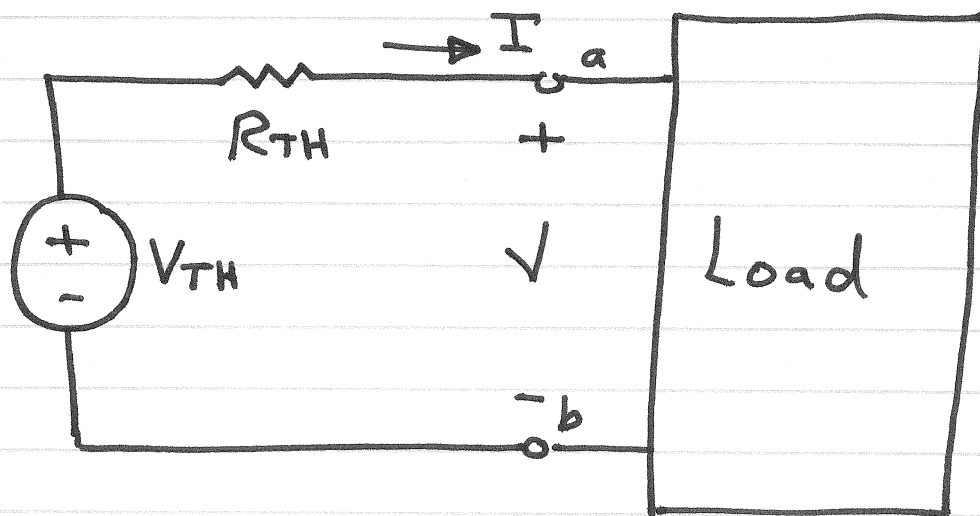
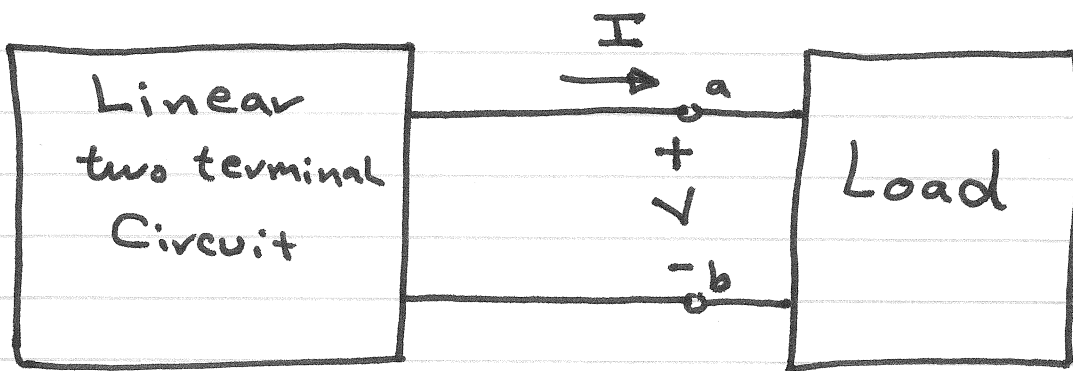


Thevenin's Theorem

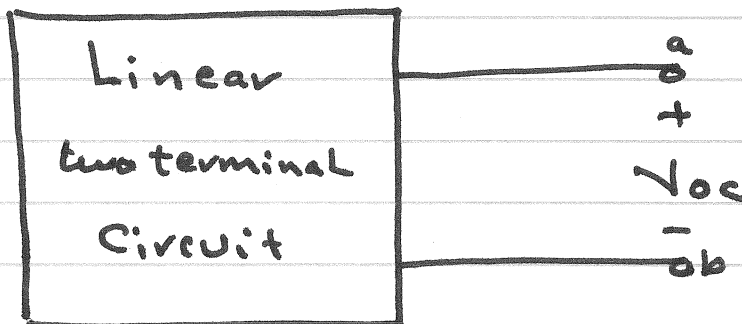


It states that a Linear two terminal circuit can be replaced by an equivalent circuit consisting of a voltage source V_{TH} in series with a resistor R_{TH} , where V_{TH} is the open circuit voltage at the terminals and R_{TH} is the input or equivalent resistance at the terminals when the independent sources

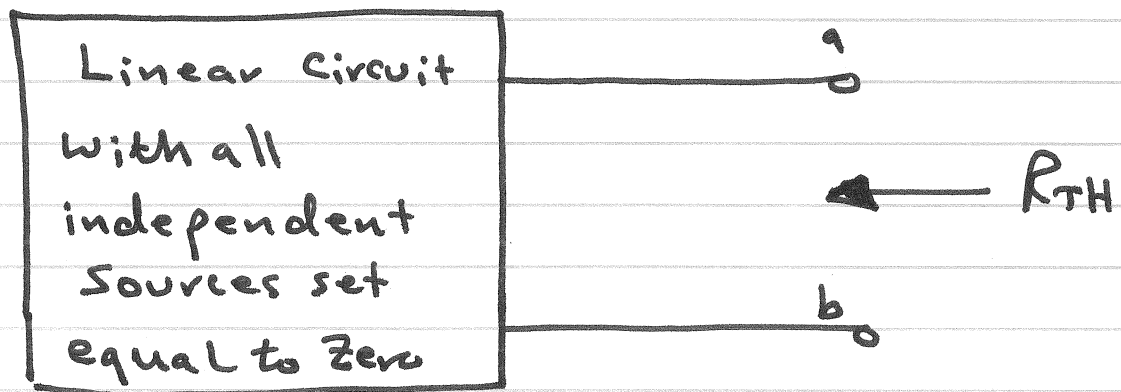
are turn off.

How to find Thevenin's Voltage?

$$V_{TH} = V_{oc}$$



How to find Thevenin's Resistance?



- a-b open circuited
- Turn off all independent sources

How to find R_{TH} ?

Care I

If the circuit has no dependent sources

- Turn off all independent sources
- R_{TH} can be obtained via simplification of either parallel or series connection seen from a-b.

Care II

If the circuit has dependent sources

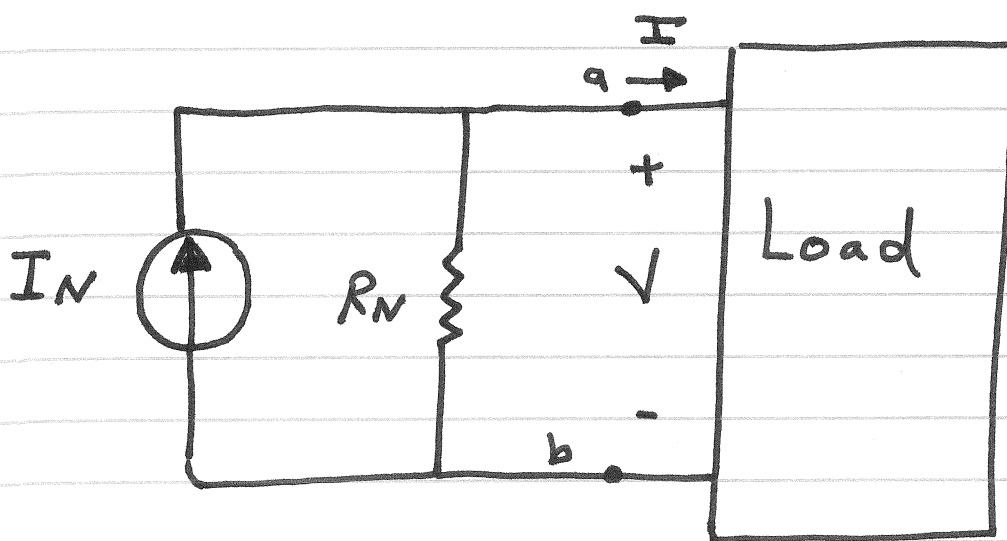
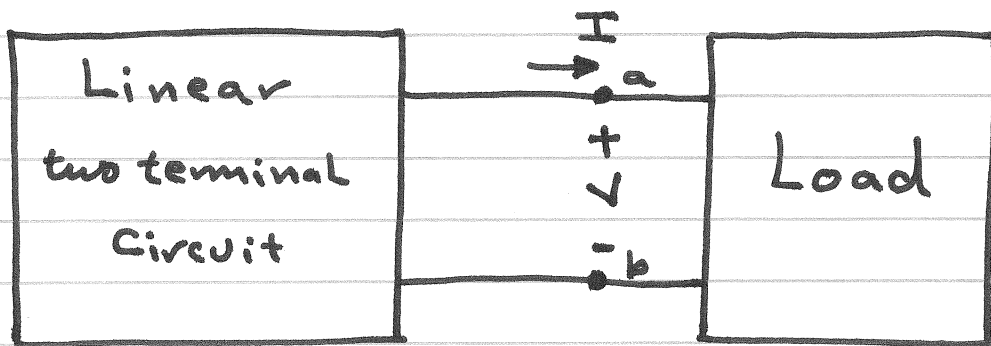
- Turn off all independent sources
- Apply a voltage source V_T at a-b

$$R_{TH} = \frac{V_T}{I_T}$$

- Alternatively, Apply a current source I_T at a-b

$$R_{TH} = \frac{V_T}{I_T}$$

Norton's Theorem



It states that a Linear two terminal Circuit can be replaced by an equivalent circuit of a current source I_N in parallel with a resistor R_N .

where

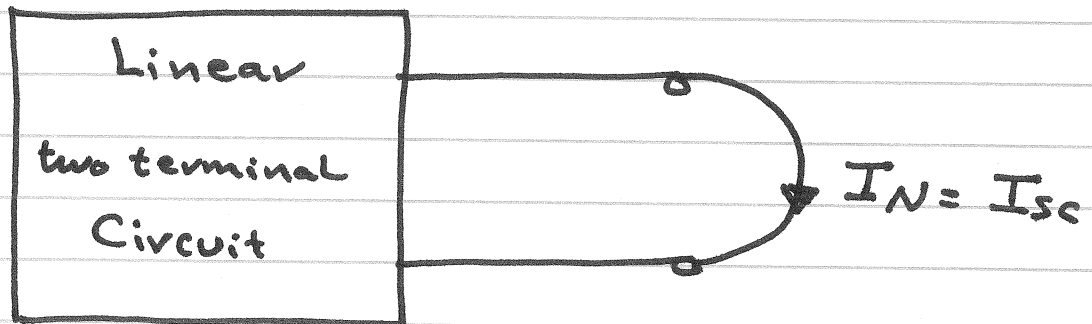
- I_N is the short circuit current through the terminals.

. R_N is the input or equivalent resistance at the terminals when the independent sources are turned off.

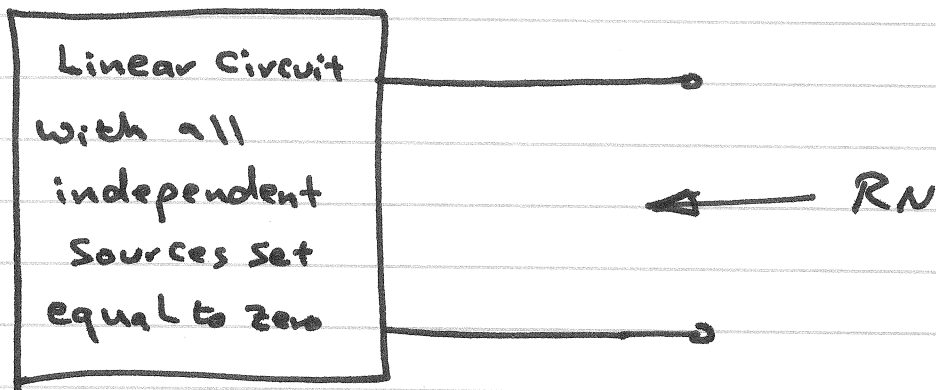
. $R_N = R_{TH}$

Norton's Theorem

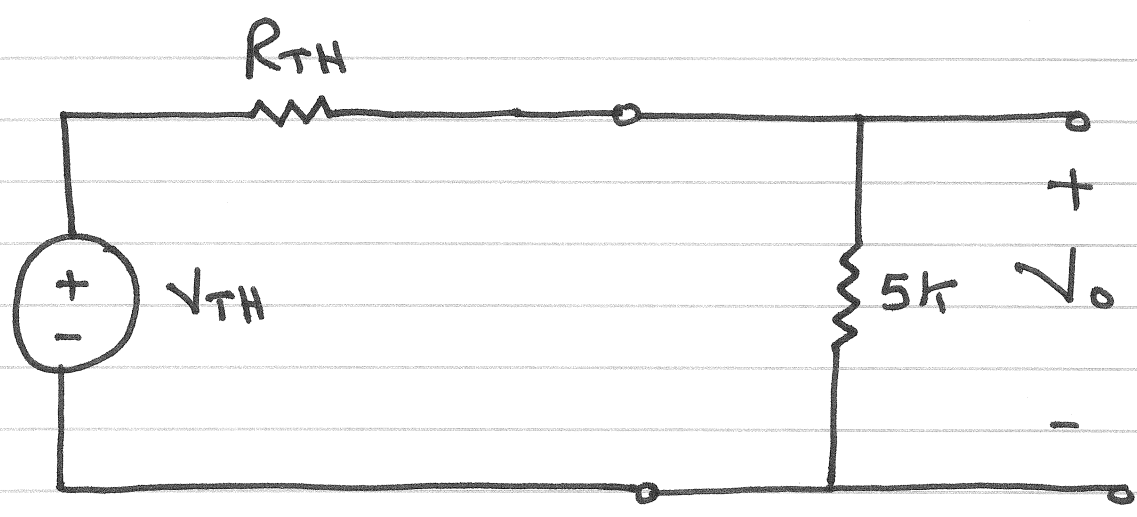
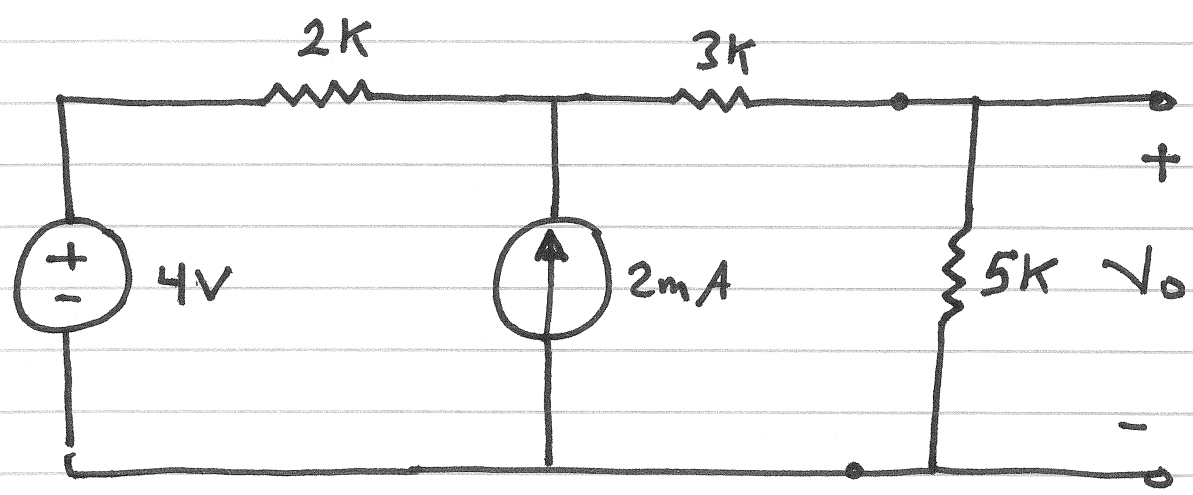
- How to find I_N



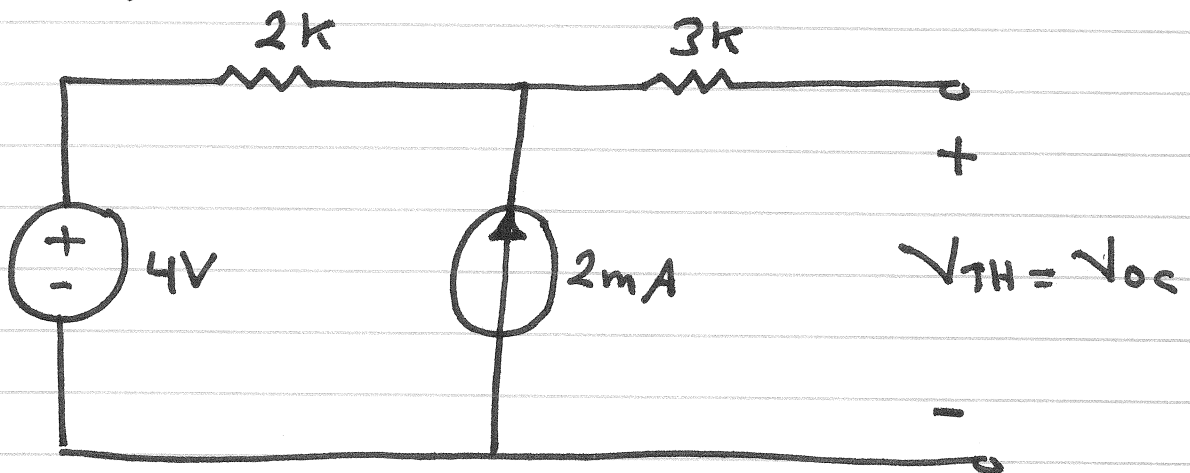
- How to find $R_N = R_{TH}$



Find V_o using thevenin's theorem

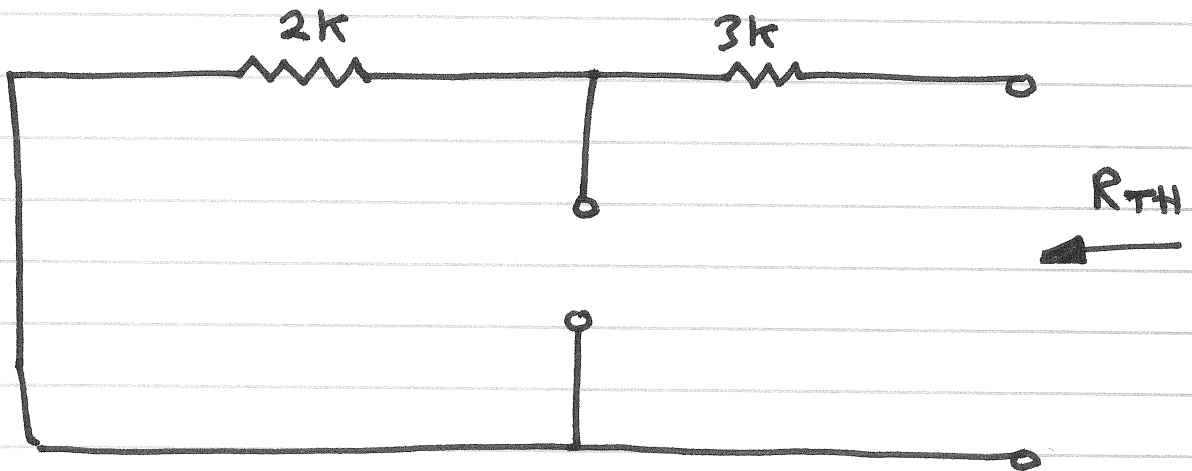


1) To find V_{TH}



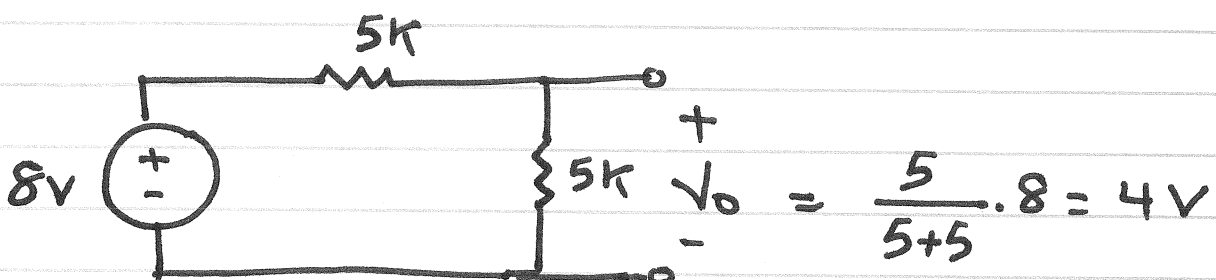
$$V_{TH} = (2k)(2mA) + 4 = 8V$$

2) To find R_{TH}

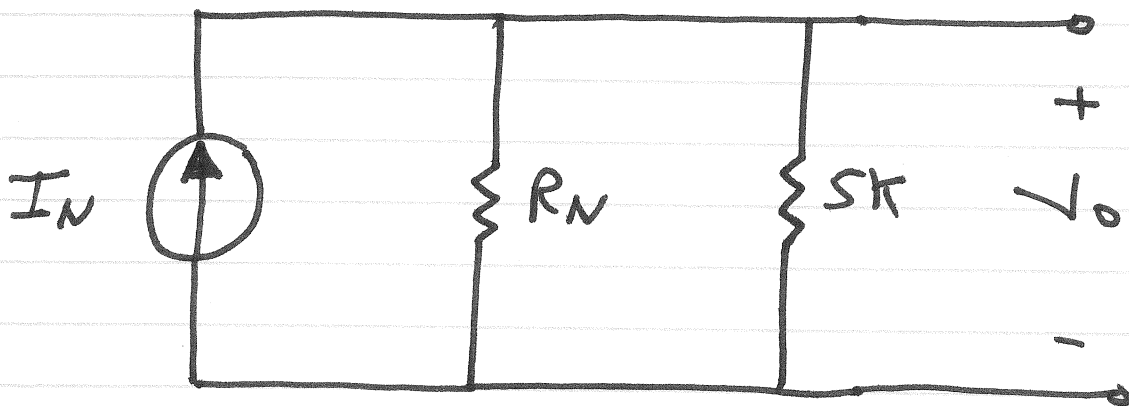
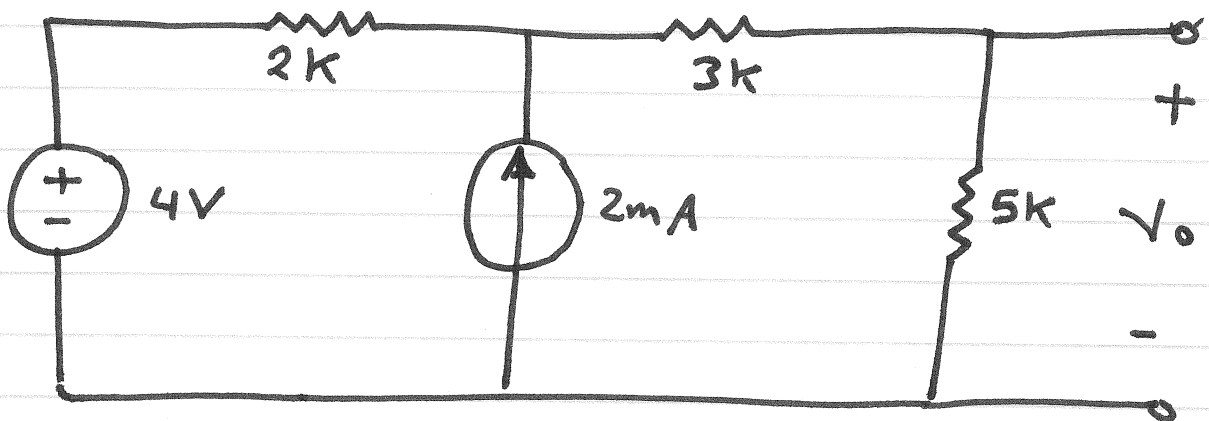


$$R_{TH} = 3k + 2k = 5k\Omega$$

3) To find V_o



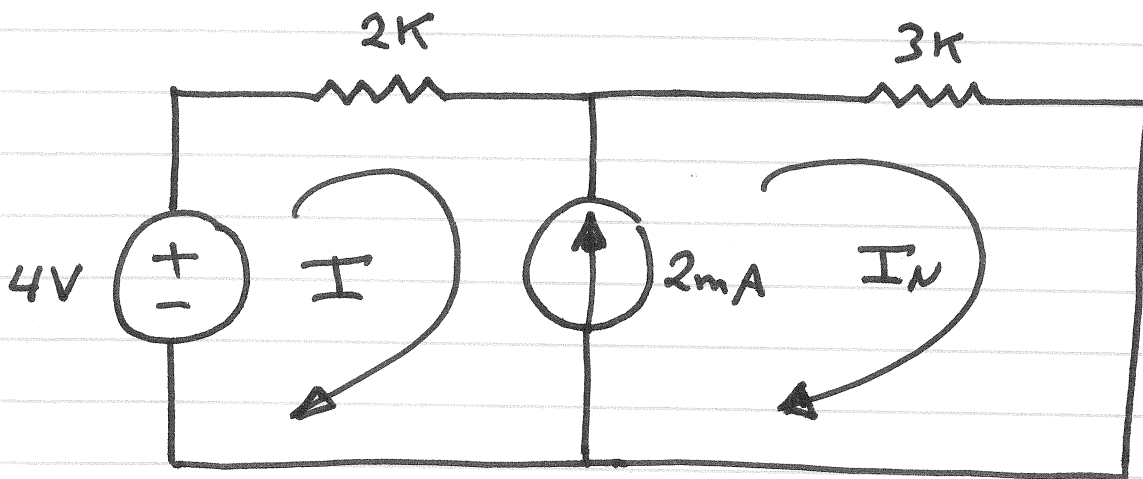
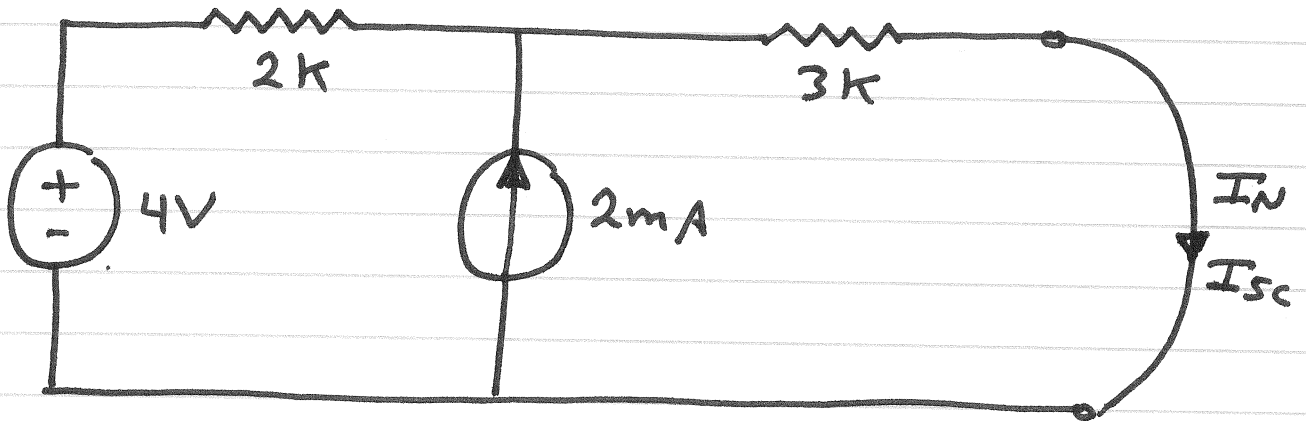
Find V_o using Norton's theorem



$$V_o = (R_N \parallel 5k) I_N$$

1) To find I_N

$$I_N = I_{sc}$$



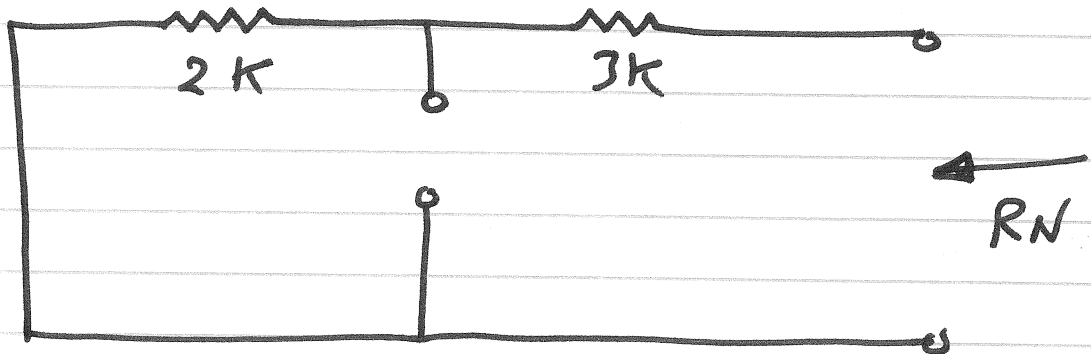
$$2\text{mA} = I_N - I \quad \text{Constraint equation}$$

$$4 = (2\text{k})I + (3\text{k})I_N \quad \text{Supermesh equation}$$

$$\therefore I_N = 1.6\text{mA}$$

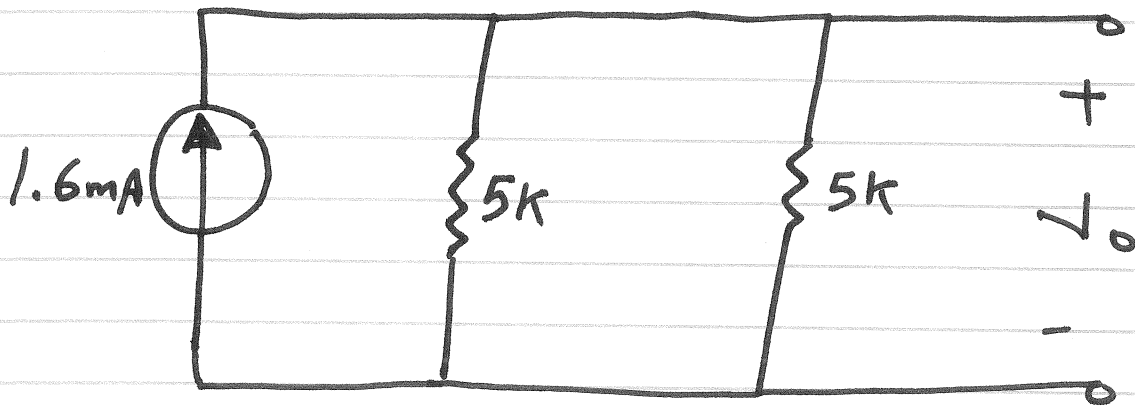
2) To find $R_N = R_{TH}$

turn off all the independent sources



$$R_N = 3k + 2k = 5k$$

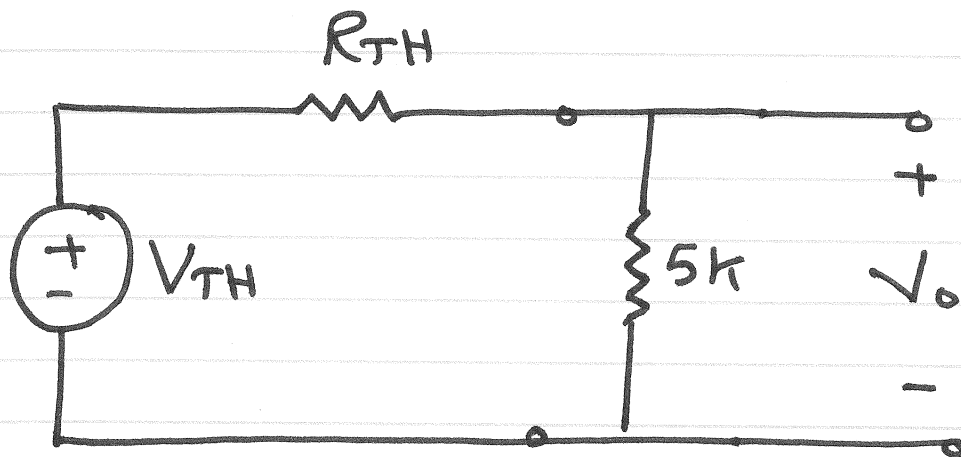
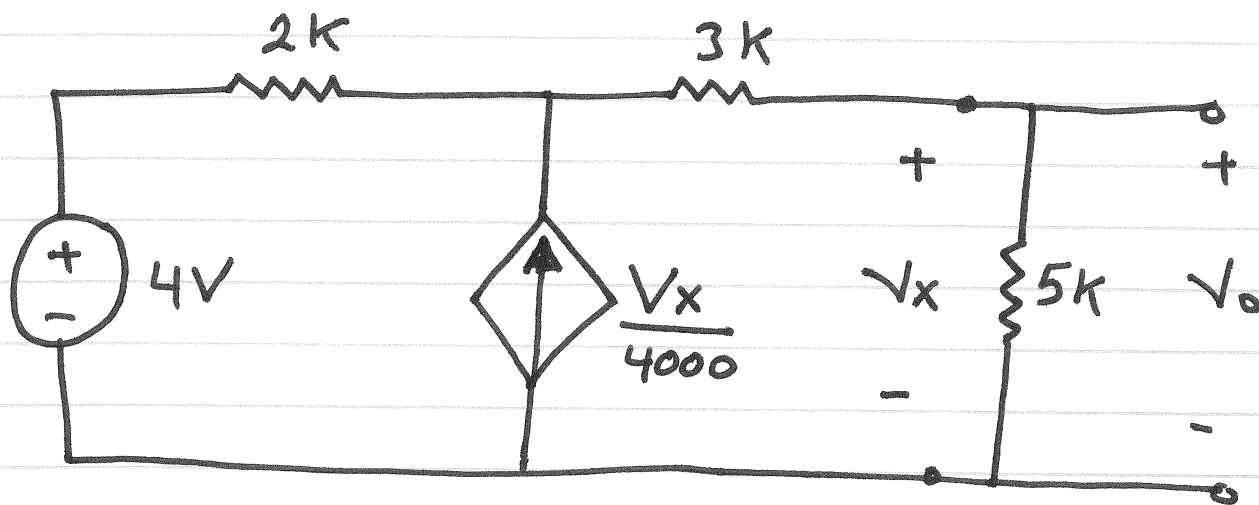
3) To find V_o



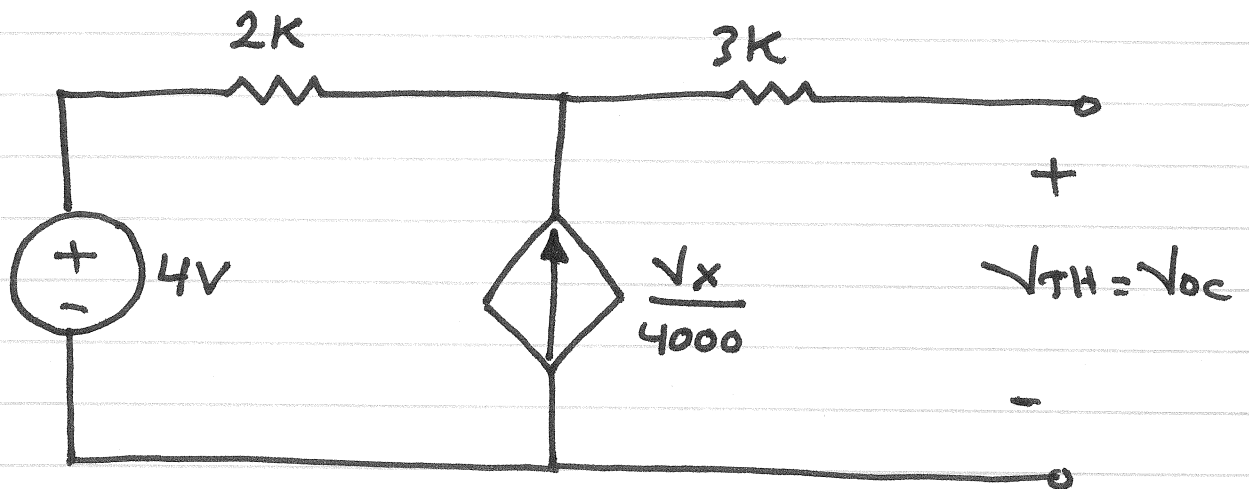
$$V_o = (5k || 5k) (1.6mA)$$

$$V_o = 4V$$

Find V_o using thevenin's theorem



1) To find V_{TH}



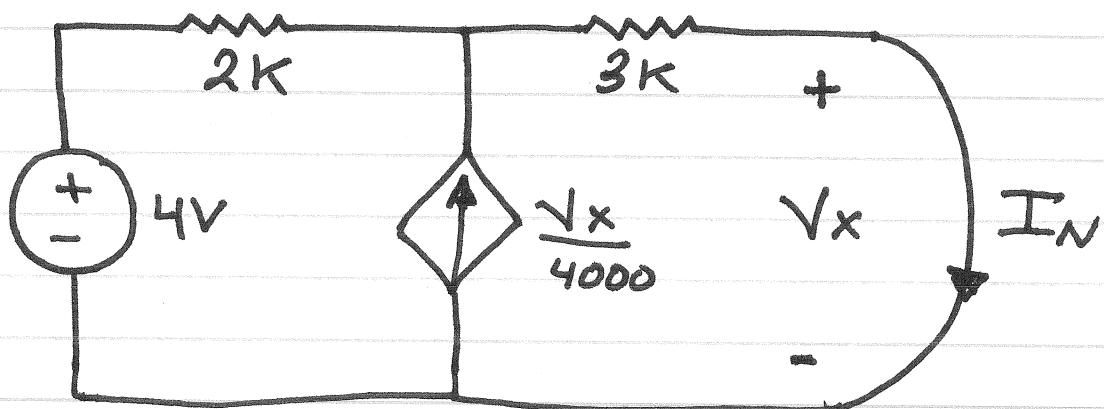
$$V_{TH} = (2k) \left(\frac{V_x}{4000} \right) + 4$$

$$V_x = V_{TH}$$

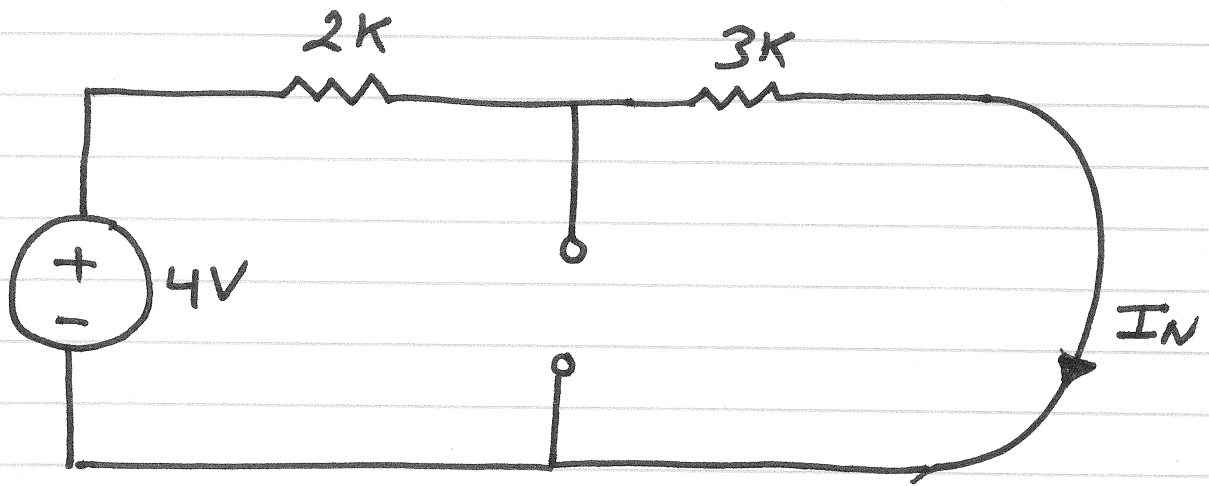
$$\therefore V_{TH} = 8V$$

2) To find R_{TH}

a) method 1 : $R_{TH} = \frac{V_{TH}}{I_N}$



$$V_x = 0 \rightarrow \frac{V_x}{4000} = 0 \rightarrow \text{open circuit}$$

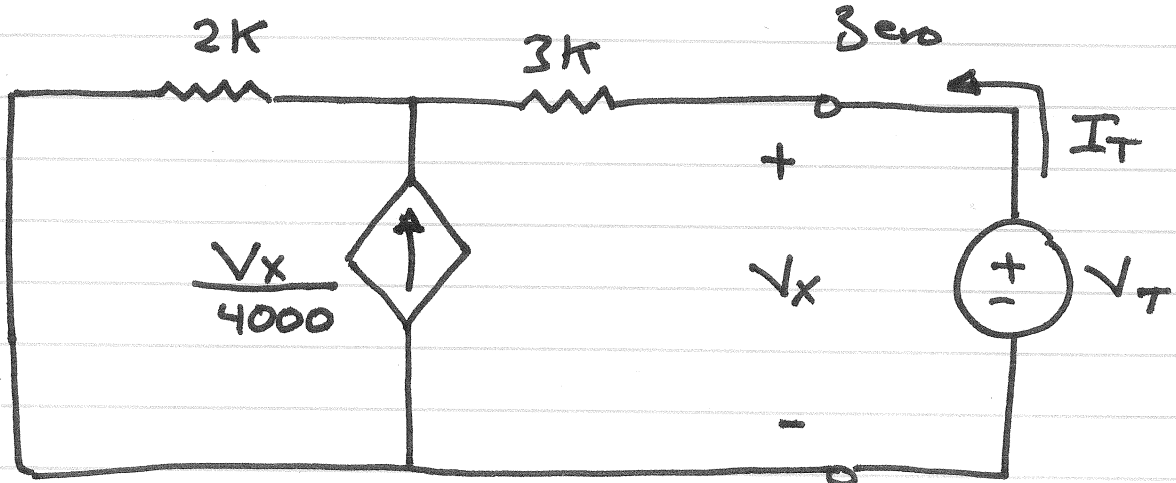


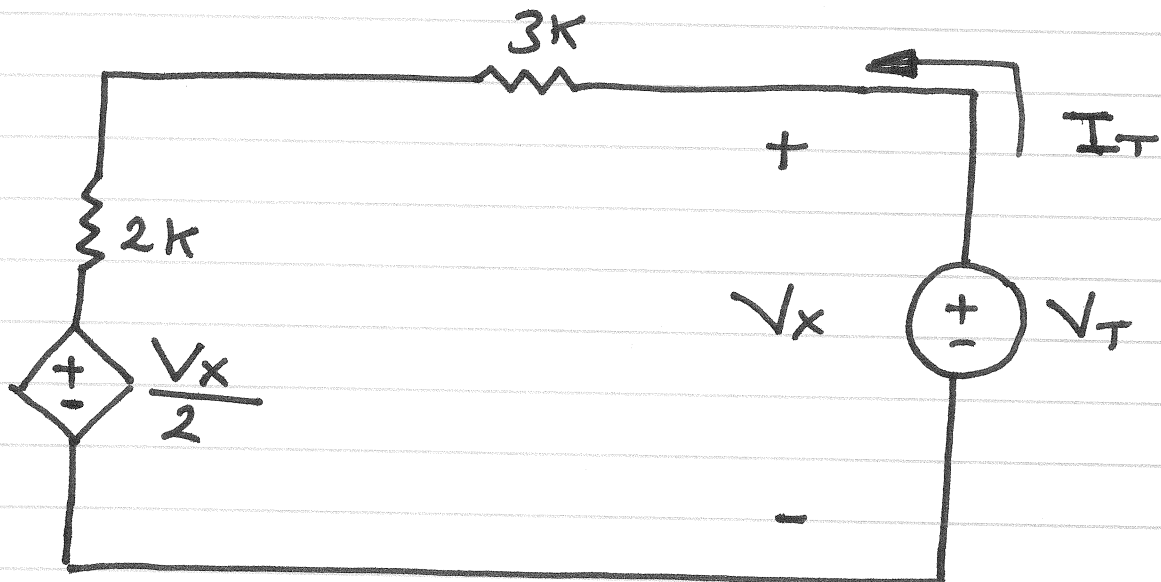
$$I_N = \frac{4V}{5k} = 0.8 \text{ mA}$$

$$\therefore R_{TH} = \frac{8V}{0.8 \text{ mA}} = 10k$$

b) method 2 : $R_{TH} = \frac{V_T}{I_T}$

all independent sources set to zero



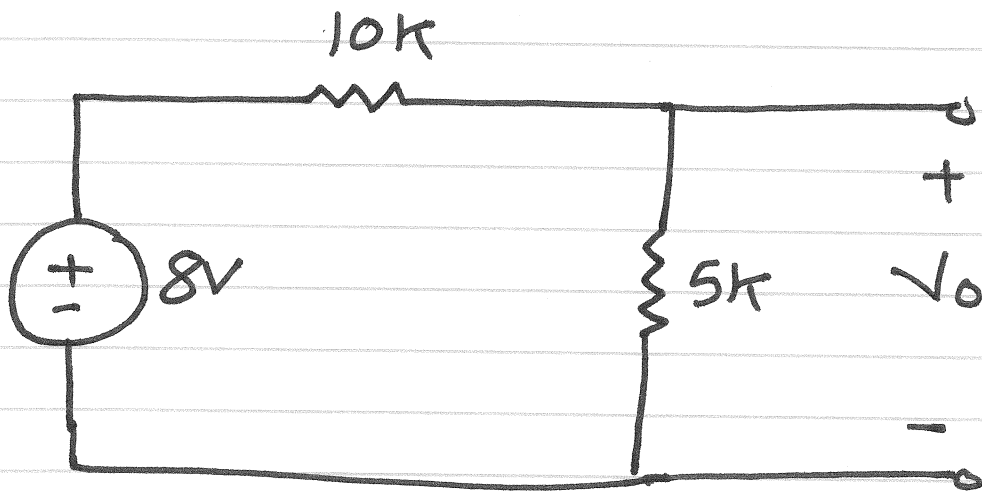


KVL :

$$-V_T + 3k I_T + 2k I_T + \frac{V_x}{2} = 0$$

$$V_x = V_T$$

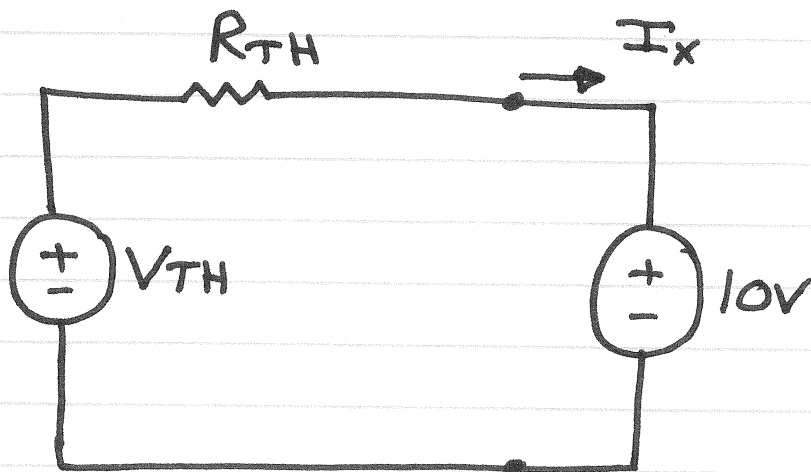
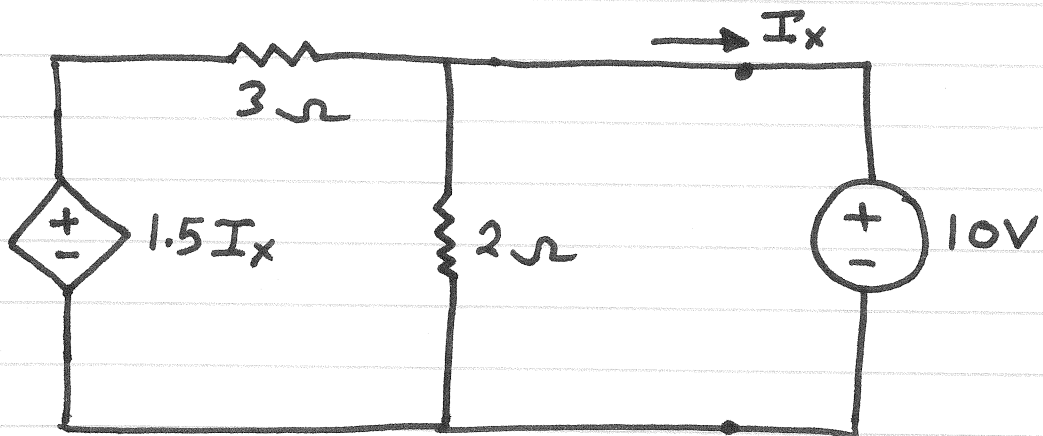
$$\therefore R_{TH} = \frac{V_T}{I_T} = 10k$$



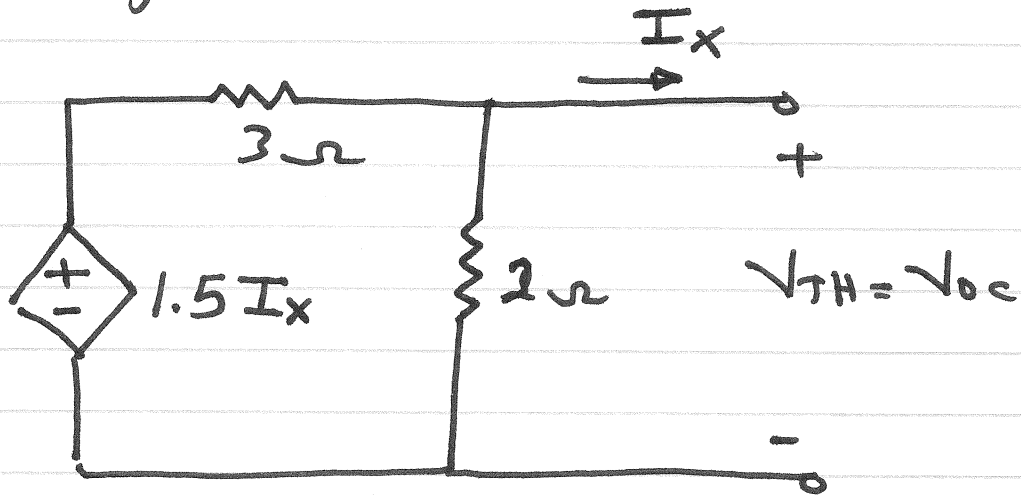
$$V_0 = \frac{5k}{5k+10k} (8V)$$

$$V_0 = \frac{8}{3} V$$

Find I_x using thevenin's theorem



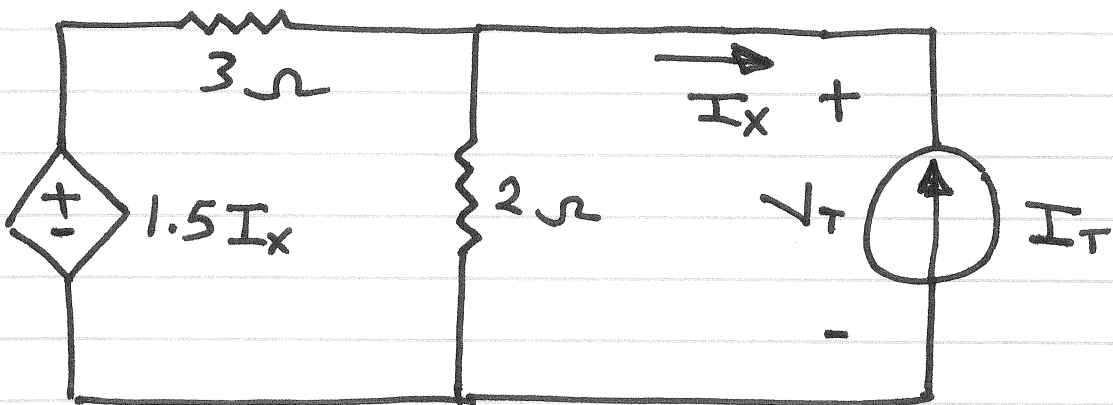
1) To find V_{TH}

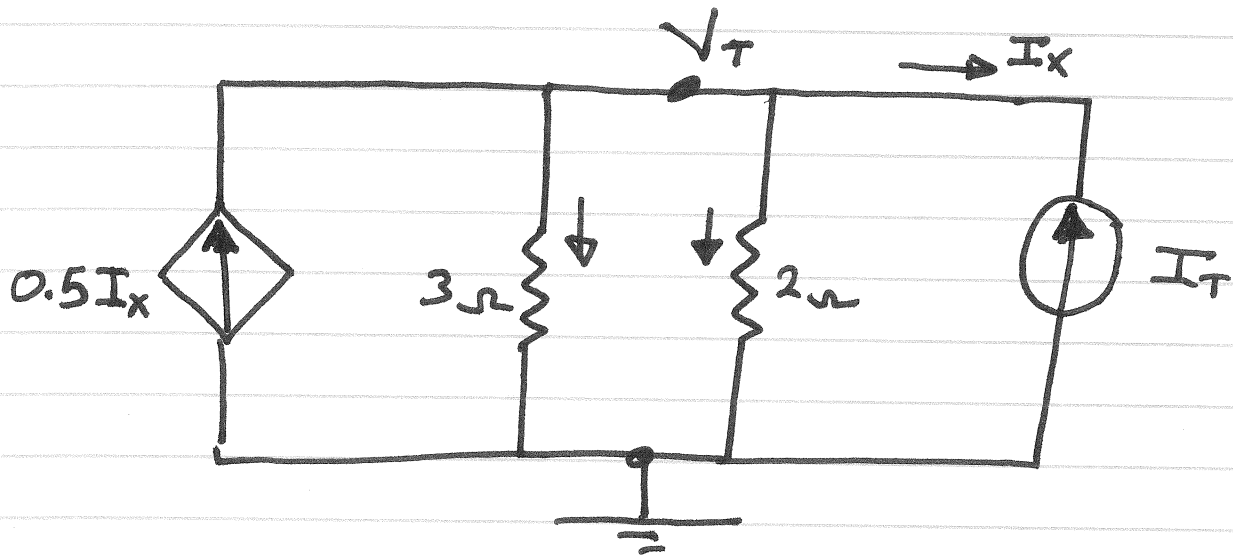


Since there is no independent sources

$$\therefore V_{TH} = 0$$

2) To find R_{TH} : $\frac{V_T}{I_T}$



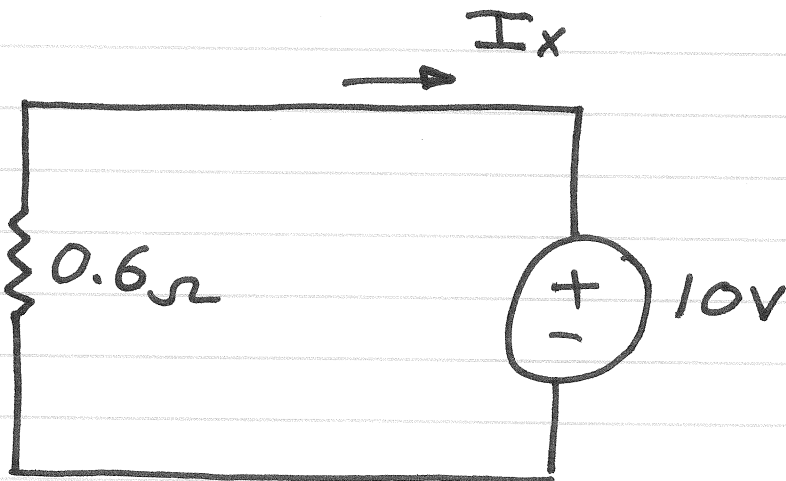


KCL :

$$0.5 I_x + I_T = \frac{V_T}{3} + \frac{V_T}{2}$$

$$I_x = - I_T$$

$$\therefore R_{TH} = \frac{V_T}{I_T} = 0.6 \Omega$$



$$I_x = - \frac{10}{0.6} = - 16.67 \text{ A}$$