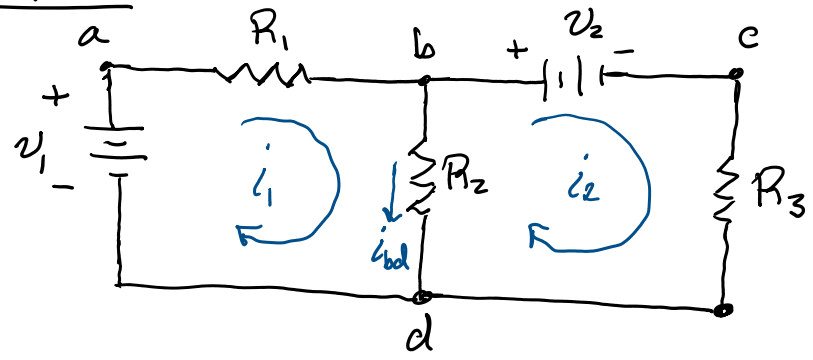
Lecture 4

Monday, September 9, 2024 12:53 PM

Loop & Mesh Analysis

1. Identify N independent loops in circuit.
   "independent" ⇒ each loop contains a distinct branch.
2. Apply KVL to each loop
3. Solve N-equations that resulted from step

Example:



Choose the meshes abd, and bcd

Assume current flow directions in each loop

By KCL,

$$i_{bd} = i_1 - i_2$$

Apply KVL to mesh 1:

$$v_1 - i_1 R_1 - \underbrace{(i_1 - i_2)}_{i_{bd}} R_2 = 0$$

$$\Rightarrow \quad (R_1+R_2)\,i_1 - R_2 i_2 = v_1$$

Apply KVL to mesh 2:

$$-v_2 - i_2 R_3 + \underbrace{(i_1 - i_2)}_{i_{bd}} R_2 = 0$$

$$\Rightarrow \quad -R_2 i_1 + (R_3+R_2)\,i_2 = -v_2$$

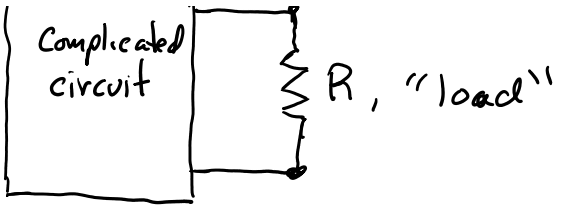
write in matrix form

$$\begin{bmatrix} R_1+R_2 & -R_2 \\ -R_2 & R_3+R_2 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} v_1 \\ -v_2 \end{bmatrix}$$

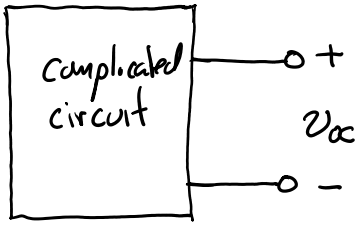
Thevenin's Theorem

Useful for finding the current, voltage or power delivered to some load on the circuit (a resistor).

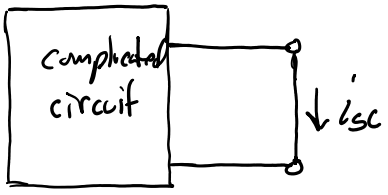
Theorem. The entire network (circuit), exclusive of the load, can be represented by an equivalent circuit that consists of an independent voltage source in series with a resistor such that the current-voltage relationship in the load remains unchanged.



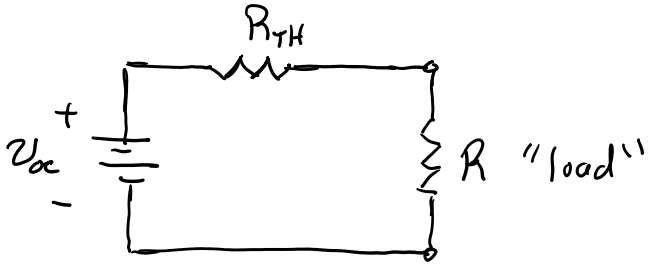
Remove the load & find open circuit voltage, v_{oc}



Find short circuit current, i_{sc}

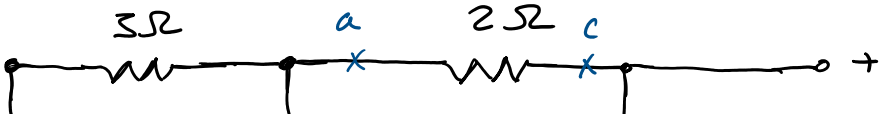


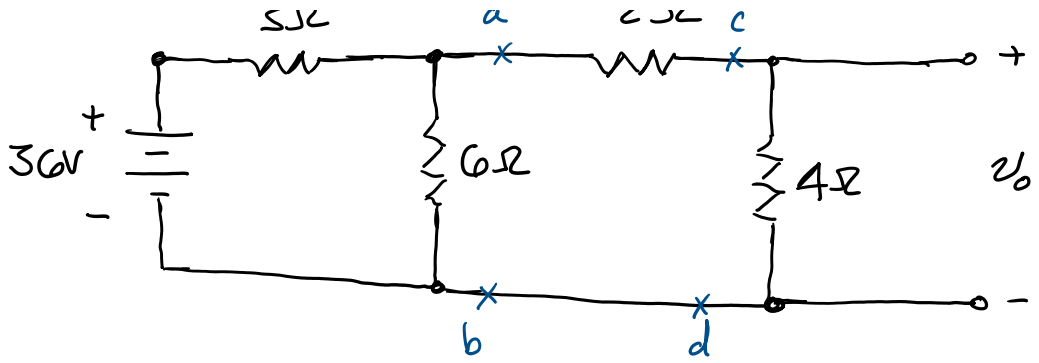
The equivalent Thevenan circuit is



$$R_{TH} = \frac{v_{oc}}{i_{sc}}$$

Example:

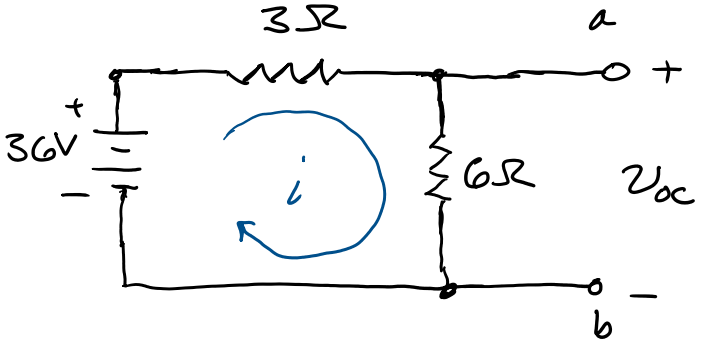




Find v_o

Solution.

We could "cut" at c and d, but the resulting analysis will be more complicated than we want. So, we'll cut at a and b.



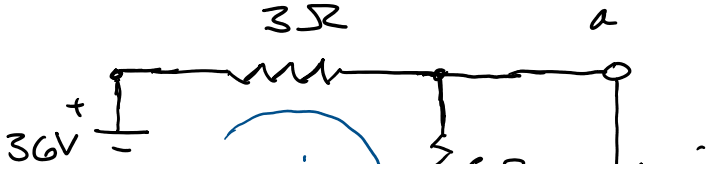
Use KVL to find v_{oc}

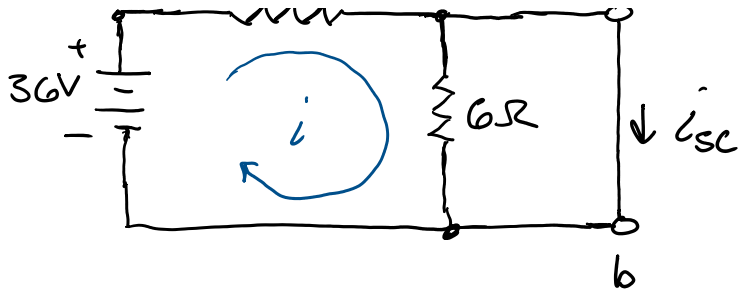
$$36V - i3\Omega - i6\Omega = 0$$

$$\Rightarrow i = \frac{36V}{3\Omega + 6\Omega} = 4A$$

$$v_{oc} = i6\Omega = 4A(6\Omega) = 24V$$

Now, find i_{sc}





No current flow through 6Ω resister due to short!

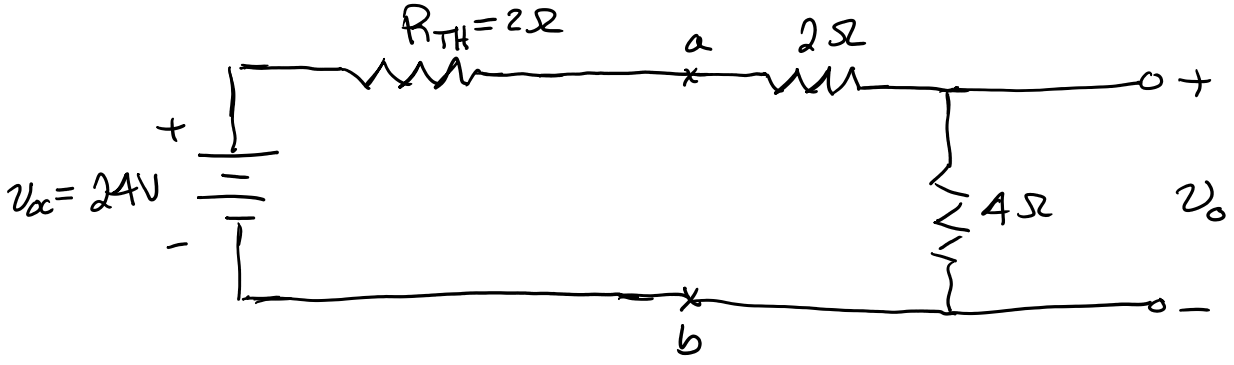
By KVL

$$36V - i_{sc}\,3\Omega = 0 \quad \Rightarrow \quad i_{sc} = \frac{36V}{3\Omega} = 12A$$

Thevenin resistance,

$$R_{TH} = \frac{v_{oc}}{i_{sc}} = \frac{24V}{12A} = 2\Omega$$

So, we represent our original circuit as



Can now find v_o easily.

$$v_o = 24V \frac{4\Omega}{2\Omega+2\Omega+4\Omega} = 12V$$