Pre-tutorial 1 Questions

Chapter 2, Ex 26: Power

A fuse must be selected for a certain application. You may choose from fuses rated to "blow" when the current exceeds 1.5 A, 3 A, 4.5 A or 5 A. If the supply voltage is 110 V and the maximum allowed power dissipation is 500 W, which fuse should be chosen and why?

$V = 110V$

Max power $= 500W$

What is max current allowed?

$P = VI$ or $I_{max} = \frac{P_{max}}{V} = \frac{500}{110} = 4.545A$

If choose fuse for $I_{max} = 4.5A$

$P = VI = 110 \times 4.5 = 495W$ ✓

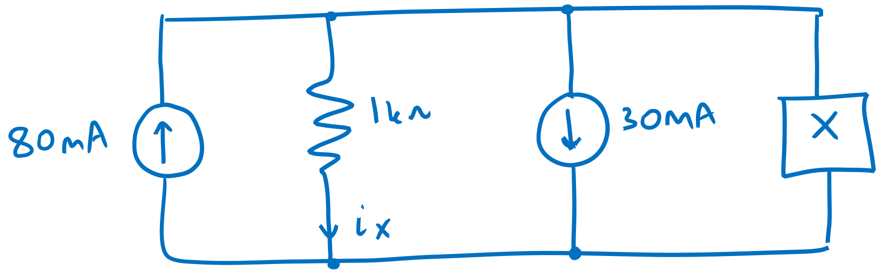
If choose fuse for $I_{max} = 5A$

$P = VI = 110 \times 5 = 550W$ ×

Our choice is a little conservative. If device draws it maximum current of 500W, then fuse blows.

Similar problem: ch 2 ex 27 in extra problems.

Chapter 3, Ex 38: KCL



Using KCL, find the power absorbed by element X in the circuit above if it is a
(a) 4 kΩ resistor

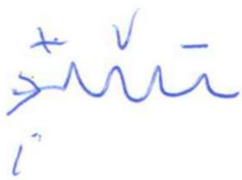
$\sum I_{in} = 0$ (top node)

$$80m - \frac{V}{1k} - 30m - \frac{V}{4k} = 0$$

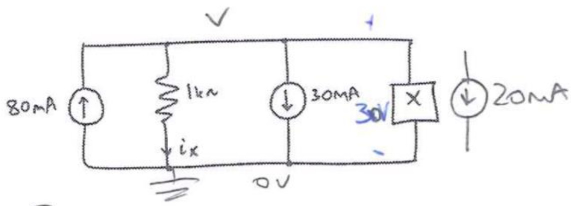
$$50m = \frac{5V}{4k}$$

$$V = 40V$$

$$P = VI = \frac{V^2}{R} = \frac{40^2}{4k} = 400mW \text{ absorbed}$$



(b) 20mA independent current source (arrow down)



$\sum I_{in} = 0$

$$80m - \frac{V}{1k} - 30m - 20m = 0$$

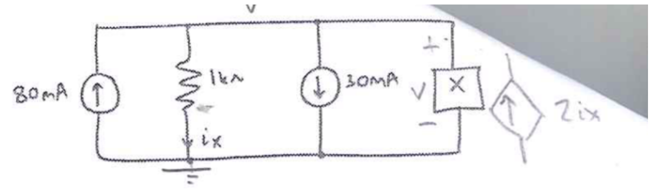
$$30m = \frac{V}{1k}$$

$$V = 30V$$

$$P = VI = 30 \times 20m = 600mW \text{ absorbed}$$

(charging)

(c) dependent current source (arrow up, labelled $2i_X$)



$$\sum I_{in} = 0$$

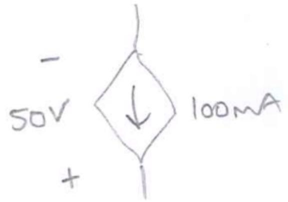
$$80mA - i_x - 30mA + 2i_x = 0$$

$$i_x = -50mA$$

$$i_x = \frac{V}{1k}$$

$$\text{or} \quad V = i_x \times 1k$$

$$= -50V$$

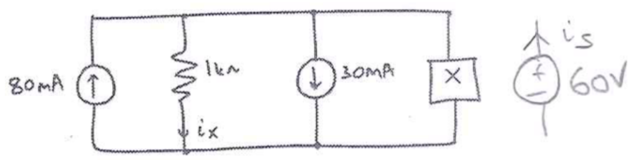


$$P = VI = -(-50) \times 2(-50m)$$

$$= -5W \text{ absorbed}$$

or 5W generated.

(d) 60V independent voltage source (+ at top)



$$i_x = \frac{V}{1k} = \frac{60}{1k} = 60mA$$

$$\sum I_{in} = 0$$

$$80mA - \underbrace{i_x}_{60mA} - 30m + i_s = 0$$

$$i_s = 10mA$$

$$P = VI = 60(-10m) = -600mW$$

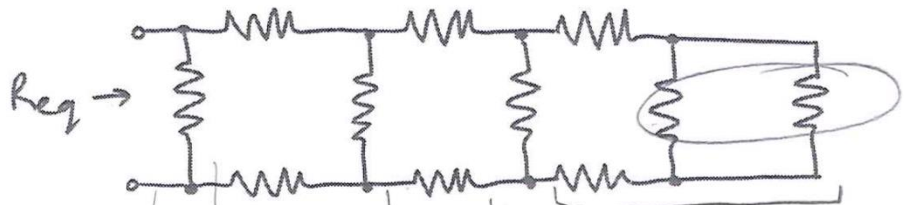
You may want to try Ch 3 ex 36 with KCL.

At Tutorial 1 – Marked Question

Chapter 3, Ex 58: Equivalent resistance

Find the equivalent resistance, R_{eq}, for each of the three resistive networks shown.

a) Each resistor is 100 Ω.



$100 // 100 = 50\Omega$

$100 + 50 + 100 = 250\Omega$

$100 // 250 = 71.4\Omega$

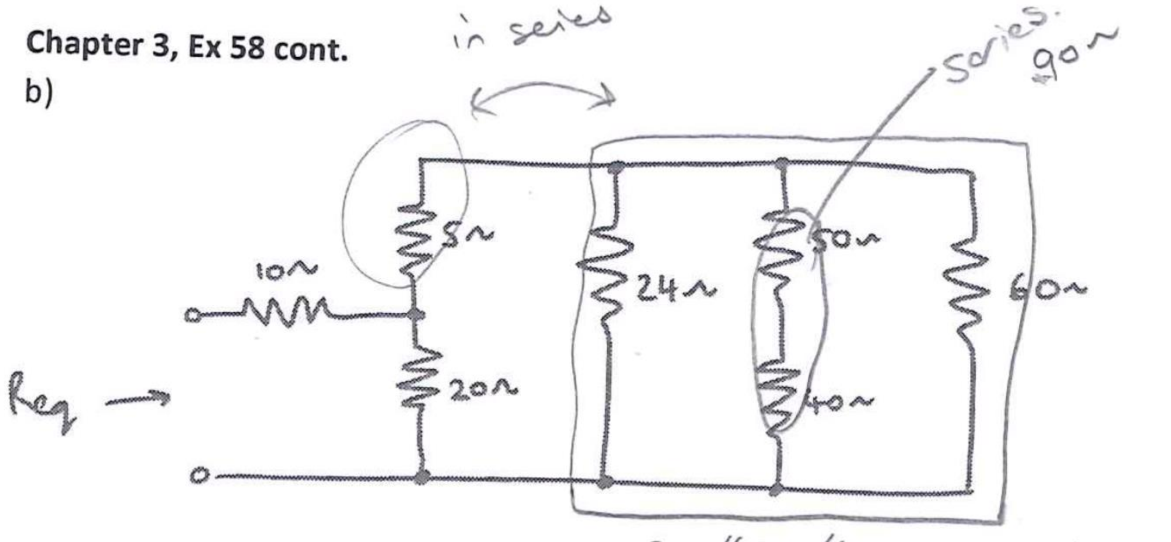
$100 + 100 + 100 // 250 = 271.4\Omega$

$100 + 100 + 271.4 // 100 = 273.1\Omega$

$R_{eq} = 100 // 273.1\Omega = 73.2\Omega.$

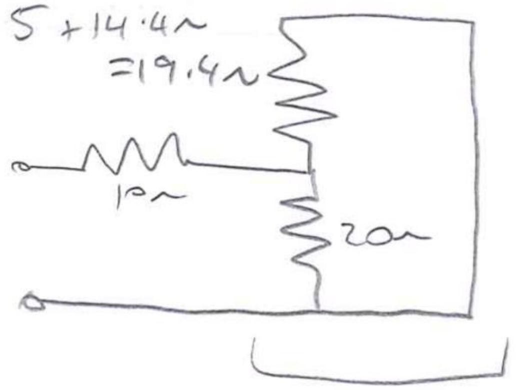
Chapter 3, Ex 58 cont.

b)



$24 \parallel 90 \parallel 60 = 14.4\,\Omega$.

Parallel,



Parallel

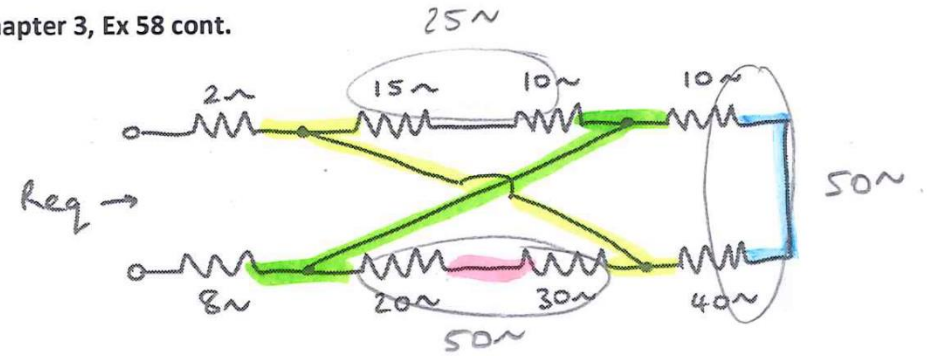
$20 \parallel 19.4\,\Omega = 9.85\,\Omega$

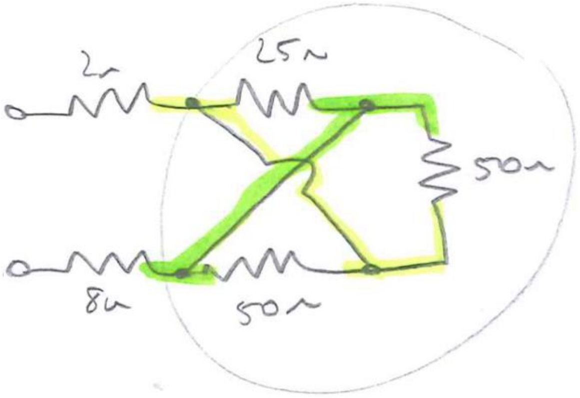
$R_{eq} = 10 + 9.85$

$= 19.85\,\Omega$

Chapter 3, Ex 58 cont.

c)

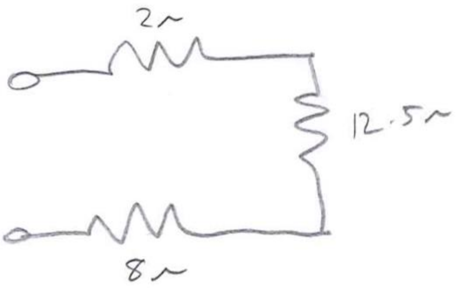




All 3 are between green & yellow nodes

$50 \,//\, 25 \,//\, 50$

$= 12.5\Omega$.



$2 + 12.5 + 8$

$= 22.5\Omega$

At Tutorial 1 – Unmarked Questions

Chapter 2, Ex 42: Ohm's Law

Determine the magnitude of the current flowing through a 4.7 kΩ resistor if the voltage across it is:

a) 1 mV

$$i = v/R$$
$$= \frac{1 \times 10^{-3}}{4.7 \times 10^{3}} = 212.8 \text{ nA}$$

b) 10 V

$$i = \frac{10}{4.7 \times 10^{3}} = 2.13 \text{ mA}$$

c) $4e^{-t}$ V

$$i = \frac{4e^{-t}}{4.7 \times 10^{3}} = 851 e^{-t} \, \mu\text{A}$$

d) 100 cos(5t) V

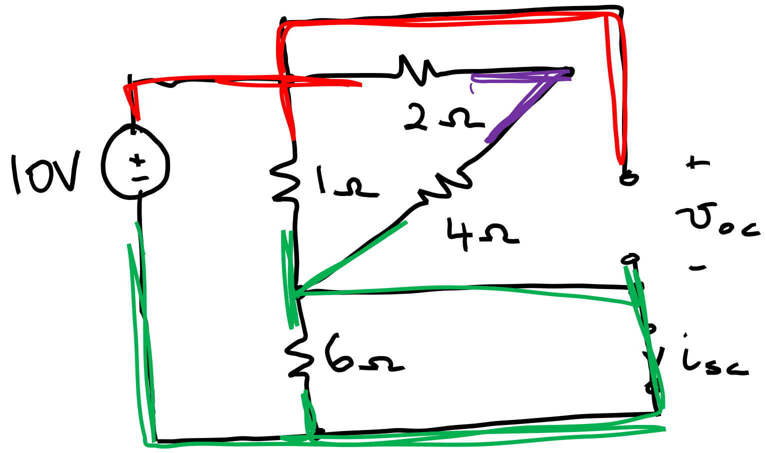
$$i = \frac{100 \cos(5t)}{4.7 \times 10^{3}} = 21.3 \cos(5t) \text{ mA}$$

e) -7 V

$$i = \frac{-7}{4.7 \times 10^{3}} = -1.49 \text{mA}$$

magnitude of i = 1.49 mA

KS Question 1: Parallel Components, Open Circuits, Short Circuits, Ohm's Law



For the circuit above, determine the following:

a) what (if anything) in in parallel

⇒ voltage source, 1Ω resistor and open circuit in //

⇒ 6Ω resistor & short circuit in //

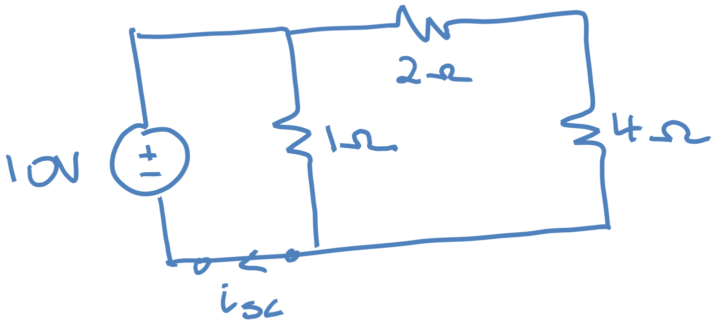
$\therefore i_{6\Omega} = 0A$

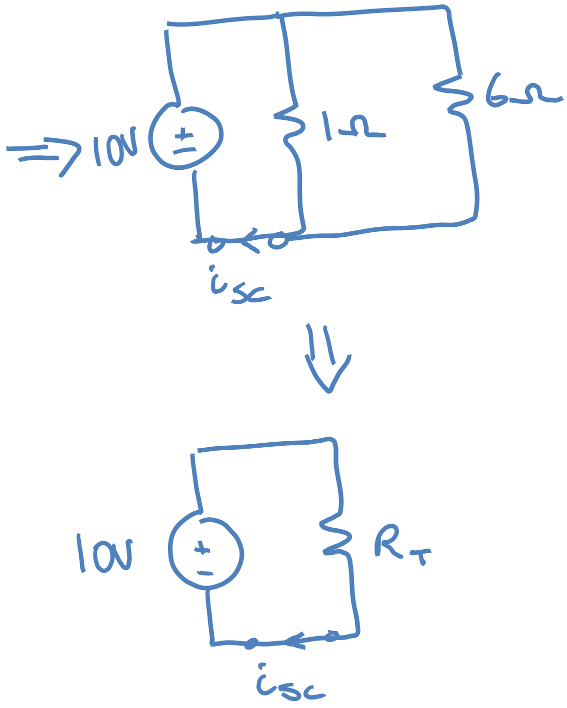
b) the voltage across the open circuit

$v_{oc} = v_{1\Omega} = v_s = 10V$

c) the current through the short circuit

Redraw cct:





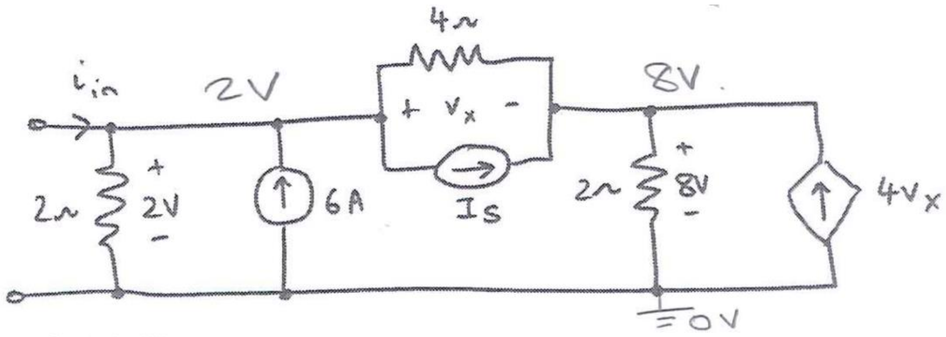
$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{1 \times 6}{1+6} = \frac{6}{7}\,\Omega$$

$$i_{sc} = \frac{v}{R_T}$$

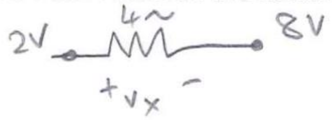
$$= \frac{10}{6/7} = 11.67\text{A}$$

Chapter 3 Ex 20: Ohm's and Kirchoff's laws

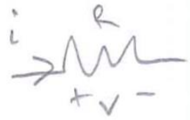


Use Ohm's and Kirchoff's laws on the circuit below to find

a) v_x



$v_x = 2 - 8 = -6V.$

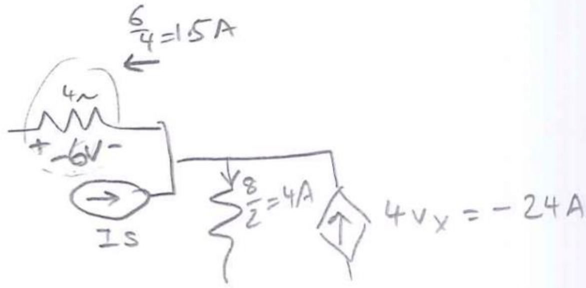


b) I_s

$\Sigma I_{in} = 0$, KCL

$I_s - 1.5 - 4 - 24 = 0$

$I_s = 29.5A$

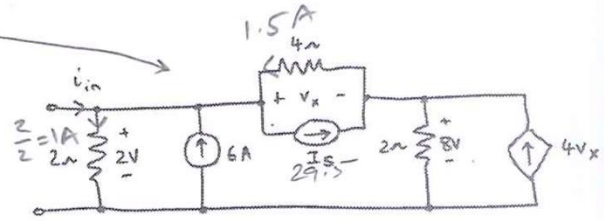


c) i_{in}

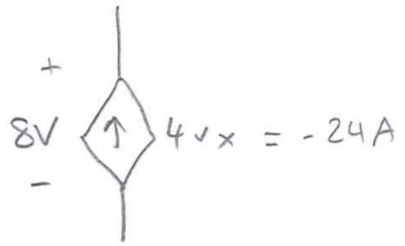
$\Sigma I_{in} = \Sigma I_{out}$

$i_{in} + 6 + 1.5 = 1 + 29.5$

$i_{in} = 23A$



d) the power supplied/ provided by the dependent source.



$P_{supp} = VI$

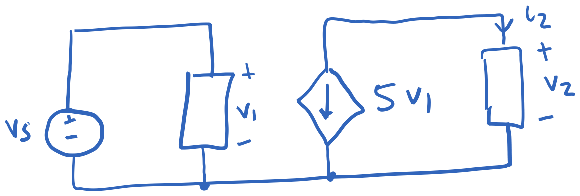
$= 8 \times (-24)$

$= -192W$

Extra Questions for Tutorial 1 (no worked solutions just final answer given)

Ch 2 ex 23 [Ans: $v_s = -1\ mV$]

For the circuit below, determine v_s if $v_2 = 1000 i_2$ and $i_2 = 5\ mA$.



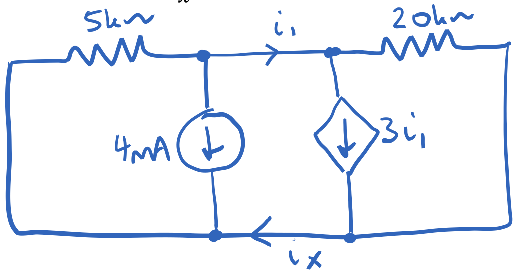
Ch 2, Ex 27 [Ans: a) 4.545 mA – 5.556 mA. b) 22.73 mW – 27.78 mW]

A 1 kΩ resistor with a 10% tolerance may have a value anywhere within the range 900 - 1100 Ω. Answer the following questions assuming 5.0 V is applied across the resistor.

a) What is the range of currents that might be measured?
b) What is the range of power that might be measured?

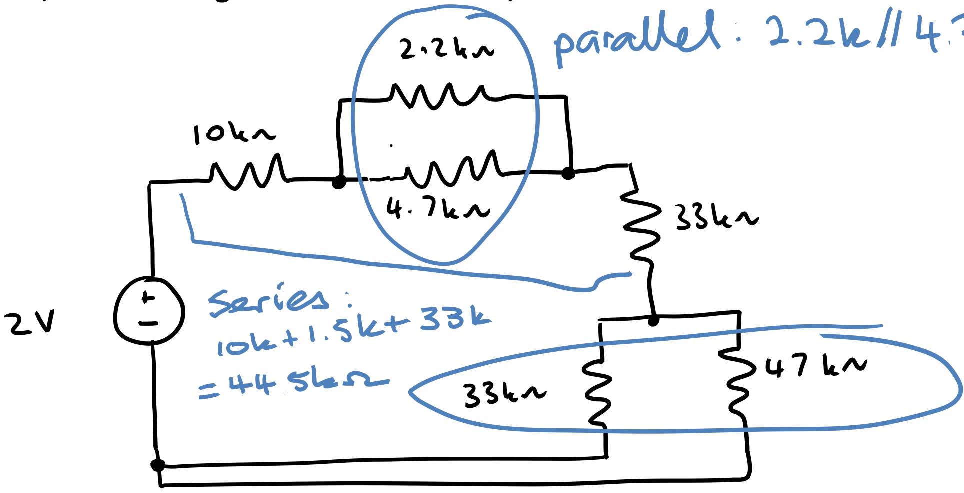
Ch 3 ex 36 [Ans: $i_x = 571.4\ \mu A$]

Find the current i_x in the circuit below.



Pre-tutorial 2 Questions

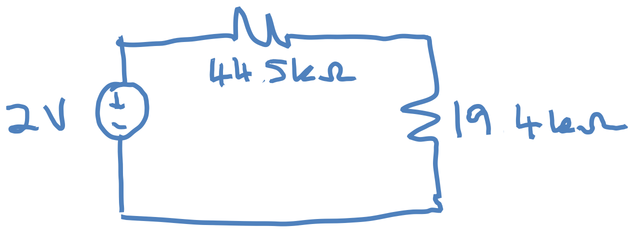
Chapter 3, Ex 67: Voltage and current divider, and resistor combinations



parallel: 2.2k // 4.7k = 1.5kΩ

parallel:
33k // 47k
= 19.4kΩ

a) Use voltage division to calculate the voltage across the 47 kΩ resistor in the circuit above.

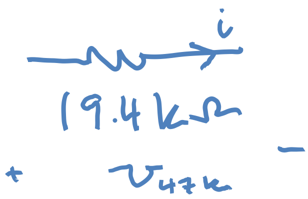


$$v_{47k} = 2 \times \frac{19.4k}{19.4k + 44.5k}$$

$$= 607\,\text{mV}$$

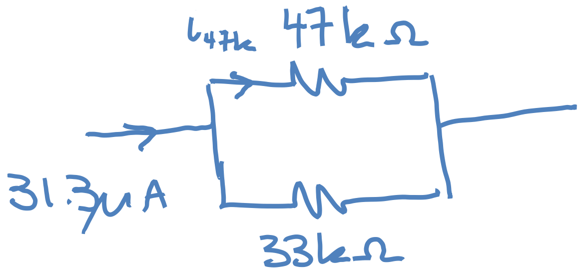
b) Find the current down the 47 kΩ resistor using current divider.

Current through main loop:



$$i = \frac{v}{R} = \frac{607 \times 10^{-3}}{19.4 \times 10^{3}}$$

$$= 31.3\,\mu A$$

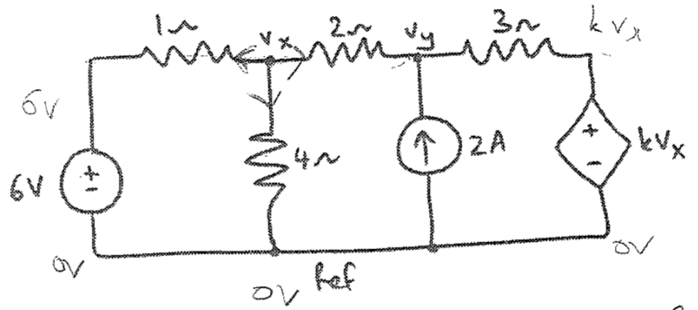


$$i_{47k} = \frac{31.3\mu \times 33k}{47k + 33k}$$

$$= 12.9\,\mu A$$

Chapter 4, Ex 19: Nodal analysis

Using nodal analysis, find the value of k that will result in $v_y = 0$ in the circuit below.



$\underline{\underline{V_x}}$

$\sum I_{out} = 0$

$$\frac{v_x - 6}{1} + \frac{v_x}{4} + \frac{v_x - v_y}{2} = 0$$

$$7v_x - 2v_y = 24 \xrightarrow{v_y = 0} 7v_x = 24 \qquad (1)$$

$\underline{\underline{V_y}}$ $\sum I_{out} = 0$

$$\frac{v_y - v_x}{2} - 2 + \frac{v_y - kv_x}{3} = 0 \qquad (2)$$

$$5v_y - v_x(3 + 2k) = 12 \xrightarrow{v_y = 0} -3v_x - 2kv_x = 12$$

From (1)

$$v_x = 24/7 = 3.429\text{V}$$

From (2)

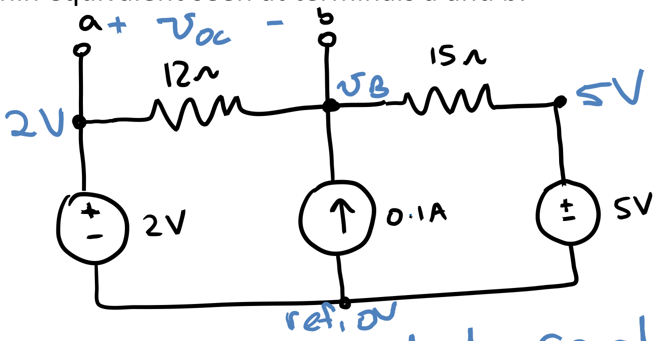
$$k = \frac{-12 - 3v_x}{2v_x} = -3.250$$

At Tutorial 2 – Marked Question

Chapter 5, Ex 45: Thévenin equivalent (use nodal analysis)

For the network below:

a) find the Thévenin equivalent seen at terminals a and b.



Find v_{oc} using nodal analysis

$\Sigma I_{out} = 0$ at node B

$$\frac{v_B - 2}{12} - 0.1 + \frac{v_B - 5}{15} = 0$$

$$\frac{5v_B - 10 + 4v_B - 20}{60} = 0.1$$

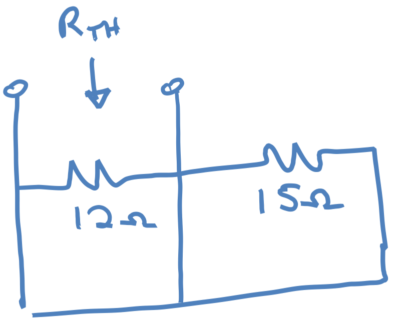
$$9v_B - 30 = 6$$

$$9v_B = 36$$

$$v_B = 4\text{ V}$$

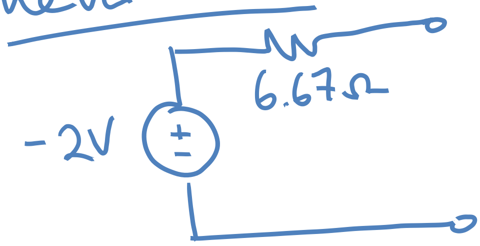
$$v_{oc} = 2 - v_B$$
$$= -2\text{V}$$

R_{TH}

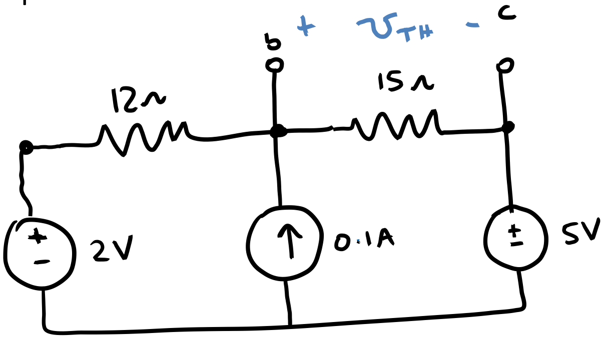


$$R_{TH} = 12 // 15$$
$$= 6.67\,\Omega$$

Thévenin cct:



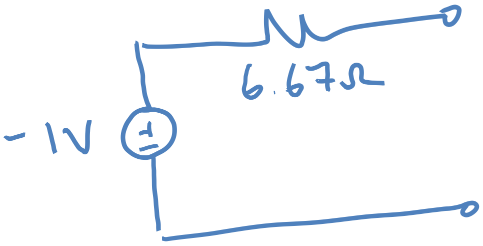
b) find the Thévenin equivalent seen at terminals b and c.



$\Rightarrow v_B$ is the same as before. $\therefore v_B = 4V$

$v_{TH} = 4 - 5 = -1\,V$

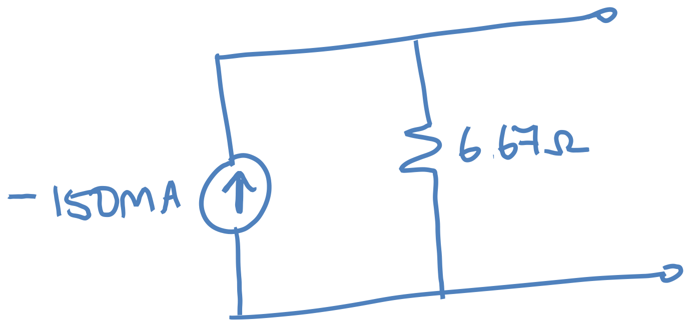
$R_{TH} = 15 // 12 = 6.67\,\Omega$



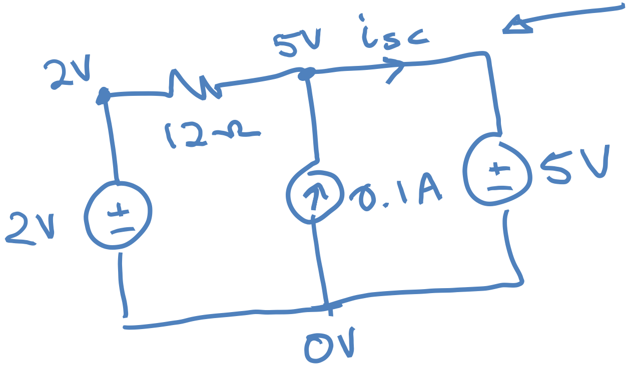
Thévenin cct

Norton

$i_N = \dfrac{v_{TH}}{R_{TH}} = -150mA$



OR



SC in // w 15Ω resistor, so can remove $R_{15\Omega}$.

$i_{sc} = 0.1 + \dfrac{2-5}{12}$

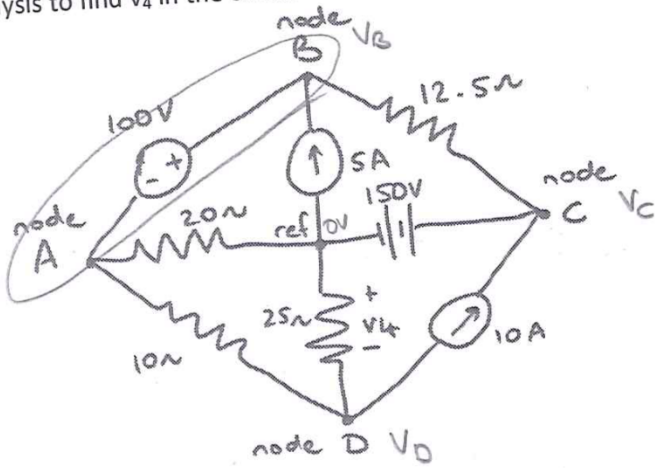
$= 150mA$ as before $\ddot{\smile}$

At Tutorial 2 – Unmarked Questions

Chapter 4, Ex 16: Nodal analysis

$-V_D$.

Use nodal analysis to find v_4 in the circuit below.



Supernode A – B : $\Sigma I_{out} = 0$

$$\frac{V_A}{20} + \frac{V_A - V_D}{10} + \frac{V_B - V_C}{12.5} - 5 = 0$$

$$0.15 V_A + 0.08 V_B - 0.08 V_C - 0.1 V_D = 5 \quad (1)$$

Extra equation $V_B - V_A = 100 \quad (2)$

Node C

By observation $V_C = 150V$

Node D $\Sigma I_{out} = 0$

$$\frac{V_D - V_A}{10} + \frac{V_D}{25} + 10 = 0$$

$$-25 V_A + 35 V_D = -2500 \quad (3)$$

↓

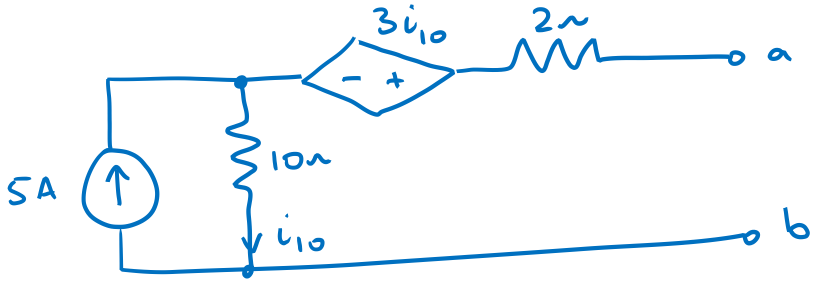
$$V_D = -63.06V$$

But $V_D = -V_4$

$\longrightarrow V_4 = 63.06V$.

Chapter 5, Ex 63: Thévenin equivalent

a) Determine the Thévenin equivalent of the network shown below.



V_{oc}

$i_{10} = 5A$ by inspection

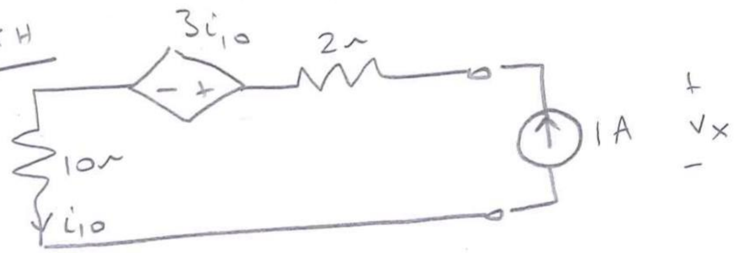
$V_{TH} = 10 i_{10} + 3 i_{10}$

$= 13 \times 5$

$= 65V$

R_{TH}

OA → OC



Test source.

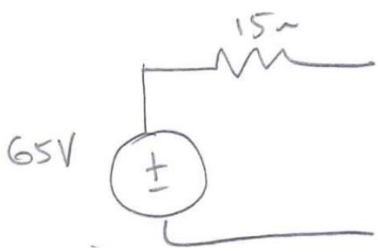
$V_x = 2 \times 1 + 3i_{10} + 10 i_{10}$ (KVL)

$i_{10} = 1A$

$\hookrightarrow V_x = 15V$

$R_{TH} = \frac{V_x}{1} = 15 \Omega$

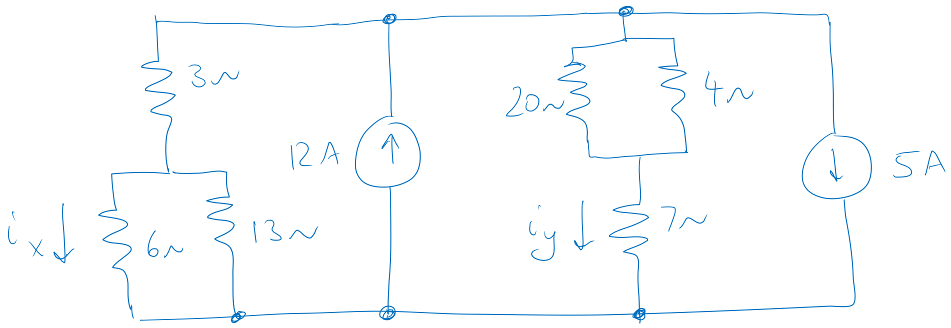
Or could calculate isc and use ohms law.



Extra Questions for Tutorial 2 (no worked solutions just final answer given)

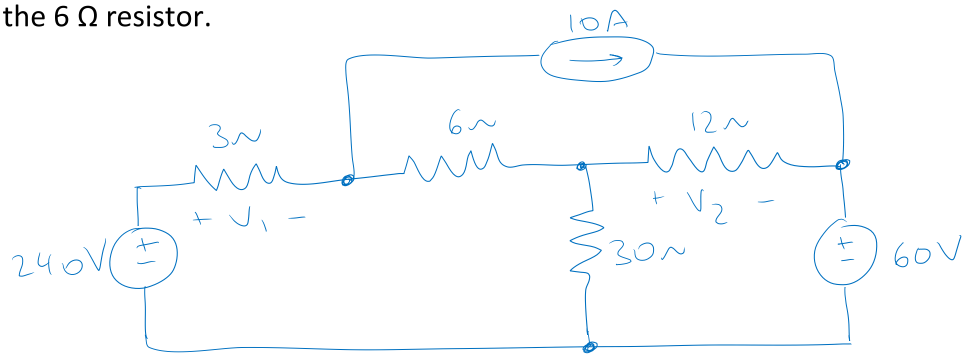
Ch 3, Ex 74: Current divider [Ans: $i_x = 2.837$ A, $i_y = 2.853$ A, P = 51.59 W]

For the circuit below, find i_x, i_y and the power dissipated/ absorbed by the 3 Ω resistor.



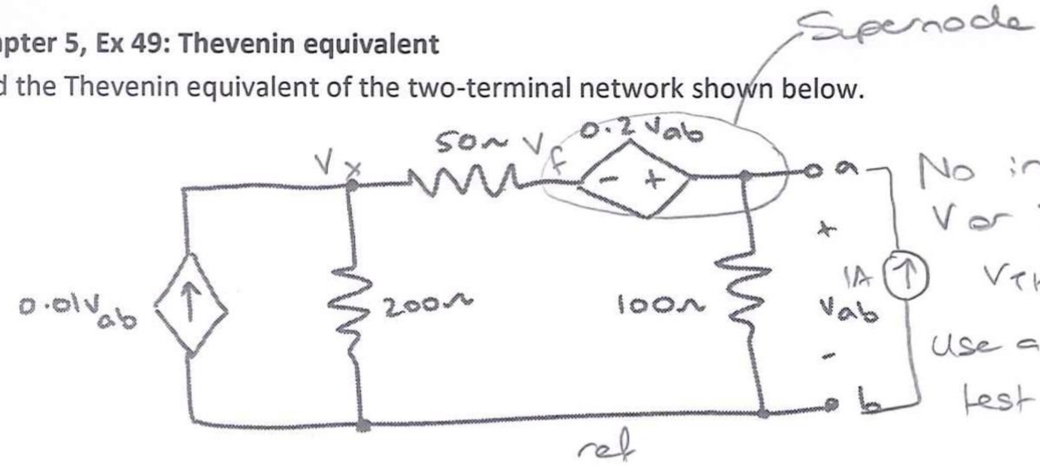
Ch 4, Ex 9: Nodal analysis [Ans: $v_1 = 58.5$ V, $v_2 = 64.4$ V, P = 543.4 W]

For the circuit below: (a) Use nodal analysis to determine v_1 and v_2. (b) Compute the power absorbed by the 6 Ω resistor.



Chapter 5, Ex 49: Thevenin equivalent

Find the Thevenin equivalent of the two-terminal network shown below.



No indep V or I sources

$V_{TH} = 0$

Use a 1A test source.

Node x ($\Sigma I_{out} = 0$)

$$-0.01 V_{ab} + \frac{V_x}{200} + \frac{V_x - V_f}{50} = 0$$

Supernode f–a ($\Sigma I_{out} = 0$)

$$\frac{V_f - V_x}{50} + \frac{V_{ab}}{100} - 1 = 0$$

$$V_{ab} - V_f = 0.2 V_{ab}$$

$$\downarrow$$

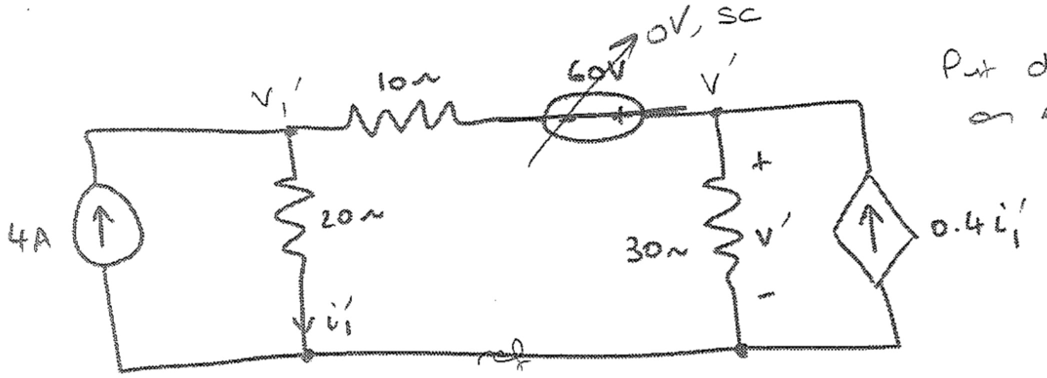
$$V_{ab} = 192.3 V$$

$$R_{TH} = \frac{V_{ab}}{1} = 192.3 \Omega$$

Pre-tutorial 3 Question

Chapter 5, Ex 10: Superposition

Use superposition on the circuit below to find the voltage v. Note that there is a dependent source present.



Put dashes on everything

Consider 4 A source (kill 60V source)

Nodal analysis

Node v_1' $\quad \sum I_{out} = 0$

$$-4 + \frac{v_1'}{20} + \frac{v_1' - v'}{10} = 0 \qquad (1)$$

Node v'

$$-0.4i_1' + \frac{v'}{30} + \frac{v' - v_1'}{10} = 0 \qquad (2)$$

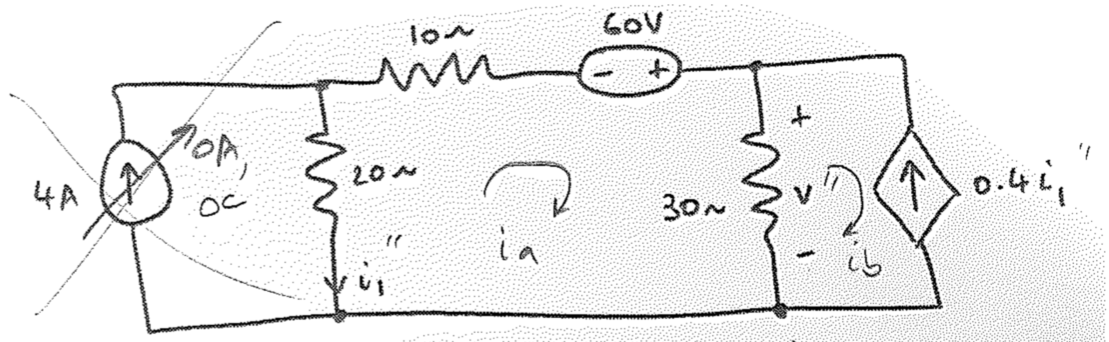
$$i_1' = \frac{v_1'}{20} \qquad (3)$$

$\downarrow$

$$3v_1' - 2v' = 80$$

$$-7.2v_1' + 8v' = 0$$

$\Rightarrow v' = 60V$



<u>Consider 60V source</u> (kill 4A source)

Mesh analysis

$$20 i_a + 10 i_a - 60 + 30(i_a - i_b) = 0$$

$$60 i_a - 30 i_b = 60 \qquad (1)$$

$$i_b = -0.4 i_1''$$

$$i_a = -i_1''$$

$$\hookrightarrow i_b = 0.4 i_a \qquad (2)$$

(2) into (1)

$$60 i_a - 12 i_a = 60$$

$$i_a = 1.25\text{A}, \quad i_b = 0.5\text{A}$$

$$v'' = 30(i_a - i_b)$$

$$= 22.5\text{V}$$

<u>Overall</u>

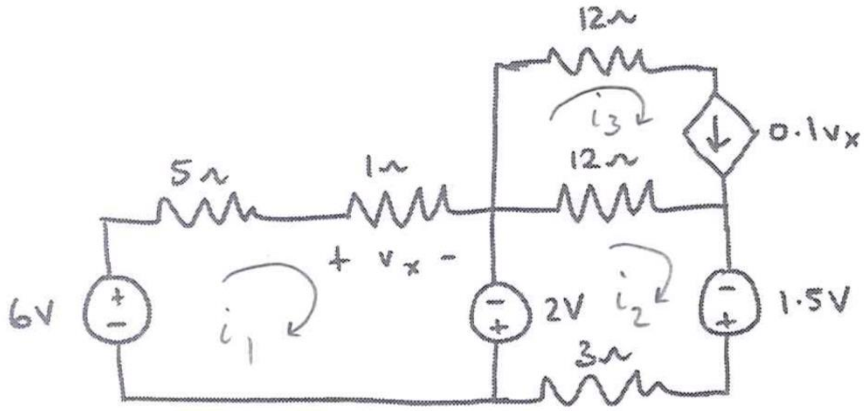
$$v = v' + v'' = 60 + 22.5$$

$$= 82.5\text{V}$$

At Tutorial 3 – Marked Question

Chapter 4, Ex 36: Mesh analysis

Determine each mesh current in the circuit below.



Mesh 1: $-6 + 5i_1 + i_1 - 2 = 0$

$$6i_1 = 8 \rightarrow i_1 = 1.3\dot{3}\,A$$

Mesh2: $2 + 12(i_2 - i_3) - 1.5 + 3i_2 = 0$

$$15i_2 - 12i_3 = -0.5 \qquad (1)$$

Mesh 3:

First find Vx in terms of mesh currents.

L looking at loop 1.

$$V_x = i_1$$

Looking at mesh 3

$$i_3 = 0.1V_x = 0.1i_1 = 133.3\,\overset{10^{-3}}{m}A$$

Subst i_3 into (1)

$$i_2 = \frac{-0.5 + 12(133.3m)}{15}$$

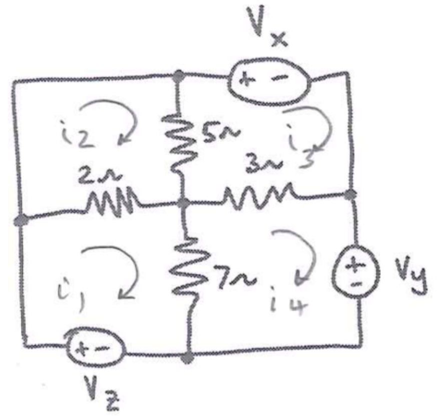
$$= 73.31\,mA$$

Recall $i_1 = 1.33\,A$

At Tutorial 3 – Unmarked Questions

Chapter 4, Ex 40: Mesh analysis

Choose non-zero values for the three voltage sources in the circuit below, such that no current flows through any resistor in the circuit. Recommend using mesh analysis to solve.



Mesh 1 : $-V_z + 2(i_1 - i_2) + 7(i_1 - i_4) = 0$

$-V_z + 9i_1 - 2i_2 - 7i_4 = 0 \quad (1)$

Mesh 2 : $2(i_2 - i_1) + 5(i_2 - i_3) = 0$

$-2i_1 + 7i_2 - 5i_3 = 0 \quad (2)$

Mesh 3 : $3(i_3 - i_4) + 5(i_3 - i_2) + V_x = 0$

$-5i_2 + 8i_3 - 3i_4 + V_x = 0 \quad (3)$

Mesh 4 : $V_y + 7(i_4 - i_1) + 3(i_4 - i_3) = 0$

$V_y - 7i_1 - 3i_3 + 10i_4 = 0 \quad (4)$

For no current flow through any resistor we want

$i_1 - i_2 = 0 \rightarrow i_1 = i_2$

$i_2 - i_3 = 0 \rightarrow i_2 = i_3$

$i_3 - i_4 = 0 \rightarrow i_3 = i_4$

$i_1 - i_4 = 0 \rightarrow i_1 = i_4$

So, $i_1 = i_2 = i_3 = i_4 = i$

From (1)

$$-V_z + i(9-2-7) = 0$$

$$V_z = 0.$$

From (2)

$$i(-2+7-5) = 0$$

$$0 = 0$$

From (3)

$$V_x + i(-5+8-3) = 0$$

$$V_x = 0$$

From (4)

$$V_y + i(-7-3+10) = 0$$

$$V_y = 0.$$

Request for non-zero values can't be satisfied.

Sometimes as an engineer you will be asked to do the impossible.

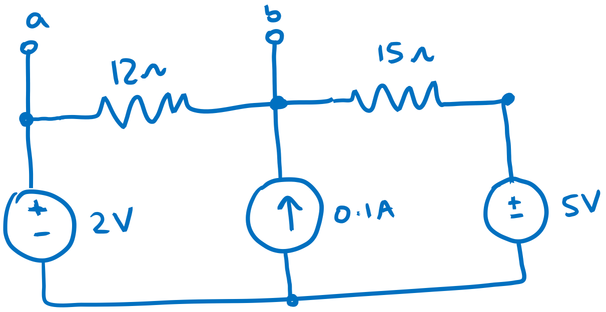
You must check and double check your results.

Then you can argue why it is impossible.

Chapter 5, Ex 45: Norton equivalent (use mesh analysis)

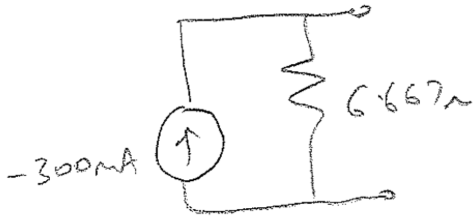
For the network below:

a) find the Norton equivalent seen at terminals a and b.

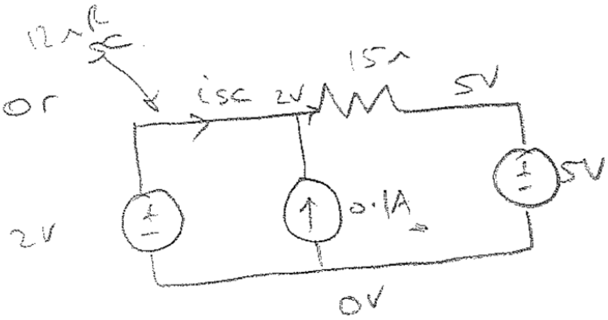


For Norton

$$I_N = \frac{V_{TH}}{R_{TH}} = -300\text{mA}$$



or



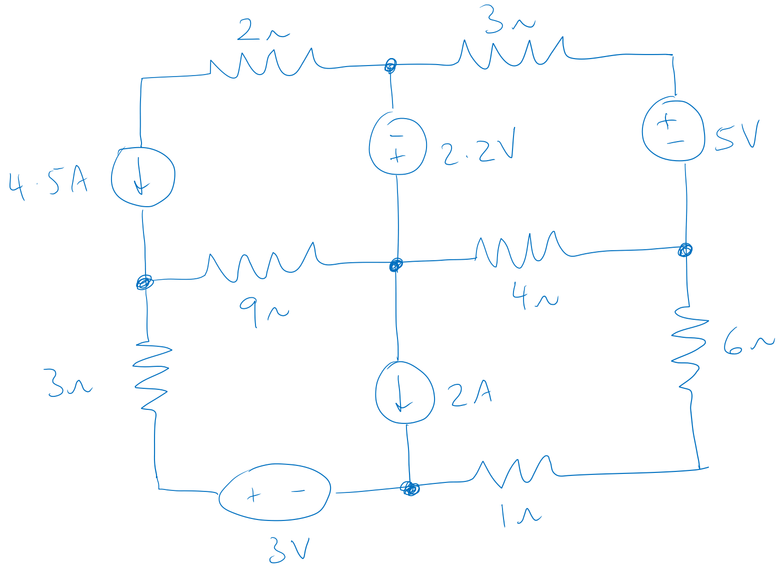
$$i_{sc} + 0.1 = \frac{2-5}{15}$$

$$i_{sc} = -0.3\text{A}$$

Extra Questions for Tutorial 3 (no worked solutions just final answer given)

Ch 4, Ex 43: Mesh analysis [Ans: -3.654 W]

Use the supermesh technique to determine the power supplied by the 2.2 V source in the circuit below.



Ch 5 ex 7: Superposition [Ans: $v_x = 10.33\ V$]

Apply superposition to the circuit below in order to find the value of v_x.