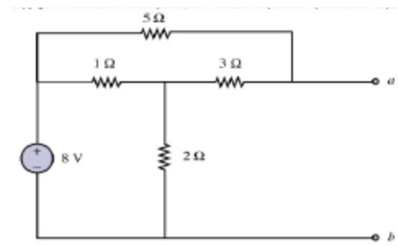
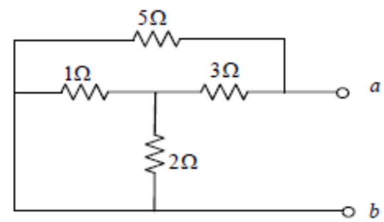
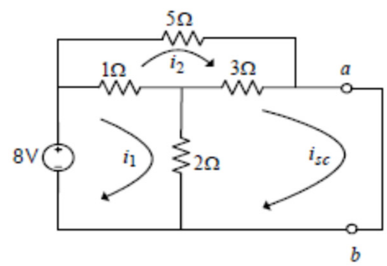
Problem 1







Solution:

Known quantities:

Circuit shown in Figure P3.54.

Find:

Norton equivalent circuit

Analysis:

$$R_N = 5\Omega \| (3\Omega + 2\Omega \| 1\Omega) = 2.12\Omega$$

Using mesh analysis,

$$8 - 1(i_1 - i_2) - 2(i_1 - i_{SC}) = 0$$

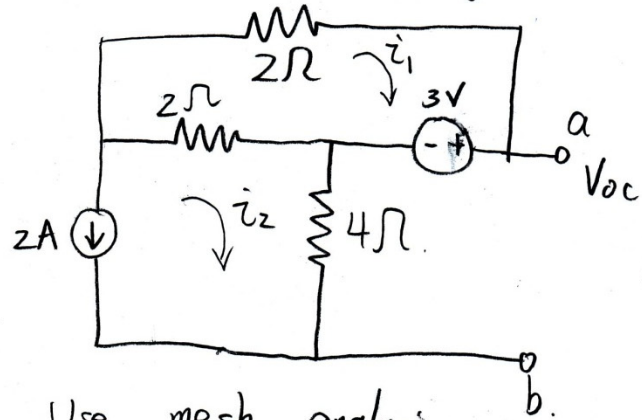
$$-1(i_2 - i_1) - 5i_2 - 3(i_2 - i_{SC}) = 0$$

$$-2(i_{SC} - i_1) - 3(i_{SC} - i_2) = 0$$

Solving, $i_{SC} = 3.05\text{A} \Rightarrow I_N = 3.05A$.

Problem 2

Calculate open circuit voltaage.



Use mesh analysis.

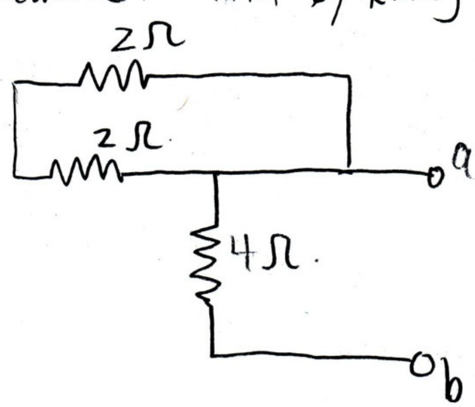
$$\begin{cases} 4i_1 - 2i_2 = -3 \\ i_2 = -2 \end{cases}$$

$$i_1 = -1.75 (A)$$
$$i_2 = -2 (A)$$

$$V_{oc} = V_a - V_b = -2 \times 4 + 3 = -5V.$$

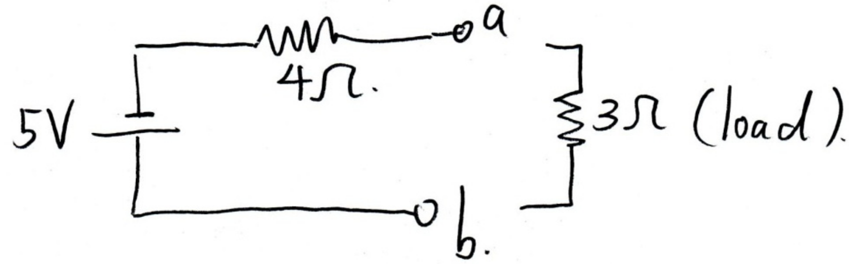
$$V_{TH} = V_{oc} = -5V$$

Calculate R_{TH} by killing the source.



$$R_{TH} = R_{ab} = 4\Omega.$$

Thevenin equivalent circuit.



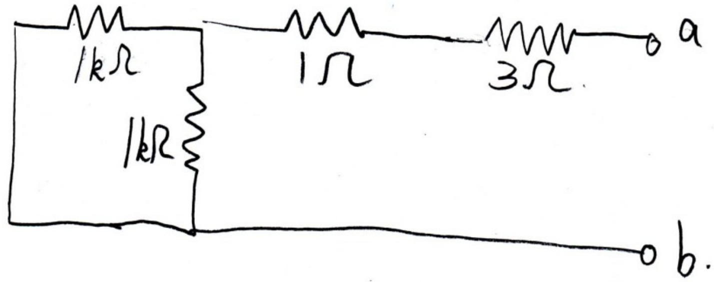
Voltage on 3Ω resistor.

$$V = (-5) \cdot \frac{3\Omega}{4\Omega + 3\Omega}$$

$$= -2.14 \, (V)$$

Problem 3

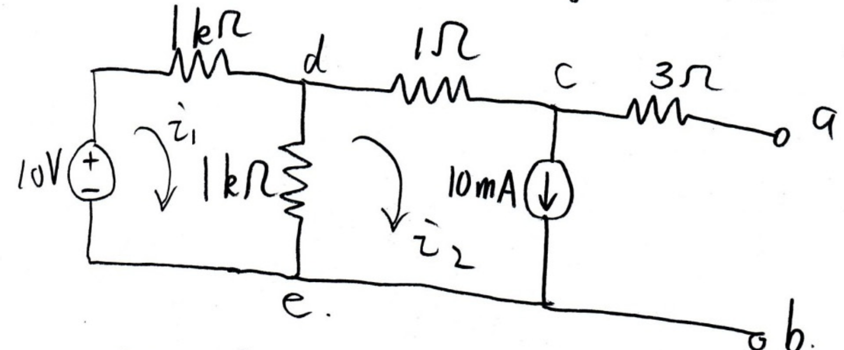
Calculate R_{TH} (or R_N) by killing the source.



$$R_{TH} = R_N = R_{ab} = 1k\Omega // 1k\Omega + 1 + 3$$

$$R_{TH} = R_N = 504\ \Omega.$$

Calculate open circuit voltage for V_{TH}



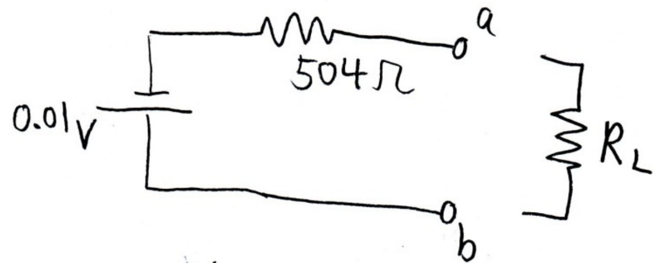
$$\begin{cases} 2000 i_1 - 1000 i_2 = 10. \\ i_2 = 0.01 \end{cases}$$

$$\therefore \begin{cases} i_1 = 0.01\ (A) \\ i_2 = 0.01\ (A) \end{cases}$$

$$V_{oc} = V_a - V_b = V_c - V_e = \Delta V_{e \to d \to c.}$$

$$= (i_1 - i_2) \times 1000 - i_2 \times 1 = -0.01\ (V)$$

$V_{TH} = V_{oc} = -0.01 \ (V)$

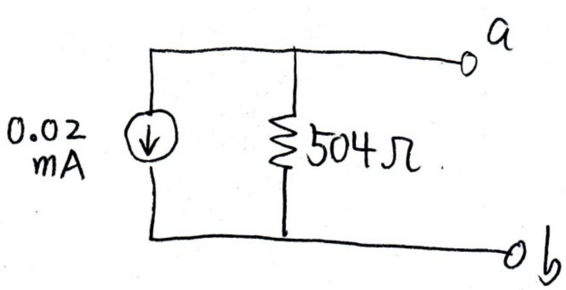


negative V_{TH} means that terminal a is the negative terminal.

Calculate I_N

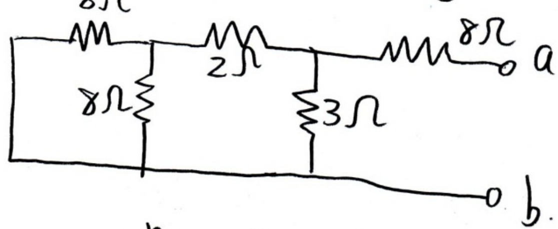
$$I_N = \frac{V_{TH}}{R_N} = \frac{V_{TH}}{R_{TH}} = \frac{-0.01}{504} = -2.0 \times 10^{-5} (A)$$

$$I_N = -0.02 \ (mA)$$



Problem 4

Calculate $R_{TH} = R_N$ by killing the sources



$$R_{TH} = R_N = R_{ab}$$

$$8 // 8 = 4\Omega$$

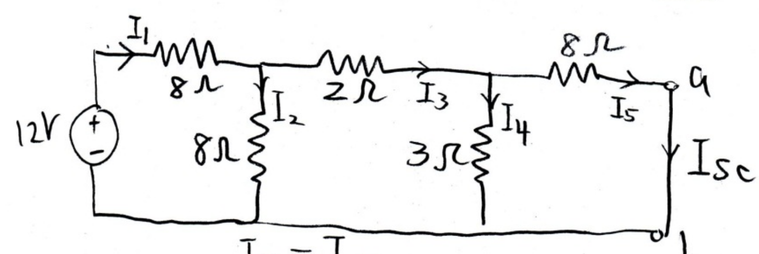
$$4\Omega + 2\Omega = 6\Omega$$

$$6\Omega // 3\Omega = \frac{6 \times 3}{3+6} = 2\Omega$$

$$2\Omega + 8\Omega = 10\Omega$$

$$\therefore \; R_{TH} = R_N = 10\Omega$$

Calculate the short circuit current I_{sc} for I_N.



$$I_5 = I_{sc}$$

R_{eq} seen by 12 V emf : $(8 // 3 + 2) // 8 + 8$

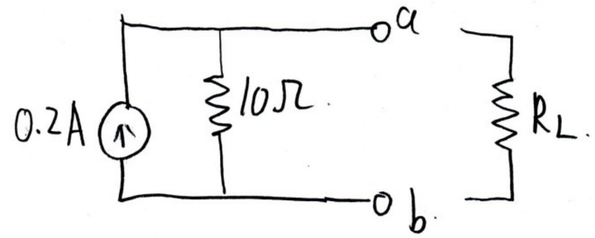
$$R_{eq} = 10.746\ \Omega$$

$$I_1 = \frac{12}{10.746} = 1.117\ (A)$$

$$I_3 = I_1 \cdot \frac{\frac{1}{4.182}}{\frac{1}{8} + \frac{1}{4.182}} = 1.117 \frac{8}{8+4.182} = 0.734\,(A)$$

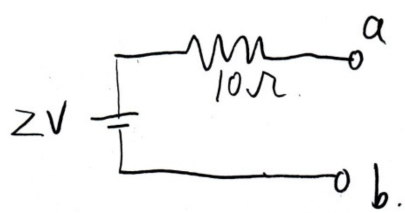
$$I_{sc} = I_5 = I_3 \cdot \frac{\frac{1}{8}}{\frac{1}{3} + \frac{1}{8}} = 0.734 \frac{3}{3+8} = 0.200\,(A)$$

Norton equivalent circuit



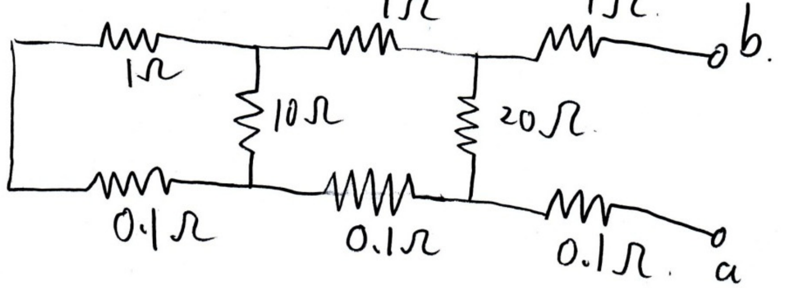
$$V_{TH} = I_N R_N = 0.2 \times 10 = 2V.$$

Thevenin equivalent circuit



Problem 5

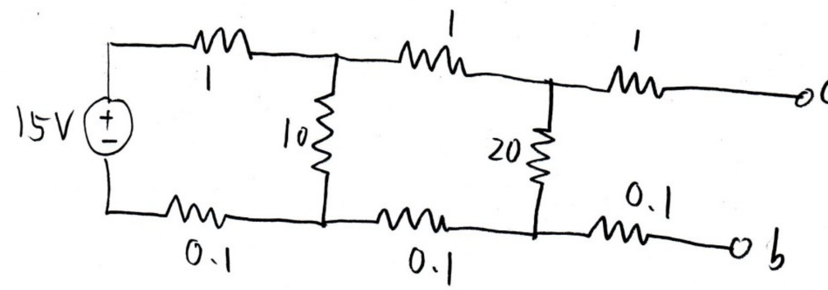
kill the sources



$R_{TH} = R_N = R_{ab} = [(1+0.1)//10 + 1+0.1]//20 + 1+0.1$

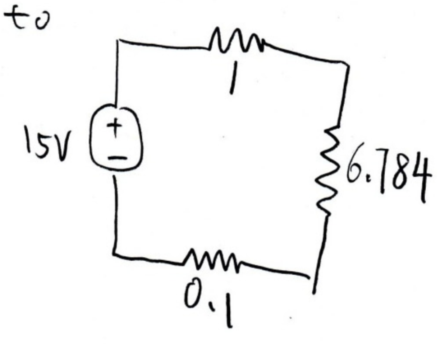
$= 2.993\ \Omega.$

Calculate V_{oc} for V_{TH}.



$V_{oc} = V_a - V_b$

Reduce to



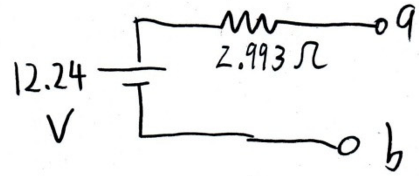
$V_{6.784} = 15 \cdot \dfrac{6.784}{1+0.1+6.784}$

$= 12.91\,V.$

$V_{ab} = 12.91 \times \dfrac{20}{1+0.1+20} = 12.24\ (V)$

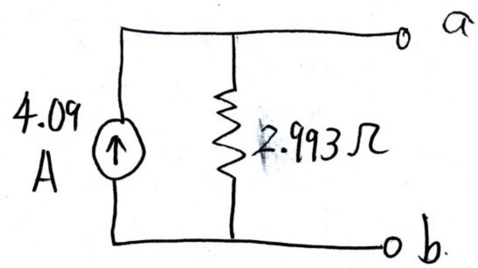
$V_{TH} = V_{oc} = V_{ab} = 12.24\ (V)$

Thevenin equivalent.

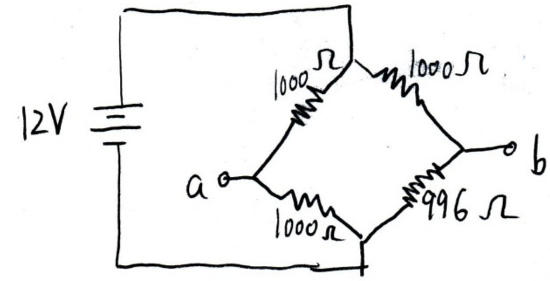


$$I_N = \frac{V_{TH}}{R_{TH}} = \frac{12.24}{2.993} = 4.09\ (A)$$

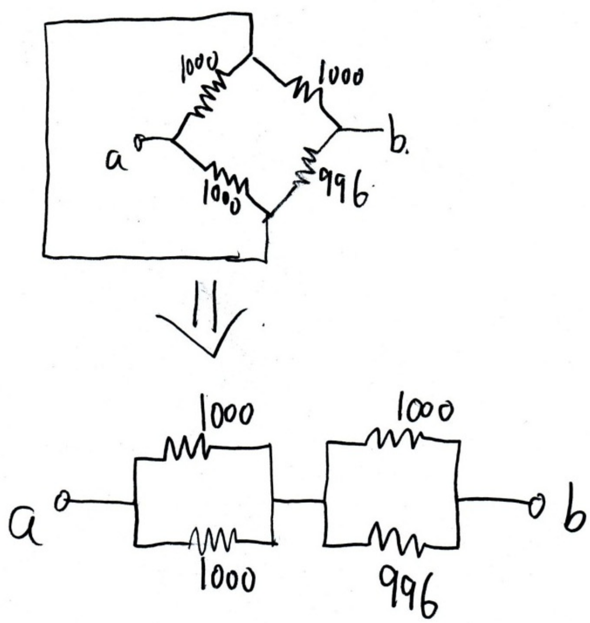
Norton equivalent



Problem 6

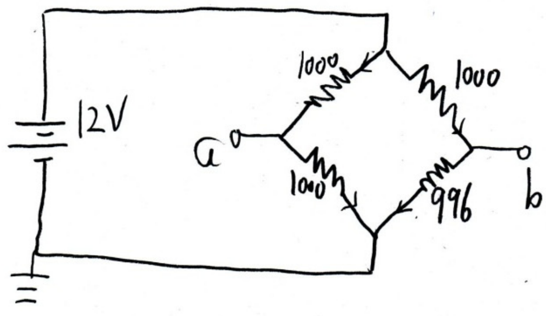


kill the source to calculate R_{TH}



$$R_{TH} = R_{ab} = 1000 // 1000 + 1000 // 996$$
$$= 500 + 499$$
$$= 999\ (\Omega)$$

Calculate open circuit voltage between a and b



↳ suppose this point has zero potential

$$V_a = \frac{12V}{2000\Omega} \times 1000\Omega.$$

$$= 6V$$

$$V_b = \frac{12V}{1996\Omega} \times 996\Omega = 5.988\ (V)$$

$$V_{TH} = V_{OC} = V_{ab} = 6 - 5.988 = 0.012\ (V)$$

$$= 12\ (mV)$$

Thevenin equivalent