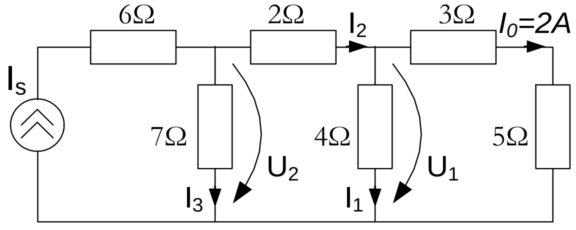
Superposition

Example 2.5.1. Assuming I_0=2A, use linearity to find the actual value of I_s in the circuit below.

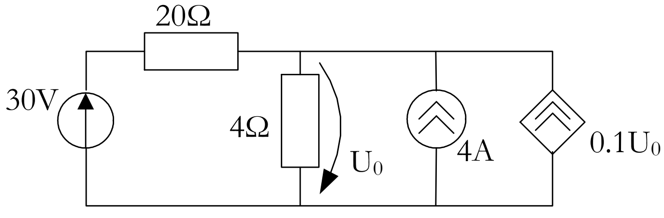


Example 2.5.1.

Solution:

If I_0=2A, the voltage drop $U_1 = (3+5)\cdot I_0 = 16\ V$ and $I_1 = \frac{U_1}{4} = 4\ A$. Applying KCL gives $I_2 = I_0 + I_1 = 6\ A$. Next, $U_2 = 2\cdot I_2 + U_1 = 28\ V$, and $I_3 = \frac{U_2}{7} = 4\ A$. Applying KCL, gives $I_s = I_2 + I_3 = 10\ A$. This shows that assuming I_0=2A gives I_s=10A.

Example 2.5.2. Use superposition to find U_0 in the circuit below.



Example 2.5.2.

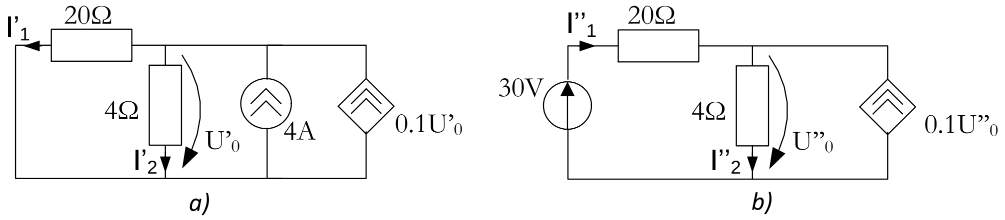
Solution:

The circuit involves a dependent source, which must be left intact. We let $U_0 = U_0' + U_0''$, where the U_0' and U_0'' are due to the 4A current source and 30V voltage source respectively.

To obtain U_0' we turn-off the 30V voltage source so that we have the circuit below denoted with a). We write the branch currents I_1' and I_2' in terms of the voltage U_0': $I_1' = \frac{U_0'}{20}$, and $I_2' = \frac{U_0'}{4}$, and apply KCL for the upper node, we have $4 + 0.1U_0' = \frac{U_0'}{4} + \frac{U_0'}{20}$. Solving for the U_0', we get $U_0' = 20\ V$.

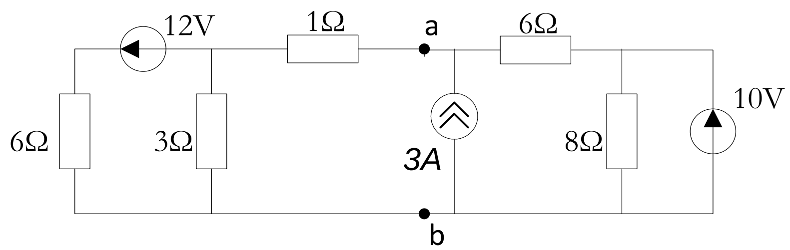
To obtain U_0'' we turn-off the 4A current source so that the circuit becomes that shown in figure below denoted with b). We write the branch currents I_1'' and I_2'' in terms of the voltage U_0'': $I_1'' = 1 - \frac{U_0''}{20}$, $I_2'' = \frac{U_2''}{4}$, and apply KCL for the upper nod, we have: $\frac{U_0''}{4} = 1 - \frac{U_0''}{20} + 0.1U_0''$. Solving for U_0'', we get $U_0'' = 5\ V$.

The voltage drop U_0 is: $U_0 = U_0' + U_0'' = 20 + 5 = 25\ V$.



For Example 2.5.2.: Applying superposition to a) obtain U_0', b) obtain U_0''.

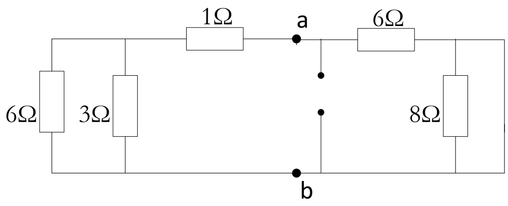
Example 2.5.3. Suppress all the sources in the circuit below and calculate the equivalent resistance, R_{eq}, regarding to the terminals a and b.



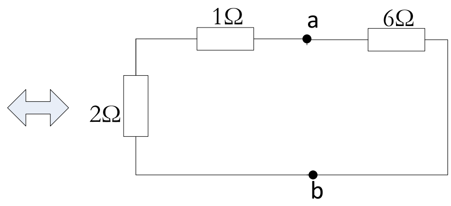
Example 2.5.3.

Solution:

By suppressing all the circuit sources, we get the passive circuit in the figure a) below. The passive circuit could be redrawn in figure b), assuming the parallel connection between 6Ω's and 3Ω's resistances and the short circuit over the 8Ω's resistance. The equivalent resistance regarding the terminals a and b will be: $R_{eq} = \frac{(2+1)\cdot 6}{2+1+6} = 2\ (\Omega)$.

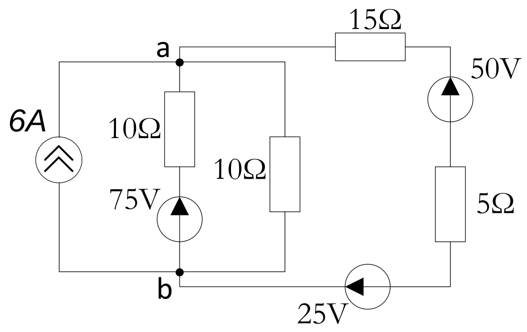


a)



b)

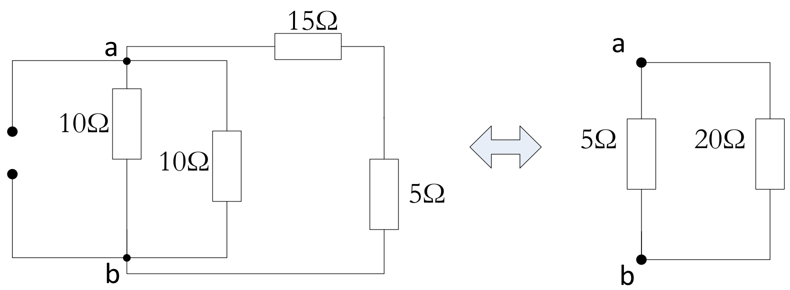
Example 2.5.4. Suppress all the sources in the circuit below and calculate the equivalent resistance, R_{eq}, regarding to the terminals a and b.



Example 2.5.4.

Solution:

By suppressing all the circuit sources, we get the passive circuit in the figure a) below. The passive circuit could be redrawn in figure b), assuming the parallel connection between 10Ω's and 10Ω's resistances and the series connection between 15Ω's and 5Ω's resistances. The equivalent resistance regarding the terminals a and b will be: $R_{eq} = \frac{5 \cdot 20}{5+20} = 4\ (\Omega)$.



a) b)