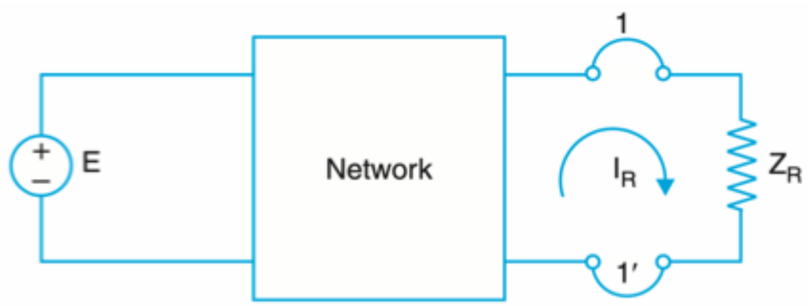
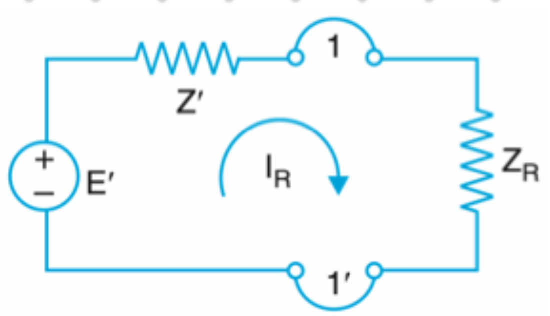
Norton's Theorem:

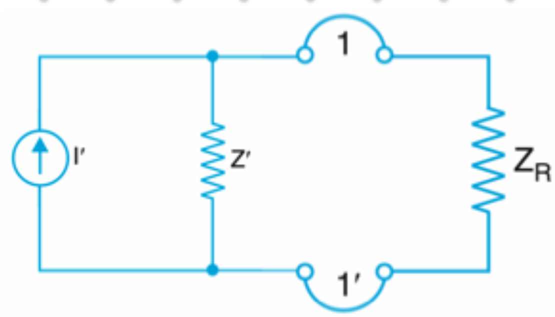
Any two terminal linear network containing energy sources and impedances can be replaced with an equivalent circuit consisting of a current source I' in parallel with an admittance Y'.

The value of I' is the short-circuit current between the terminals of the network and Y' is the admittance measured between the terminals of the network with all energy sources eliminated (but not their impedances).

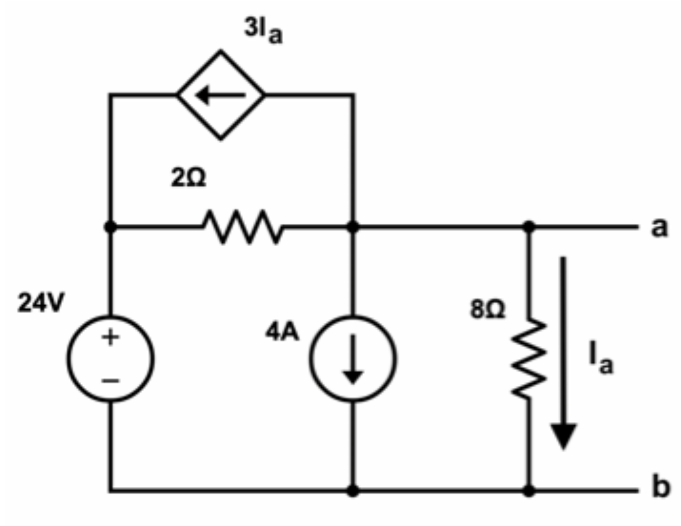
That is, the following two terminal linear network can be replaced with a simpler equivalent of I' and Y', where $I' = \frac{E'}{Z'}$ and $Y' = \frac{1}{Z'}$.







Q. For the given circuit, find the Thevenin and Norton equivalents across the terminals a-b.



A. Applying KCL equation:

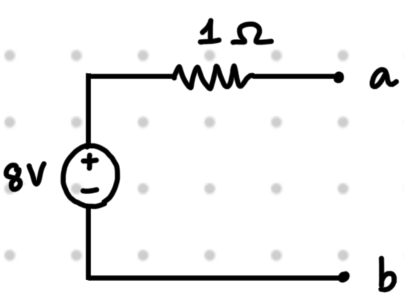
$$\frac{V_a - 24}{2} + 4 + \frac{V_a}{8} + 3\frac{V_a}{8} = 0 \quad \Rightarrow \quad V_a = 8\,V$$

Finding the short circuit current:

Placing a short across a-b makes $I_a = 0$

$$\Rightarrow \quad \frac{V_a - 24}{2} + 4 + I_{sc} = 0 \quad \Rightarrow \quad I_{sc} = 8\,A$$

$$\Rightarrow \quad R_{TH} = \frac{V_{TH}}{I_{sc}} = 1\,\Omega$$



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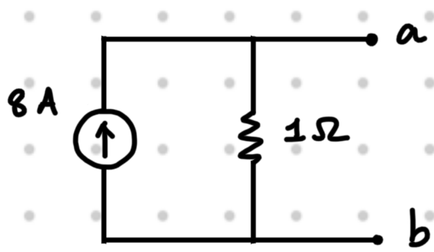
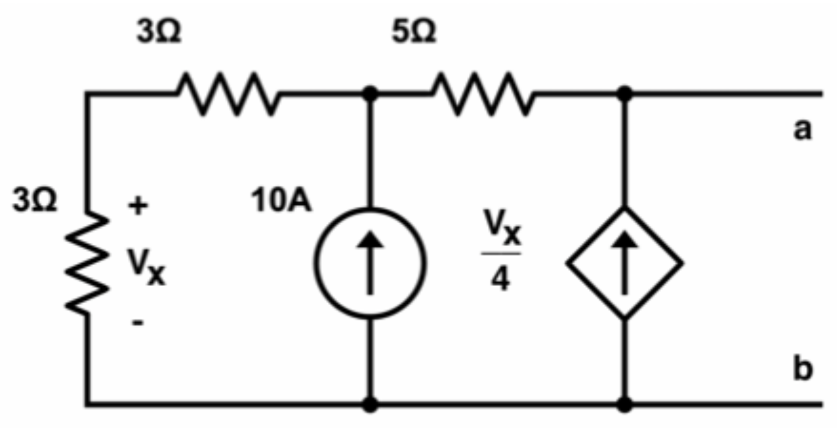


Q. For the given circuit, find the Thevenin and Norton equivalents across the terminals a-b.



A. Assuming the node voltage at 3Ω - 5Ω is V_c : $V_x = \frac{3}{6} V_c = \frac{V_c}{2}$

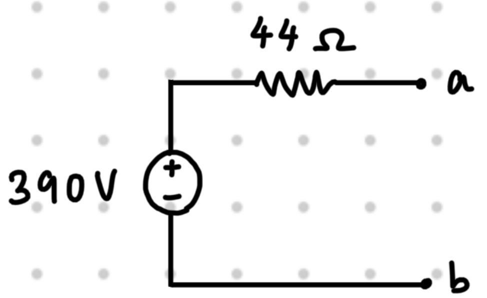
Applying KCL : $\frac{V_c}{6} - 10 - \frac{V_x}{4} = 0 \Rightarrow V_c = 240\,V$

$$V_{TH} = V_c + 5 \cdot \frac{V_x}{4} = V_c + \frac{5}{8} V_c = 390\,V$$

Finding the short-circuit current :

$$\left.\begin{aligned} \frac{V_x}{4} &= 30 - 3 I_{sc} \\ \text{and} \quad 3V_x + 30 &= 8 I_{sc} \end{aligned}\right\} \Rightarrow I_{sc} = \frac{390}{44}\,A$$

$$\Rightarrow Z_{TH} = \frac{V_{TH}}{I_{sc}} = 44\,\Omega$$



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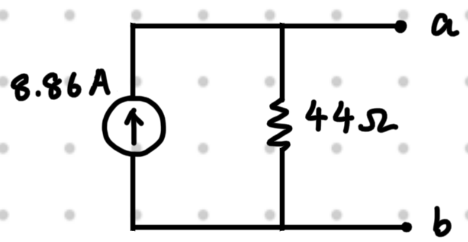
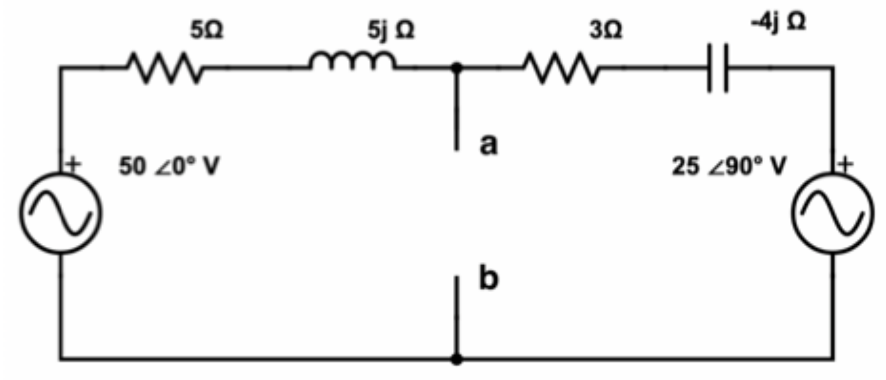


Q. For the given circuit, find the Thevenin and Norton equivalents across the terminals a-b.



A. $$I = \frac{50\angle 0^\circ - 25\angle 90^\circ}{8+j} = \frac{75-50j}{13} \text{ A}$$

$$V_{oc} = 50 - \left(\frac{75-50j}{13}\right)(5+5j)$$

$$= \frac{25-125j}{13} \approx 9.8\angle -78.7^\circ \text{ V}$$

$$I_{sc} = \frac{50}{5+5j} + \frac{25j}{3-4j}$$

$$= 1-2j$$

$$\approx 2.23\angle -63.43^\circ \text{ A}$$

$$\Rightarrow \quad Z_{ab} = \frac{V_{oc}}{I_{sc}} = \frac{55-15j}{13}\ \Omega$$