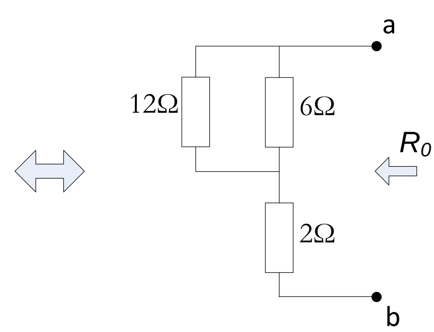


The remaining circuit used for the calculus of the U_0

To calculate the equivalent resistance R_0 of the remaining circuit, regarding the terminals a and b, we have to suppress the two sources. Figure a) shows the passive circuit which can be redrawn in an easier form in figure b). The equivalent resistance is: $R_0 = \frac{12\cdot 5}{12+6} + 2 = 6(\Omega)$.





According to the Thevenin's theorem, from the equivalent circuit, the desired current is:

$$I = \frac{U_0}{R + R_0} = \frac{16}{10+6} = 1\ (A).$$