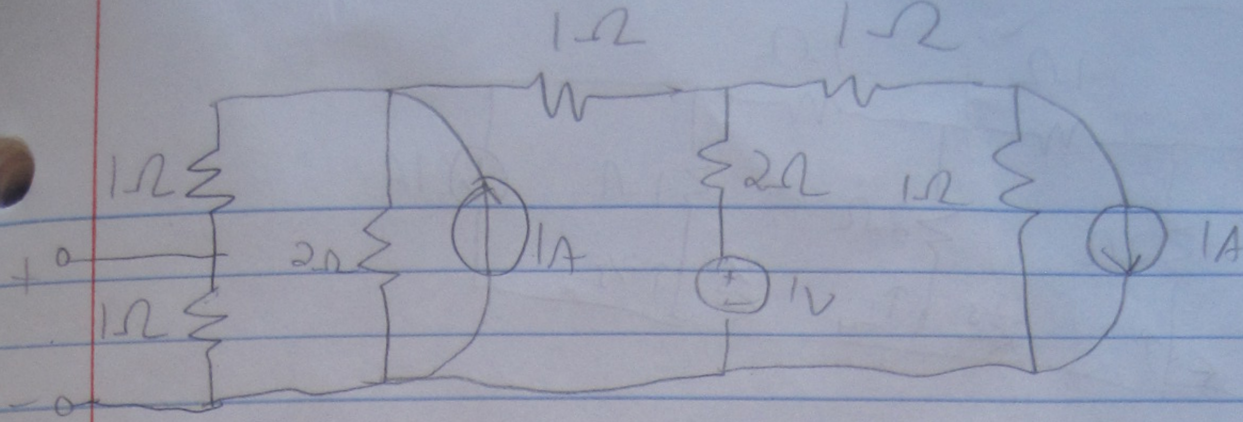


Thevenin Equivalent

Find 2 of:

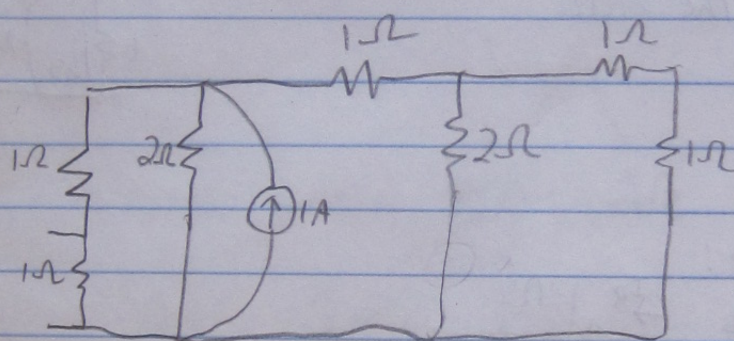
V_{oc}

I_{sc}

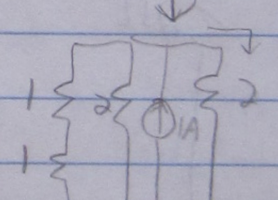
R_{TH}

V_{oc}:

Could do node voltage, but 3 equations, 3 unknowns. Somewhat cumbersome. I prefer superposition.

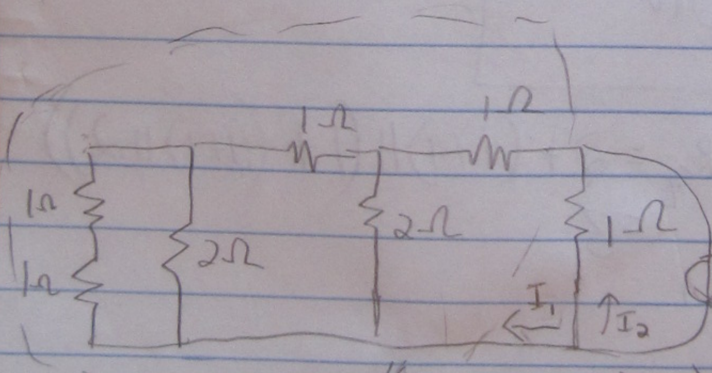


R: $((1+1)\|2)+1 = 2$



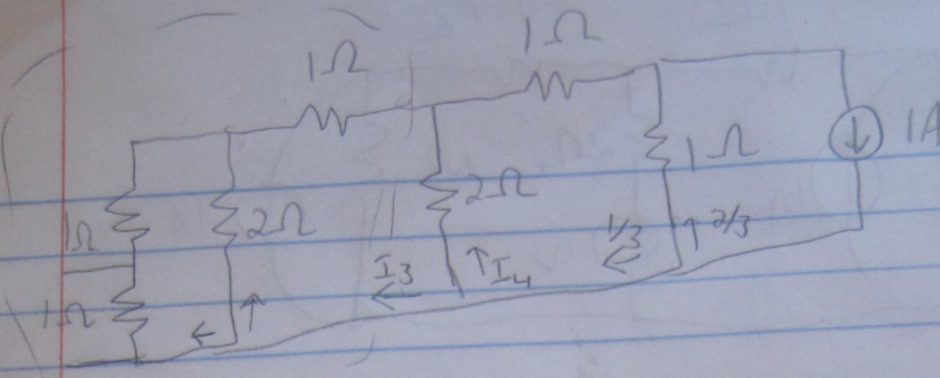
Current splits evenly

$V_0 = \frac{1}{3} A \cdot 1\Omega = \frac{1}{3} V$



$R_{eq} = ((((1+1)\|2)+1)\|2)+1 = 2$

Current divider gives us that $I_1 = \frac{1}{3} A$, $I_2 = \frac{2}{3} A$

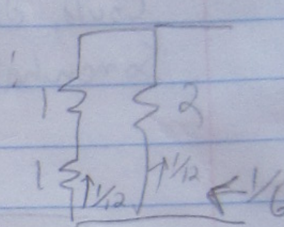


$$R_{eq} = (((1+1)\|2) + 1) = 2\,\Omega$$

Current divider: Each gets half

$$\tfrac{1}{3}A \cdot \tfrac{1}{2} = \tfrac{1}{6}\,A$$

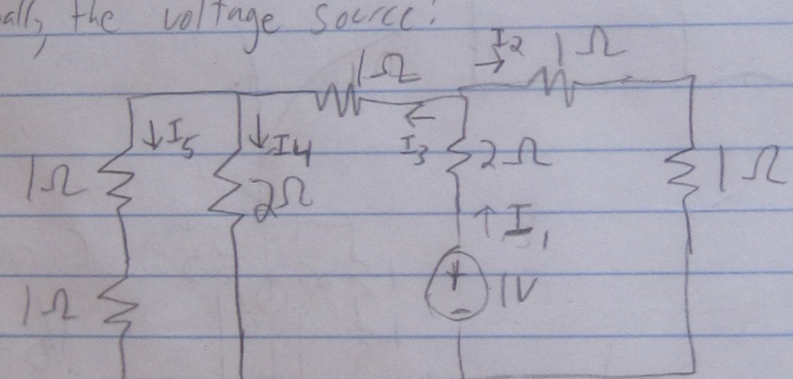
Then finally it obviously splits in half between:



So $\tfrac{1}{12}A$ goes through the 1Ω.

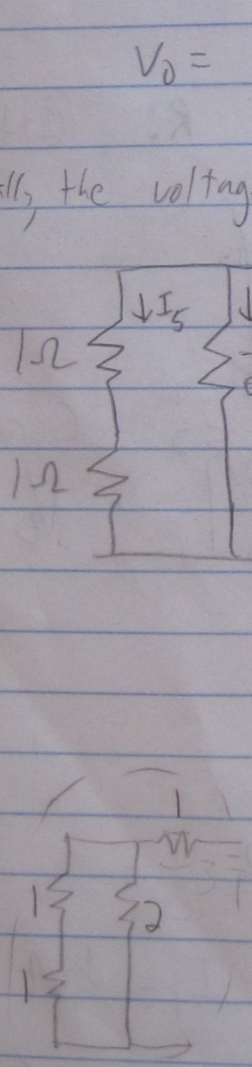
$$V_0 = -\tfrac{1}{12}\,V$$

Finally, the voltage source:



$$R_{eq} = 2 + (1+1)\|(1 + ((1+1)\|2)) = 3$$

$$I_1 = \tfrac{1}{3}\,A$$



$R_{eq} = 1 + 2\|2 = 2$

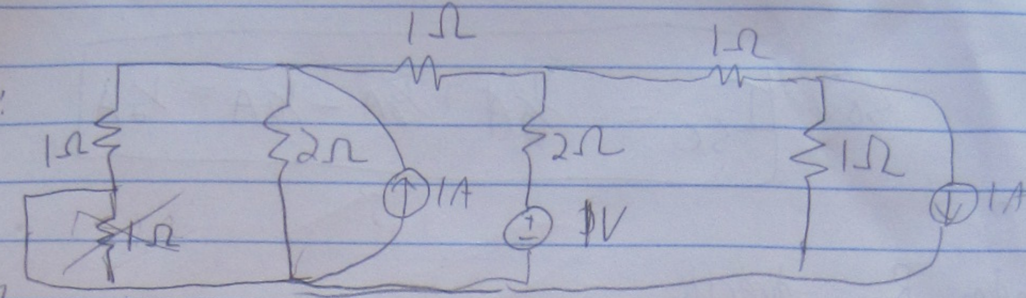
current divider: $\tfrac{1}{2}I_1 = I_2 = I_3 = \tfrac{1}{2}\cdot\tfrac{1}{3}A = \tfrac{1}{6}A$

Finally, $I_4 = I_5 = \tfrac{1}{2}I_3 = \tfrac{1}{12}A$

$$V_0 = \tfrac{1}{12}\,V$$

$$\boxed{V_\alpha = \tfrac{1}{12}V - \tfrac{1}{12}V + \tfrac{1}{3}V = \tfrac{1}{3}V}$$

I_{sc}:



Ignore 1Ω resistor, since its shorted.

Superposition:

Left current source:

Splits between $(1 \parallel 2)$ and $(1 + (2 \parallel (1+1)))$

$\frac{2}{3}\Omega$ $\qquad$ 2Ω

1Ω $\quad$ 2Ω

so $\quad 1A \cdot \dfrac{2}{2+\frac{2}{3}} \cdot \dfrac{2}{3} = \dfrac{4}{6+2} = \tfrac{1}{2}A$

Right current source:

$1A$

1 and $(((1 \parallel 2) + 1) \parallel 2) + 1$

1Ω $\qquad$ $\frac{21}{11}\Omega$

$(1 \parallel 2) + 1$ $\qquad$ 2

$\frac{5}{3}\Omega$ $\qquad$ 2Ω

1Ω $\quad$ 2Ω

$$\frac{\frac{5}{3}\cdot 2}{\frac{5}{3}+2}$$

$$\frac{\frac{10}{3}}{\frac{11}{3}}$$

$$= \frac{10}{11}$$

$$\frac{10}{11} + 1 = \frac{21}{11}$$

Current divider:

$$\frac{1}{\frac{21}{11}+1} \cdot \frac{2}{2+\frac{5}{3}} \cdot \frac{2}{3} = \frac{11}{32} \cdot \frac{2}{\frac{11}{3}} \cdot \frac{2}{3} = \frac{11}{32} \cdot \frac{6}{11} \cdot \frac{2}{3} = \frac{1}{8} \text{ A}$$

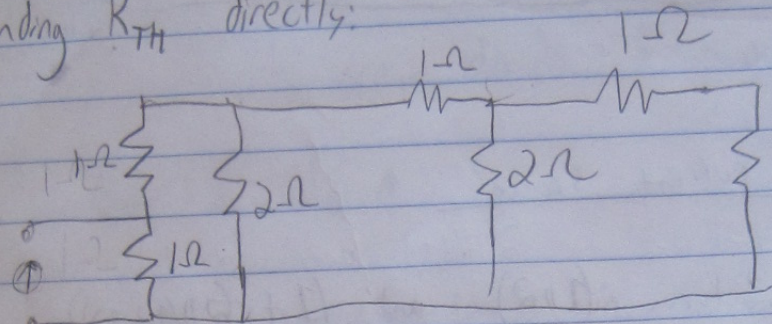
$I_{sc} = -\tfrac{1}{8}A$

Voltage source:

Similar math gives you $I_{SC} = 1/8\,A$

So $\boxed{I_{SC} = \frac{1}{2}A + \frac{1}{8}A - \frac{1}{8}A = \frac{1}{2}A}$

Finding R_{TH} directly:



1. First Remove Independent Sources

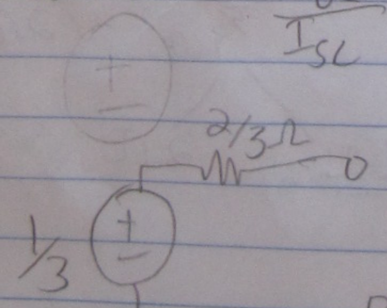
2. Find equivalent resistance between terminals.

If you get confused about where to start, pretend there's a source across the terminals of interest.

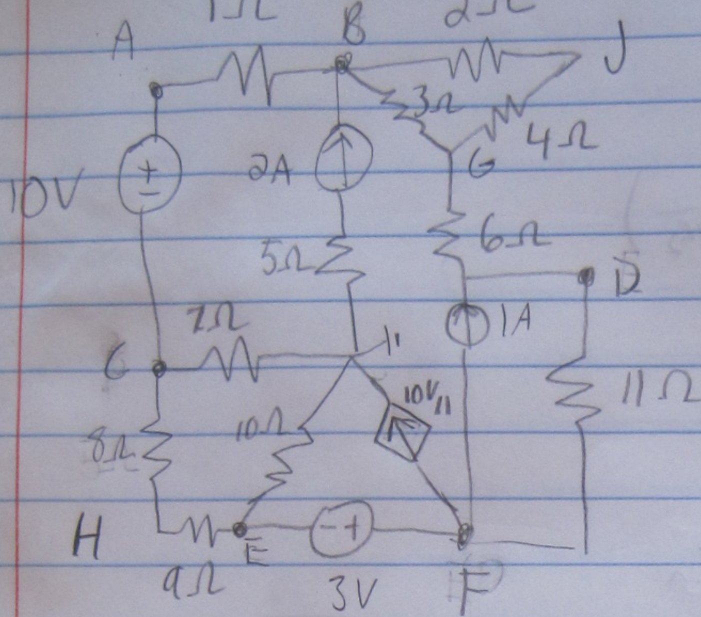
$$R_{eq} = 1 \,||\, (1 + 2 \,||\, (1 + (2 \,||\, (1+1))))$$

$$\frac{2}{3}\,\Omega = R_{TH}$$

Check: $\frac{V_{OC}}{I_{SC}} = \frac{1/3}{1/2} = 2/3\,\Omega$



Big crazy Node Voltage Problem



Let's assume we don't actually care about node voltages

V_G, V_J, V_H

$V_A = V_C + 10V$

$V_F = V_E + 3V$

$V_{11} = V_D - V_F$

B: $\frac{V_B - V_A}{1\Omega} + \frac{V_B - V_D}{((2+4)\|3)+6} - 2 = 0$

A&C: $\frac{V_A - V_B}{1} + \frac{V_C - V_E}{8+9} + \frac{V_C}{7} = 0$

E&F: $\frac{V_E - V_C}{8+9} + \frac{V_E}{10} + 10V_{11} + 1 + \frac{V_E - V_D}{11} = 0$

D: $\frac{V_D - V_B}{3+6} - 1 + \frac{V_D - V_E}{11} = 0$

7 equations (4 big ones)
7 unknowns

Annoying to solve. This is why we have computers.