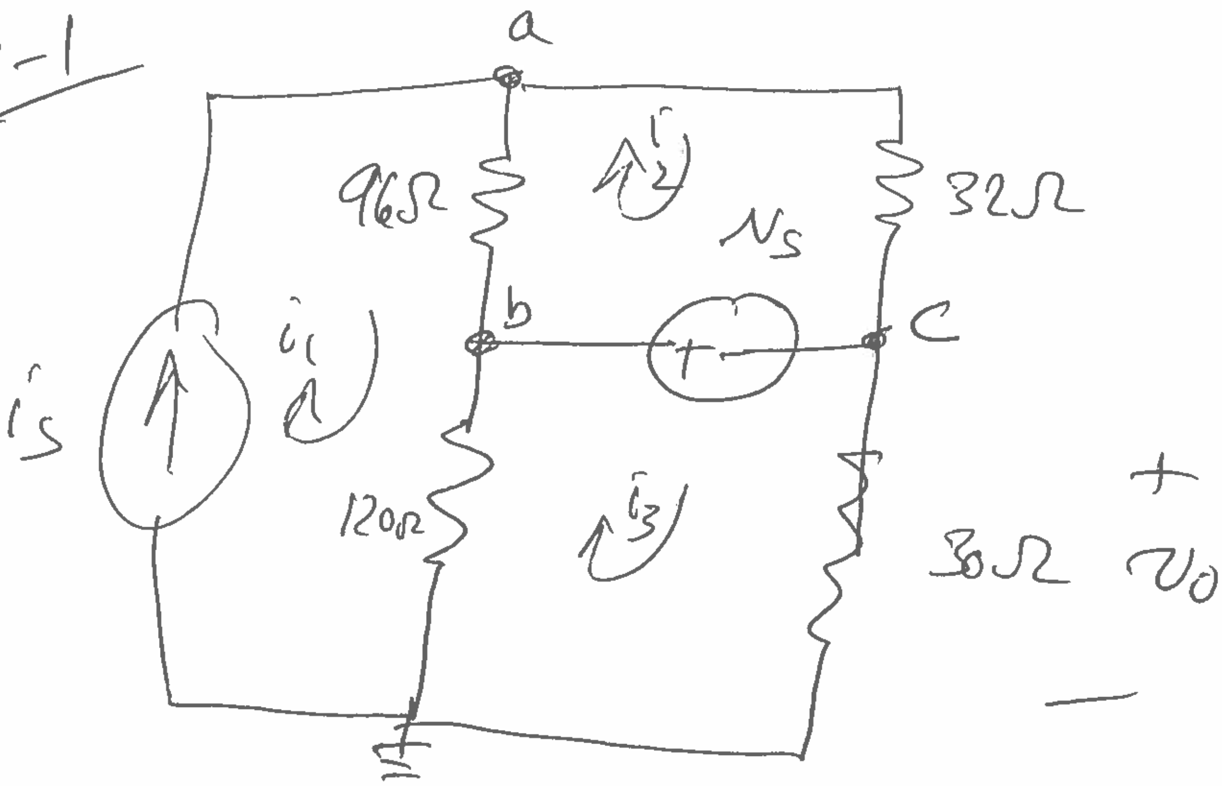
4.8-1



$v_o = a\,i_s + b\,v_s$

— Use Mesh

— Use voltage nodes

Mesh

i_1 eq $\Rightarrow$ $i_1 = i_s$

i_2 eq $\Rightarrow$ $V_s = i_2(96\Omega + 32\Omega) - i_1(96\Omega)$

i_3 eq $\Rightarrow$ $-V_s = i_3(30\Omega + 120\Omega) - i_1(120\Omega)$

$$V_s = i_2(128\Omega) - i_s(96\Omega)$$

$$-V_s = i_3(150\Omega) - i_s(120\Omega)$$

$$V_o = i_3 (30\Omega)$$

from 3rd mesh equation

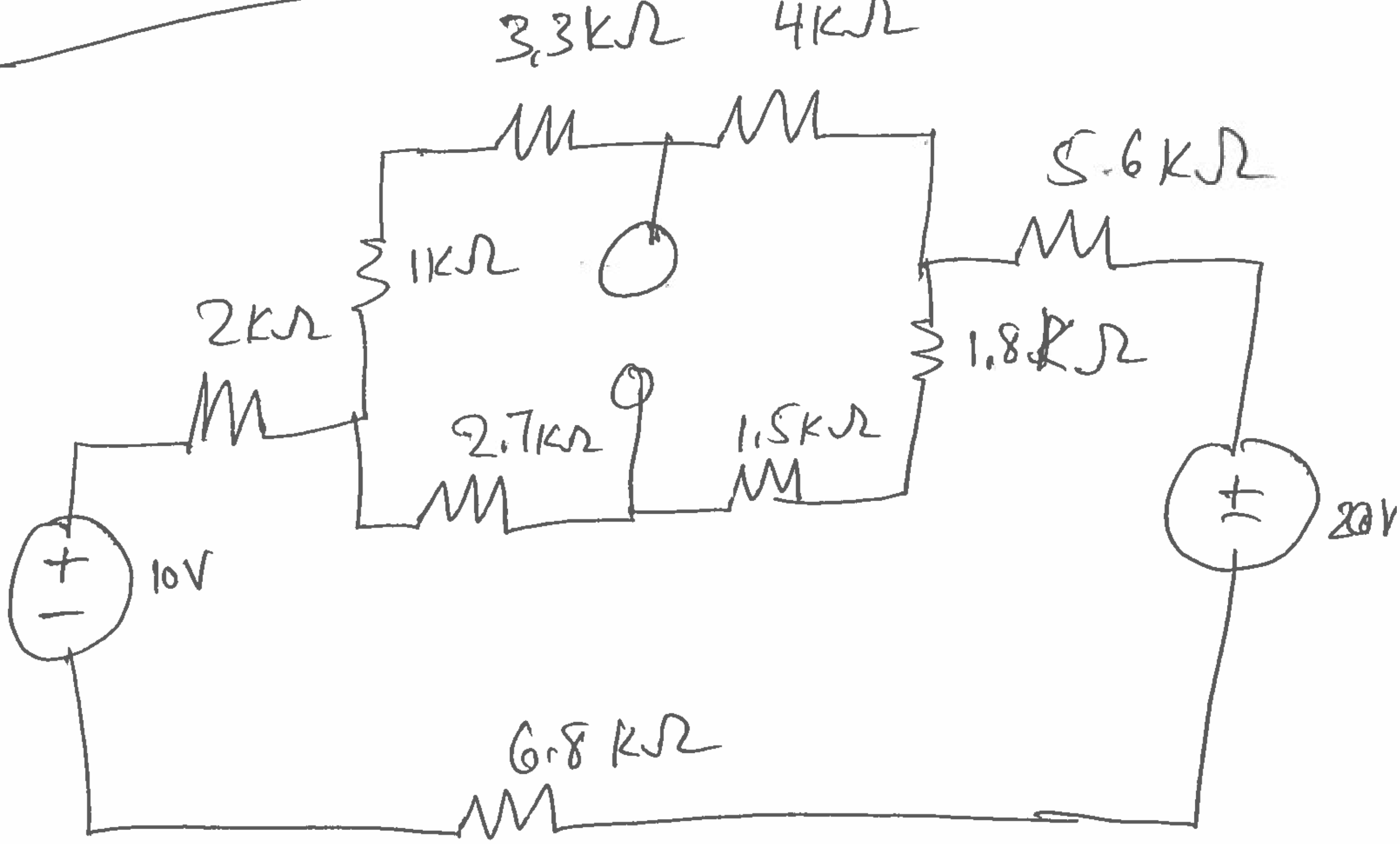
$$i_3 = \frac{i_s(120\Omega) - V_s}{150\Omega}$$

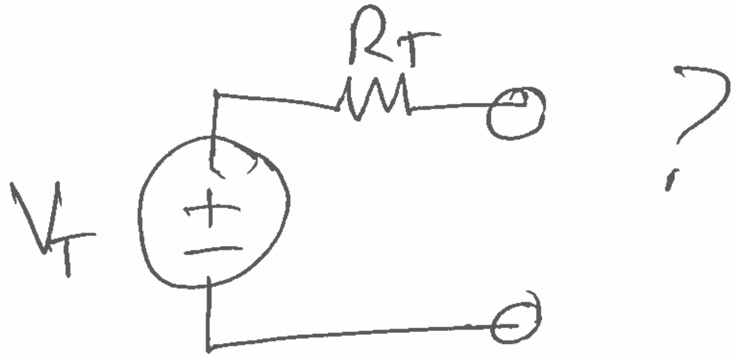
$$V_o = \left(\frac{i_s(120\Omega) - V_s}{150\Omega}\right) 30\Omega$$

Voltage nodes

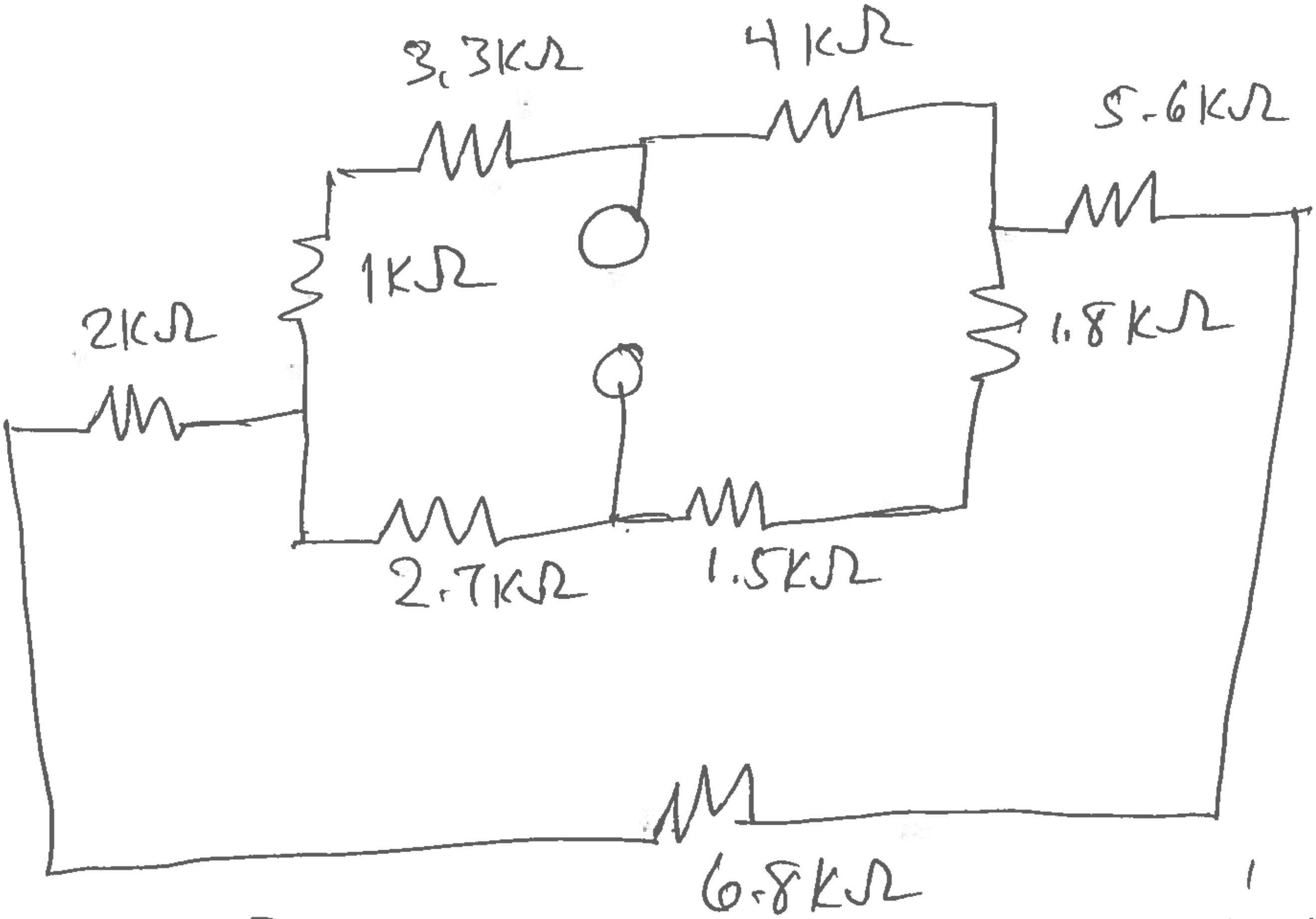
$$V_o = V_c$$

Lab ex



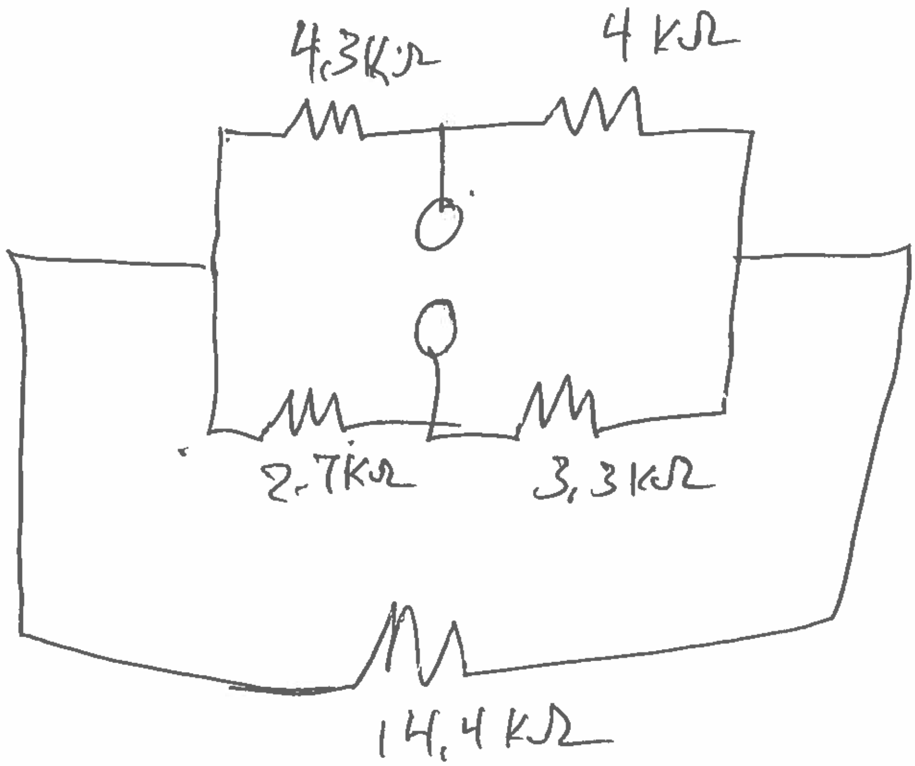


De activate Power Sources

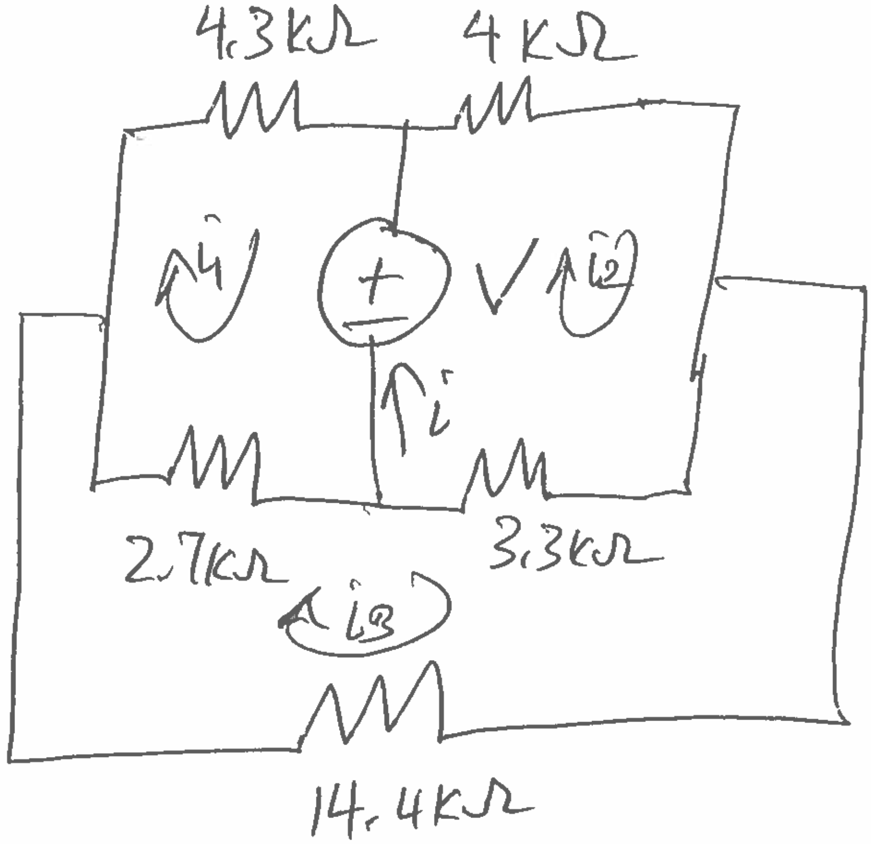


$R_T = ?$

$$\begin{array}{r} 7.6 \\ 6.8 \\ \hline 14.4 \end{array}$$



From ohm's law $R = \frac{V}{i}$ so place an arbitrary voltage source between terminals



Find i $\Rightarrow$ $R_T = \dfrac{V}{i}$ $\quad i = i_2 - i_1$

Now write out Mesh equations

$$-V = i_1 (4.3k\Omega + 2.7k\Omega) - i_3 (2.7k\Omega)$$

$$+V = i_2 (4k\Omega + 3.3k\Omega) - i_3 (3.3k\Omega)$$

$$0 = i_3 (2.7k\Omega + 3.3k\Omega + 14.4k\Omega) - i_1 (2.7k\Omega) - i_2 (3.3k\Omega)$$

Solve for first two equations

understand units for R are $k\Omega$

$$i_1 = \frac{i_3(2.7) - V}{4.3 + 2.7}$$

$$\boxed{i_1 = \frac{i_3(2.7) - V}{7.0}}$$

$$i_2 = \frac{i_3(3.3) + V}{4 + 3.3} = \boxed{\frac{i_3(3.3) + V}{7.3} = i_2}$$

3rd eqv $0 = -i_1(2.7) - i_2(3.3) + i_3(20.4)$

$$0 = \left[\frac{i_3(2.7) - V}{7}\right](2.7) - \left[\frac{i_3(3.3) + V}{7.3}\right](3.3)$$

$$+ i_3(20.4)$$

$$0 = i_3\left[\frac{(2.7)^2}{7} - \frac{(3.3)^2}{7.3} + 20.4\right] + V\left[\frac{(2.7)}{7} - \frac{(3.3)}{7.3}\right]$$

$$0 = i_3\left[17.87\right] + V\left[-0.066\right]$$

$$i_3 = \frac{V\left[0.066\right]}{\left[17.87\right]} = \left(3.69\times10^{-3}\right)V$$

$$i_3 = \left(3.69\times10^{-3}\right)V$$

$$i = i_2 - i_1 = \frac{i_3(3.3)+V}{7.3} - \frac{i_3(2.7)-V}{7.0}$$

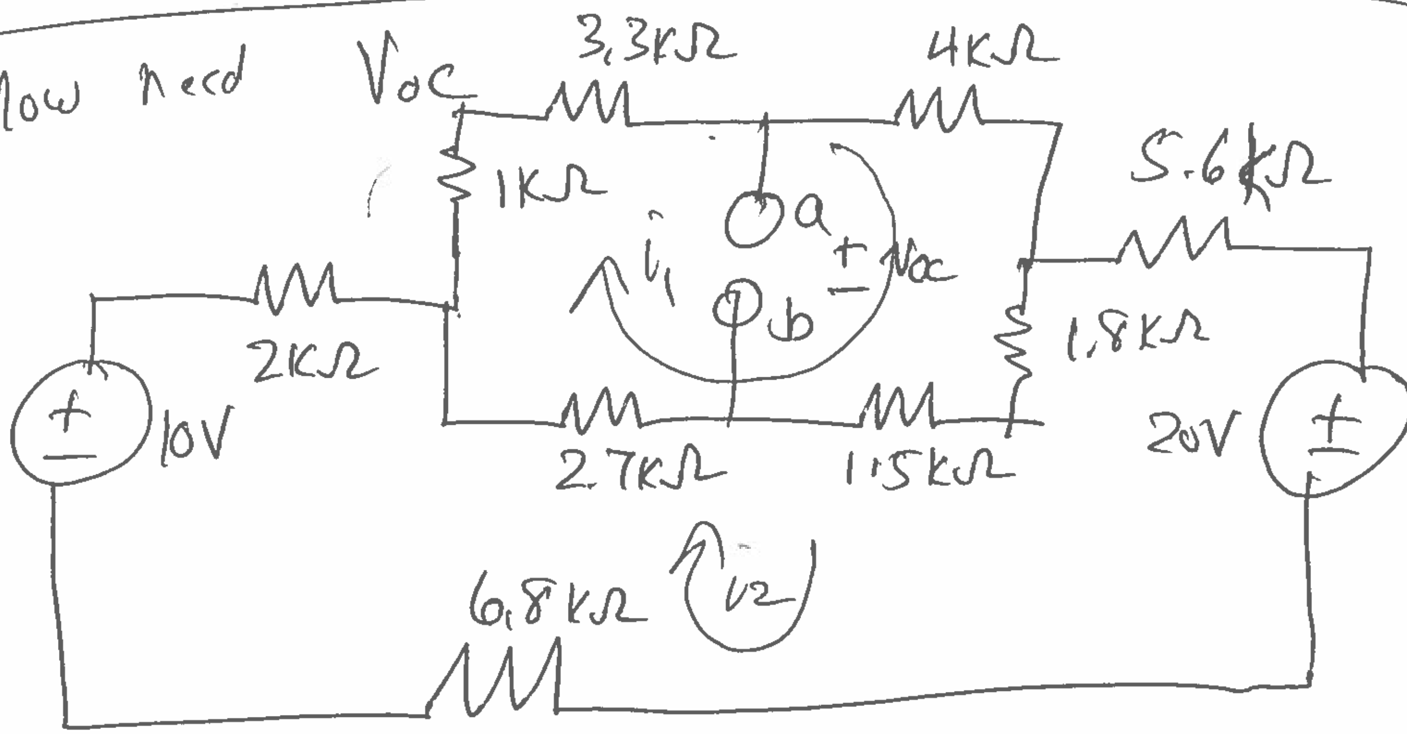
$$i = i_3\left[\frac{3.3}{7.3} - \frac{2.7}{7.0}\right] + V\left[\frac{1}{7.3} + \frac{1}{7.0}\right]$$

$$i = \left(3.69\times10^{-3}\right)V\,(0.066) + V\,(0.2798)$$

$i = V(0.280)$

$$R_T = \frac{V}{i} = \frac{V}{V(0.280)} = \boxed{3.57\,k\Omega}$$

Now need V_{oc}



find $i_1, i_2 \Rightarrow$ Do Voltage walk from $b \rightarrow a$

Mesh equations

$$0 = i_1 (1k\Omega + 3.3k\Omega + 4k\Omega + 1.5k\Omega + 2.7k\Omega + 1.8k\Omega) - i_2 (2.7k\Omega + 1.5k\Omega + 1.8k\Omega)$$

$$10V - 20V = i_2 (6.8k\Omega + 2k\Omega + 2.7k\Omega + 1.5k\Omega + 1.8k\Omega + 5.6k\Omega) - i_1 (2.7k\Omega + 1.5k\Omega + 1.8k\Omega)$$

$$0 = i_1 (14.3k\Omega) - i_2 (6.0k\Omega) \quad \times 6.0$$

$$-10V = -i_1 (6.0k\Omega) + i_2 (20.4k\Omega) \quad \times 14.30$$

$$-143V = i_2 (255.7k\Omega) \Rightarrow i_2 = \cancel{0.559}$$

$$-0.55925 mA$$

$$i_1 = i_2 \left(\frac{6}{14.3}\right)$$

$$i_1 = -0.23465 \ mA$$

$$V_{OC_L} = 2.7\,k\Omega\,(i_2 - i_1) - i_1\,(1\,k\Omega + 3.3\,k\Omega)$$

$$V_{OC\,L} = 2.7\,k\Omega\,(-0.55925\,mA - (-0.23465\,mA)$$

$$-\;(-0.23465\,mA)\,(4.3\,k\Omega)$$

$$V_{OC_L} = 0.13258\ V$$

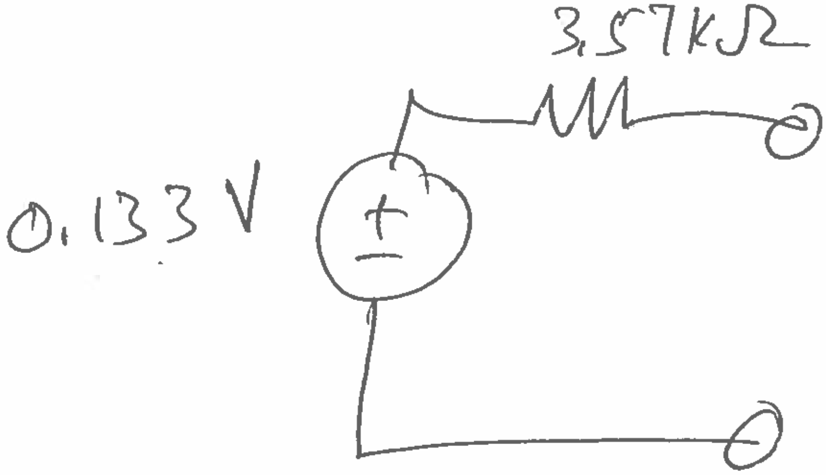
$$V_{OC_R} = (1.5\,k\Omega + 1.8\,k\Omega)\,(i_1 - i_2) + i_1\,(4\,k\Omega)$$

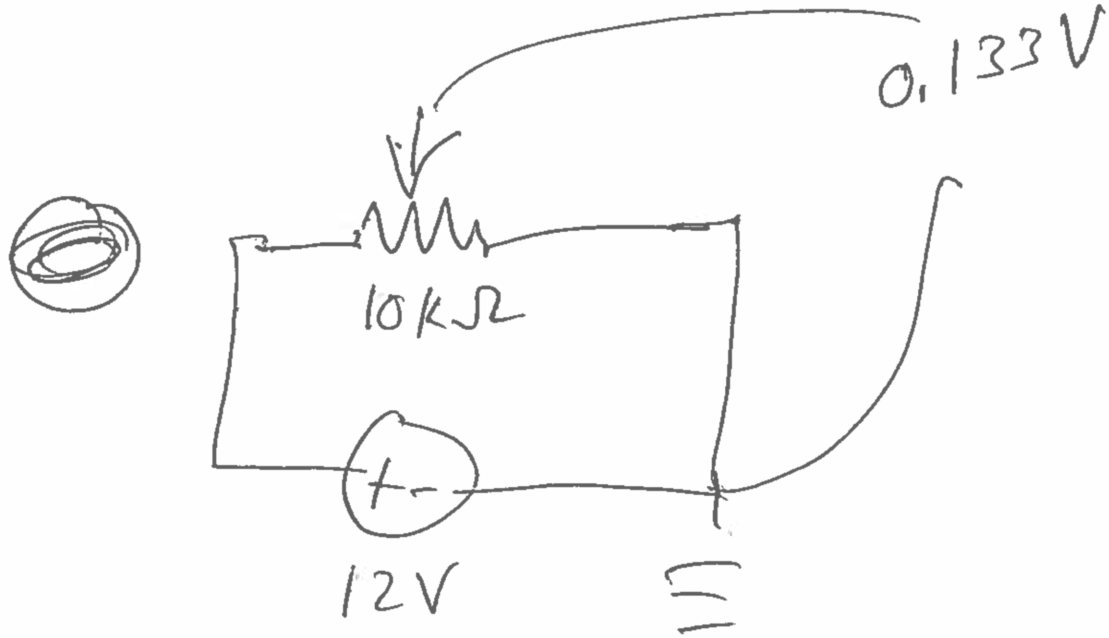
$$= (3.3\,k\Omega)\left(-0.23465\,mA - (0.55925\,mA)\right)$$

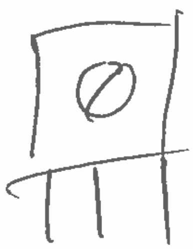
$$+\;(-0.23465\,mA)\,(4\,k\Omega)$$

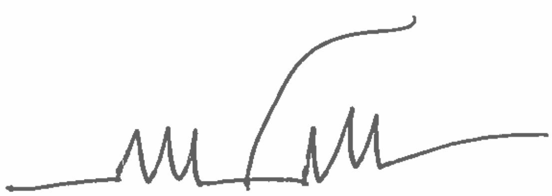
$$= 0.13258\ V \checkmark$$

Thevenin circuit $\Rightarrow$

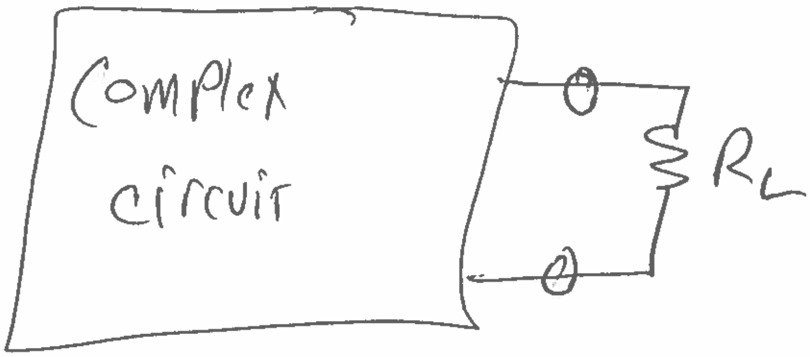




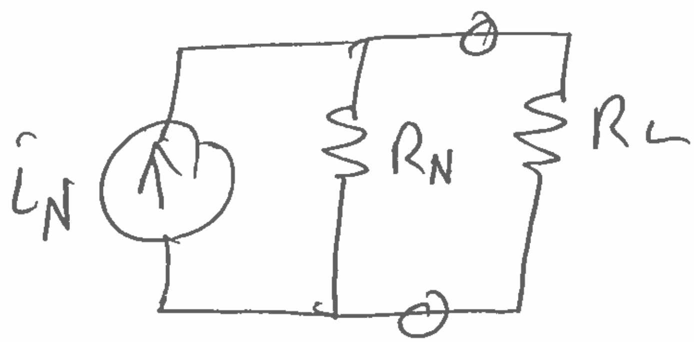




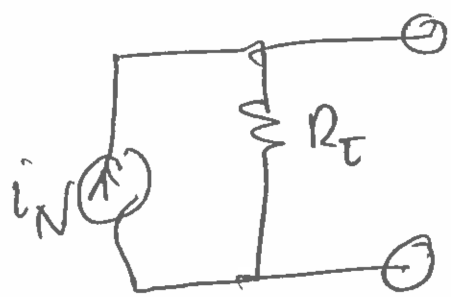
Norton Equivalent Circuit



Replace it with



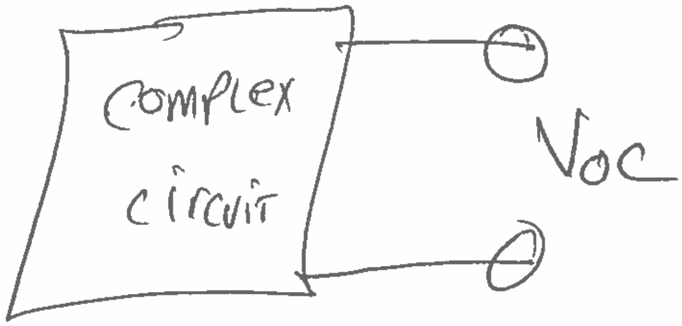
because of Source Transformations $R_N = R_T$



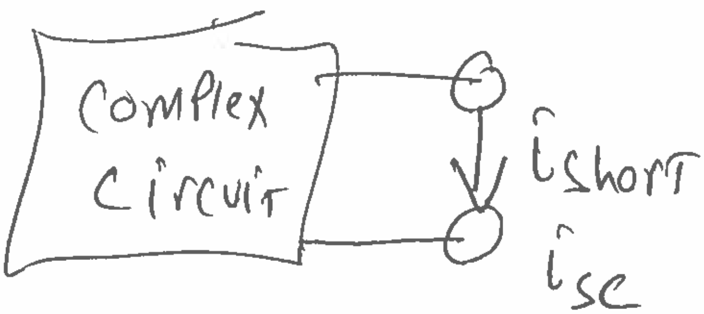
Again Deactivate power sources find

R_T = Requivalent

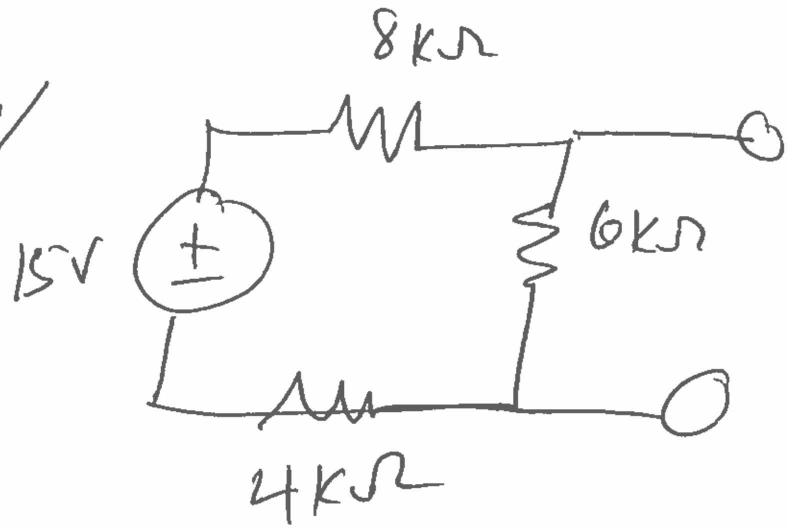
i_N is $i_{short\ circuit}$



Thevenin

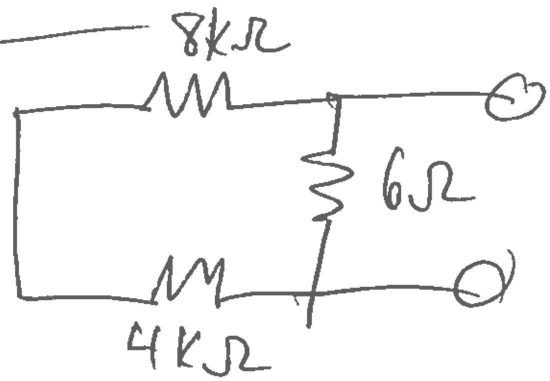


ex/



Find Norton EQUIV.

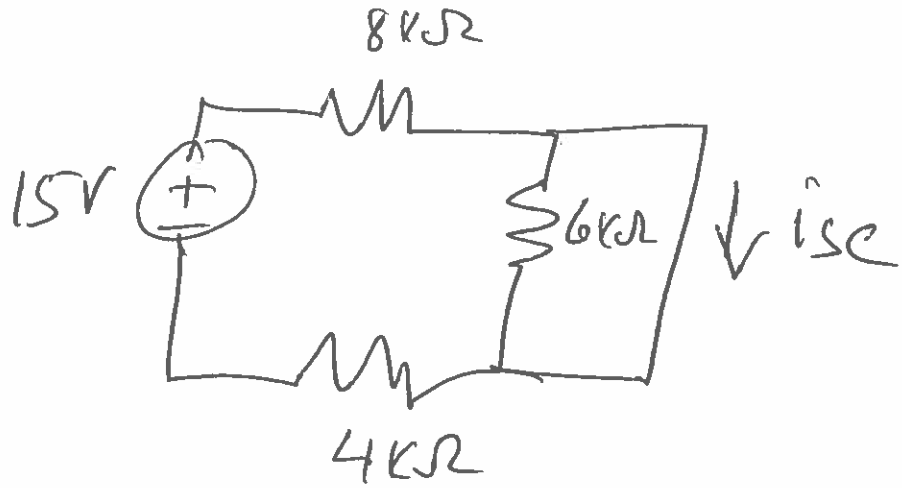
Deactivate



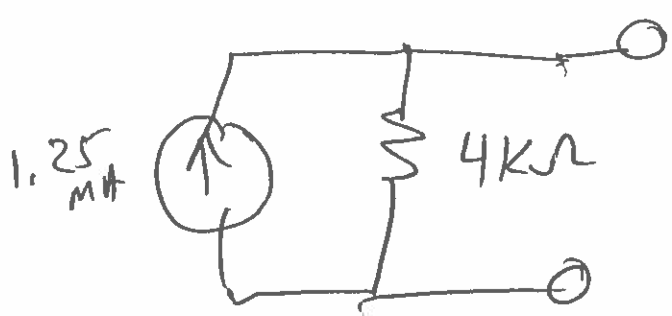
⇒

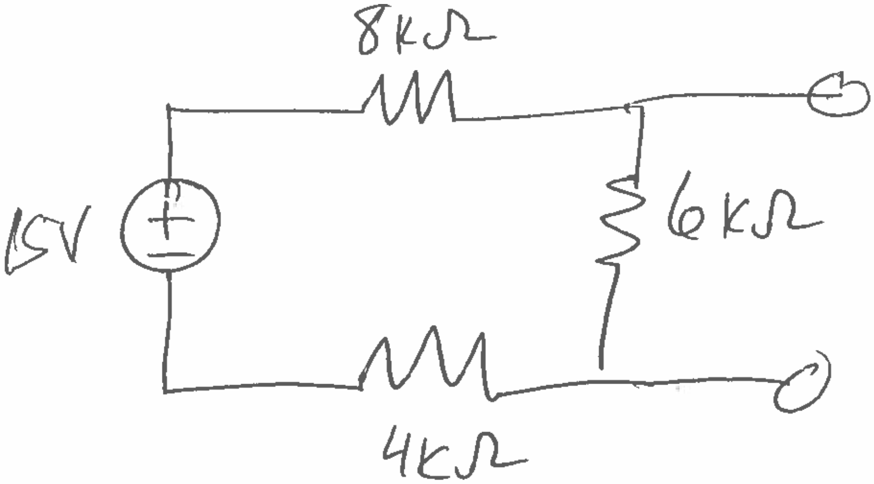
$$\frac{1}{12k\Omega} + \frac{1}{6k\Omega} = \frac{1+2}{12k\Omega} = \frac{3}{12k\Omega} = \frac{1}{4k\Omega}$$

$$\boxed{R_T = 4k\Omega}$$



$$i_{sc} = \frac{15V}{12k\Omega} = 1{,}25\,mA$$



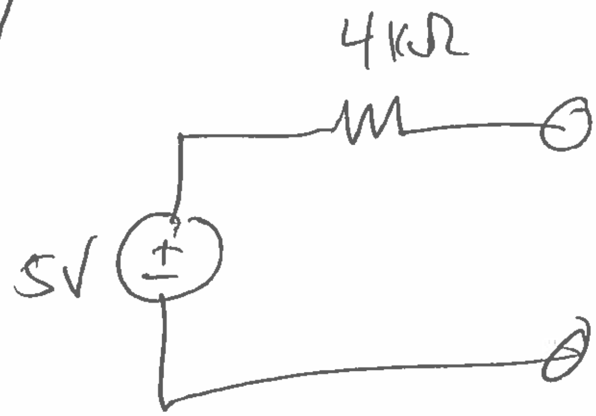


V_o ?

$$V_o = \frac{(15V)\,6k\Omega}{8k\Omega + 4k\Omega + 6k\Omega} = 15V\left(\frac{6\,k\Omega}{18\,k\Omega}\right)$$

$$V_o = 5V$$

Thevenin $\Rightarrow$



Source Transform

$$\frac{5V}{4k\Omega} = 1.25mA$$

recall Thevenin, Norton are Dual circuits