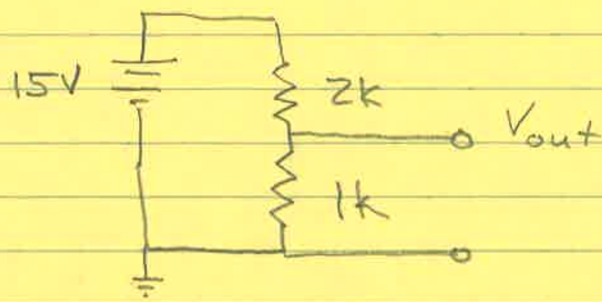
Finding Thévenin equivalent circuits
In-class examples 1/24/19

Example 1:
Voltage divider

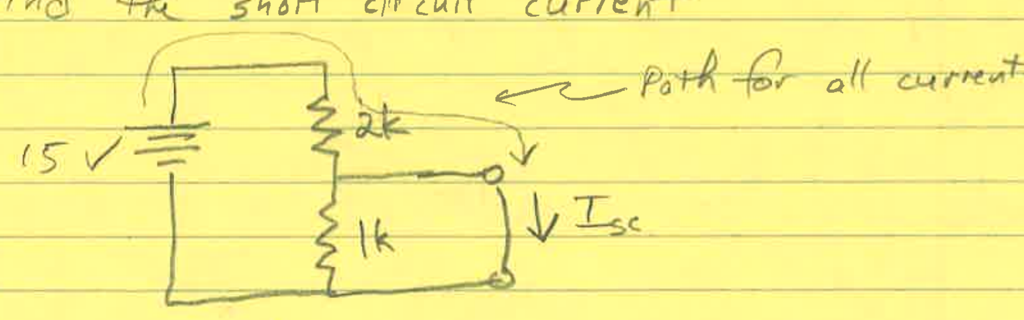


To find V_{Th} measure the open-circuit voltage across the outputs. In other words, use a good voltmeter (high-resistance – draws no current).

$$V_{o.c.} = V_{Th} = \underbrace{\frac{1k}{1k+2k} V_{in}}_{\text{Ideal voltage divider result.}} = 5\,V$$

Method A for R_{Th}:

Find the short circuit current



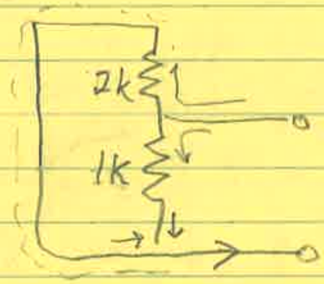
$$I_{sc} = \frac{15\,V}{2k} = 7.5\,mA$$

Now use $R_{Th} = \frac{V_{o.c.}}{I_{s.c.}}$

$$\Rightarrow R_{Th} = \frac{5}{15/2} = \frac{2}{3}\,\Omega$$

Method B for R_{Th}:

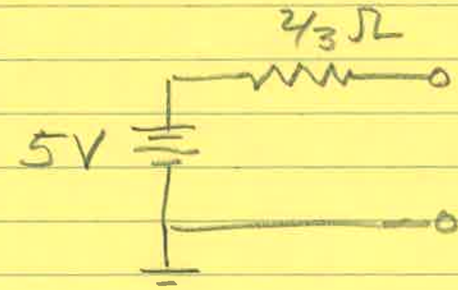
Replace batterie(s) with short-circuit(s) and measure the resistance at the outputs.



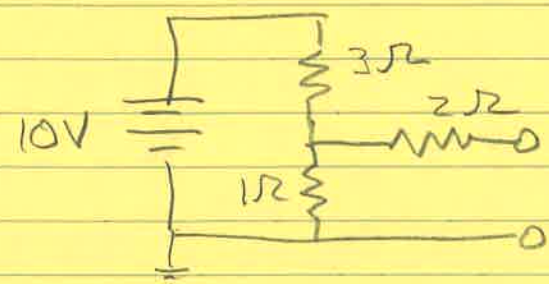
This is actually a parallel combination of the resistors.

$$R_{Th} = \frac{R_1 R_2}{R_1 + R_2} = \frac{1 \times 2}{1+2} = \frac{2}{3}\,\Omega$$

Equivalent circuit to our original circuit is



Example 2

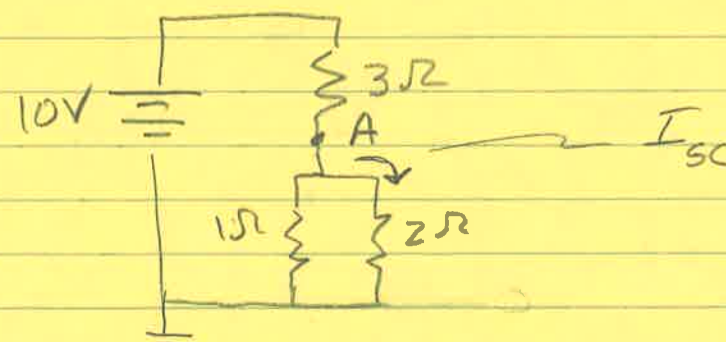


When the outputs are an open circuit no current flows through 2Ω resistor, so $\Delta V_{2\Omega} = 0$, and the measured V_{oc} is simply the voltage provided by 3Ω-1Ω voltage divider.

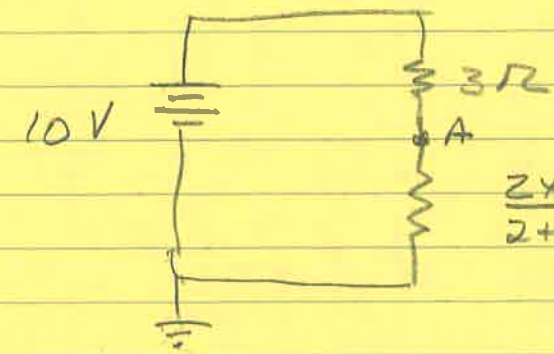
$$V_{th} = V_{oc} = 10 \cdot \frac{1}{1+3} = 2.5\ V$$

Method A for R_{Th}:

If the output is shorted, the circuit is



To find I_{sc} we need to know the voltage at A, V_A. To do this, first find the parallel combination of the 1Ω & 2Ω resistors



$$\frac{2\times1}{2+1} = \frac{2}{3}\,\Omega$$

$$V_A = \frac{\frac{2}{3}}{3+\frac{2}{3}} \times 10$$ ← Voltage divider

$$= \frac{2}{9+2} \times 10$$

$$= \frac{20}{11}\,V$$

$$I_{sc} = I_{2\Omega} = \frac{V_A}{2} = \frac{10}{11}\,V$$

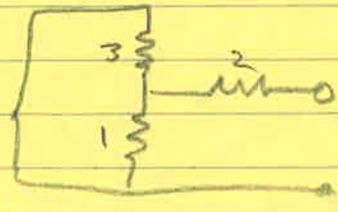
$$\Rightarrow R_{th} = \frac{V_{o.c.}}{I_{s.c}} = \frac{\frac{5}{2}}{\frac{10}{11}}$$

$$= \frac{11}{4}$$

$$= 2.75\,V$$

Method B for R_{Th}:

Shorting out battery gives



← Parallel combination of 1Ω & 3Ω in series with 2Ω

$$R_{Th} = 2 + \frac{1\times3}{1+3} = 2.75\,\Omega$$

Thévenin equivalent to our original circuit is