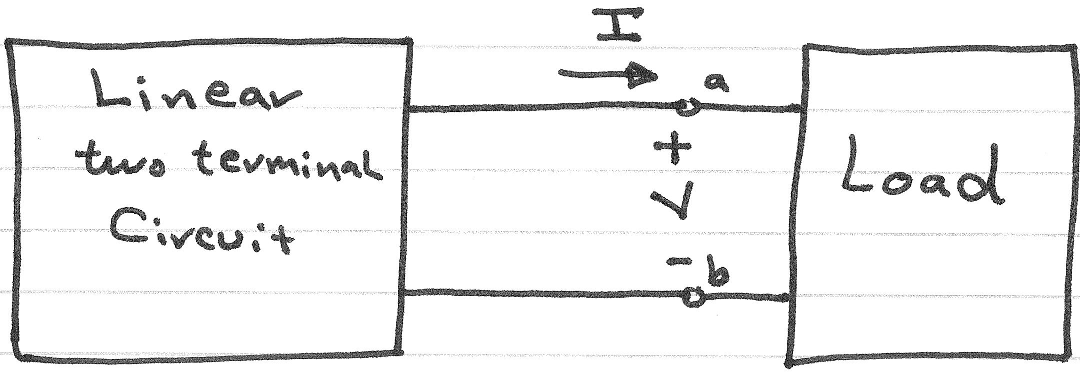
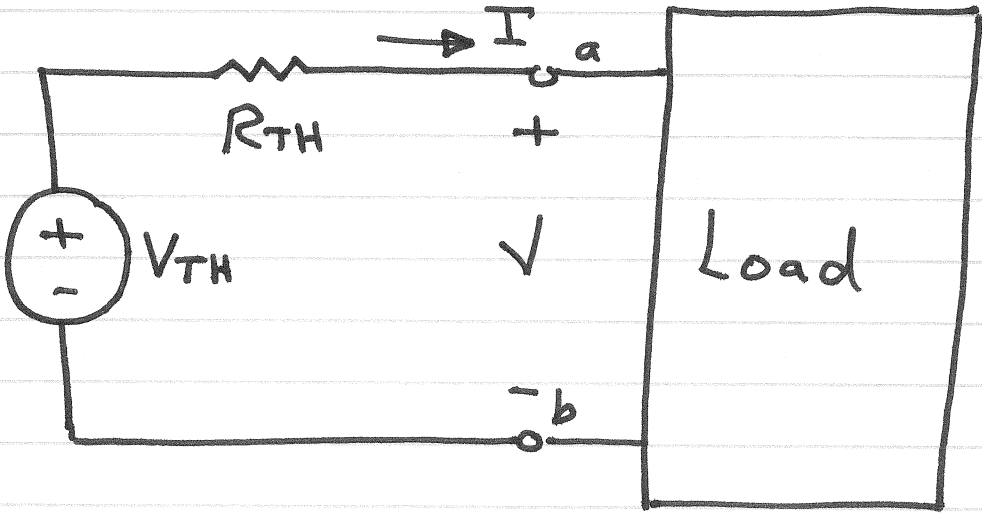
Thevenin's Theorem

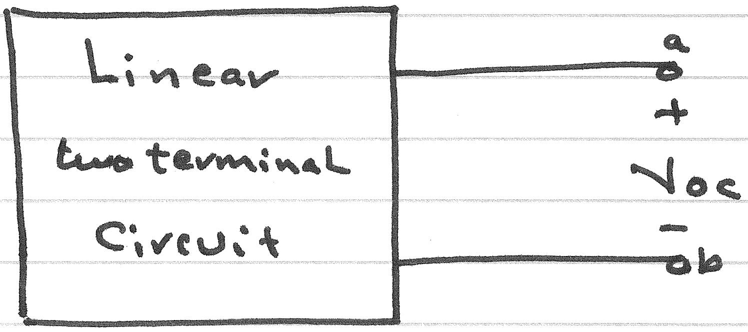




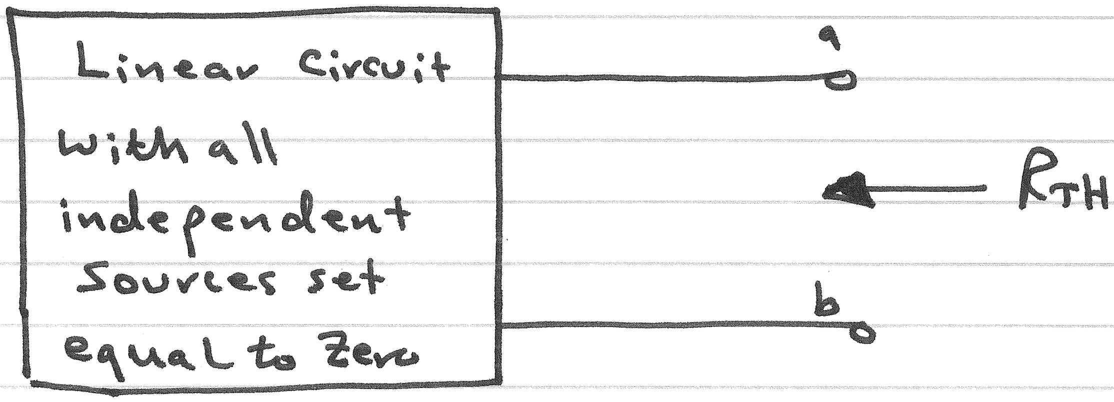
It states that a Linear two terminal Circuit Can be replaced by an equivalent Circuit Consisting of a voltage Source V_{TH} in series with a resistor R_{TH}, where V_{TH} is the open circuit voltage at the terminals and R_{TH} is the input or equivalent resistance at the terminals when the independent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

Case 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.

Case II

If the circuit has dependent sources

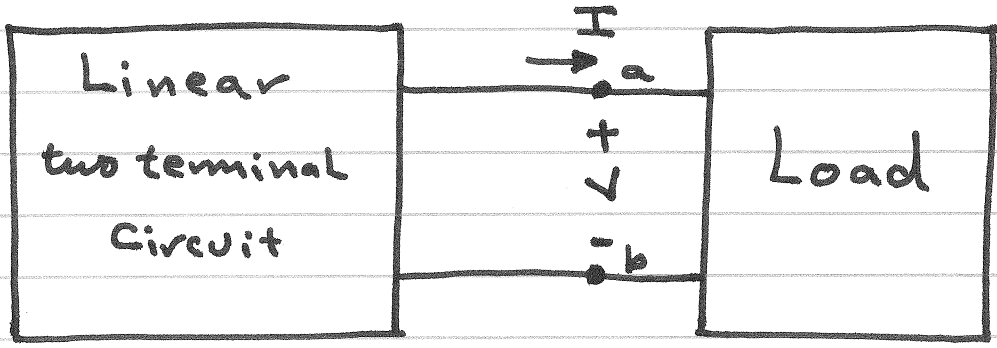
- Turn off all independent sources
- Apply a voltage source V_T at a-b

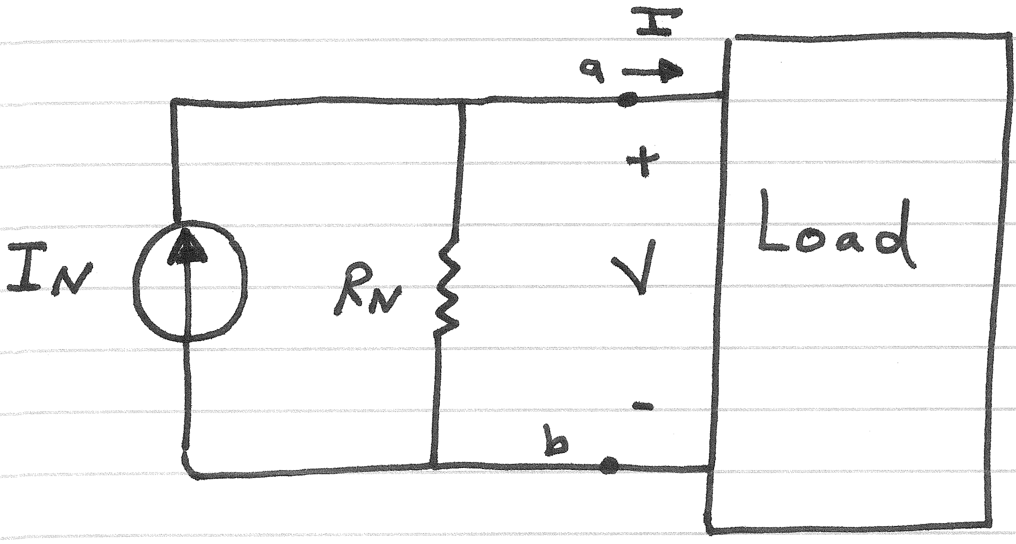
$$R_{TH} = \frac{V_T}{I_T}$$

- 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

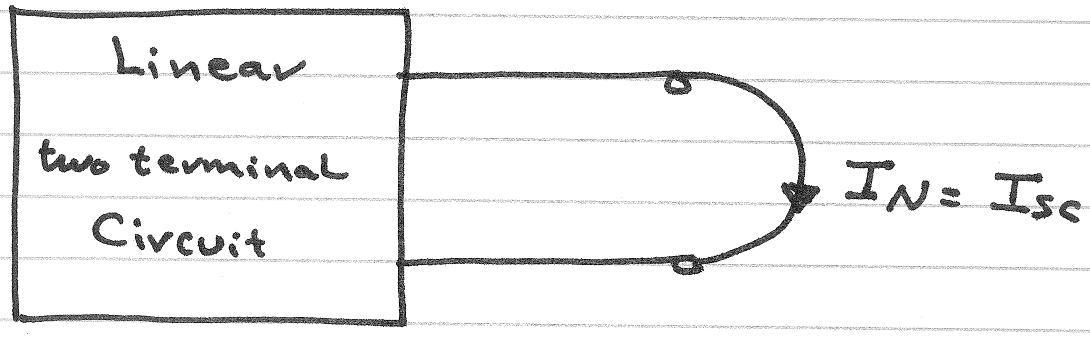
- I_N is the short circuit current through the terminals.

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

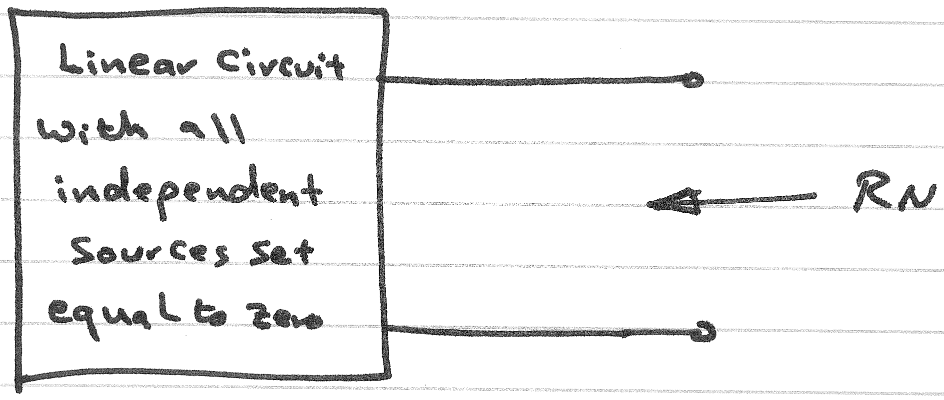
- $R_N = R_{TH}$

Norton's Theorem

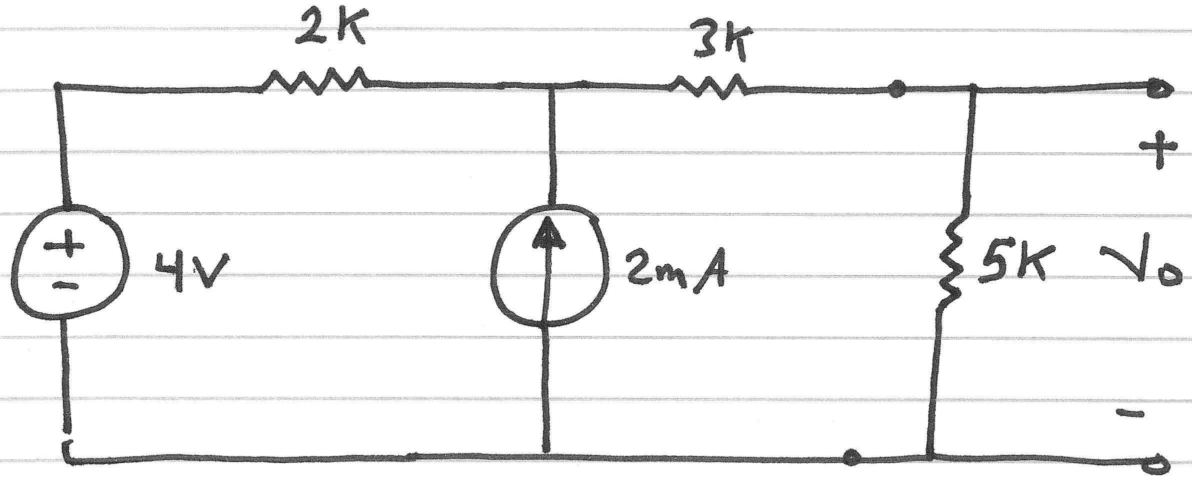
- How to find I_N

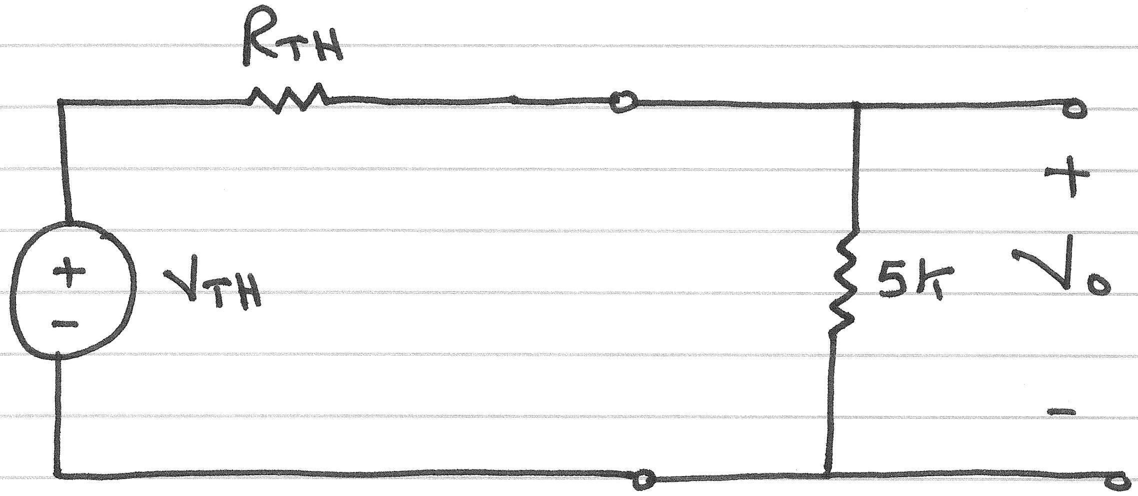


- How to find $R_N = R_{TH}$

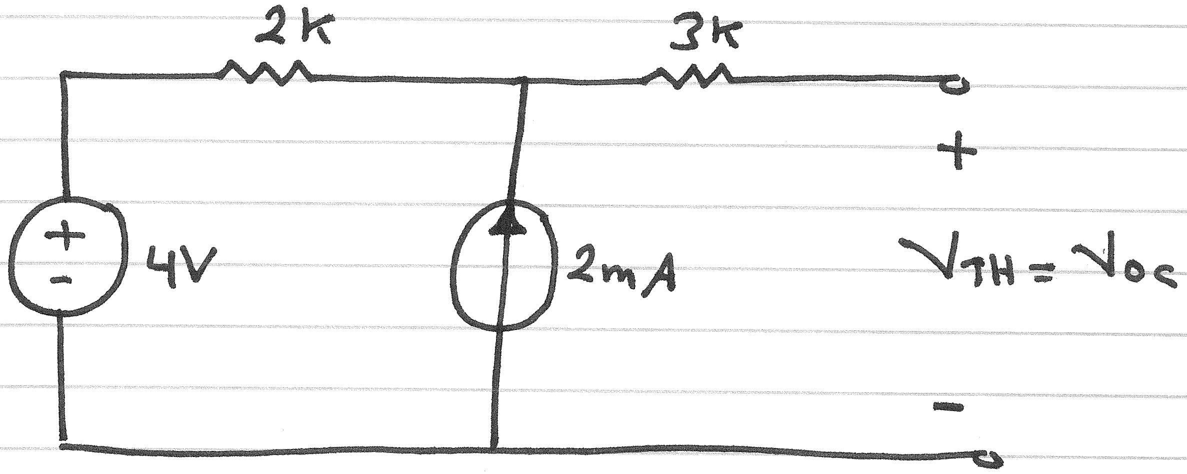


Find V_o using thevenin's theorem



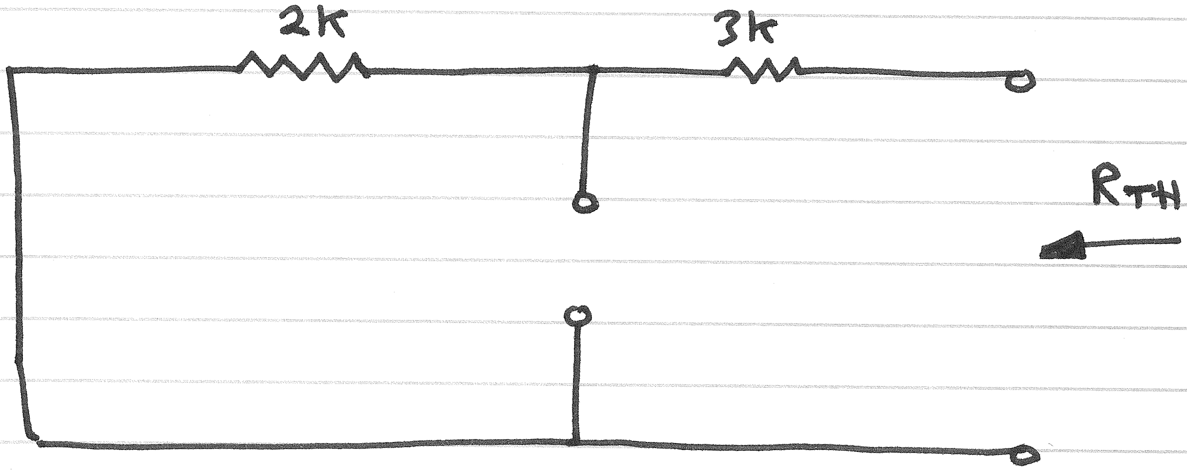


1) To find V_{TH}



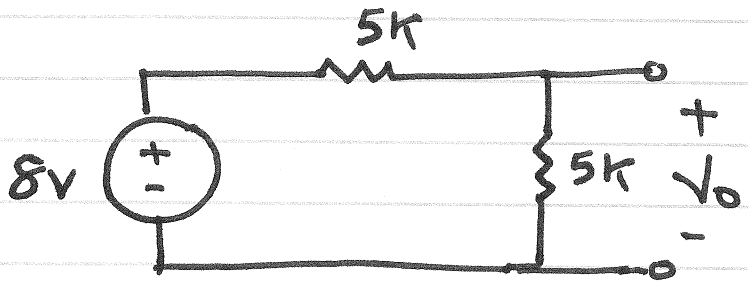
$$V_{TH} = (2K)(2mA) + 4 = 8V$$

2) To find R_{TH}



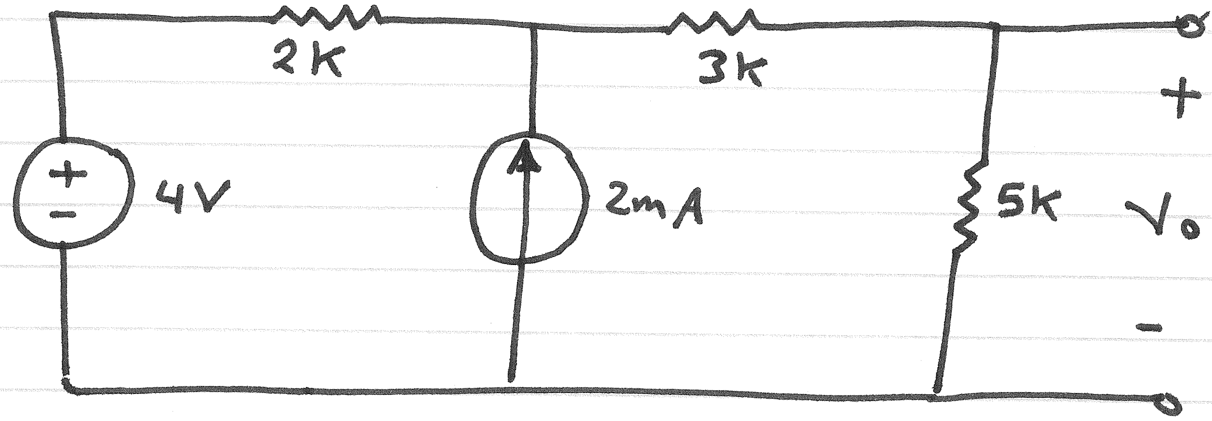
$$R_{TH} = 3K + 2K = 5K\Omega$$

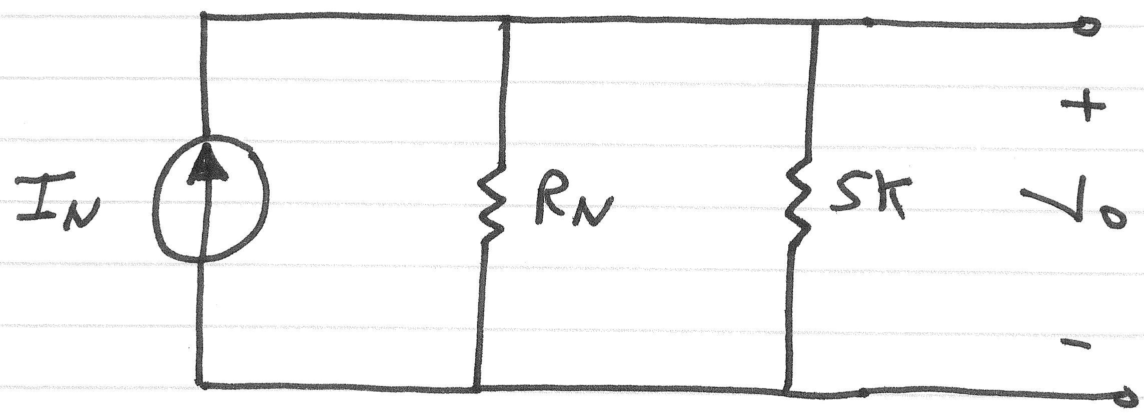
3) To find V_o



$$V_o = \frac{5}{5+5} \cdot 8 = 4V$$

Find V_o using Norton's theorem

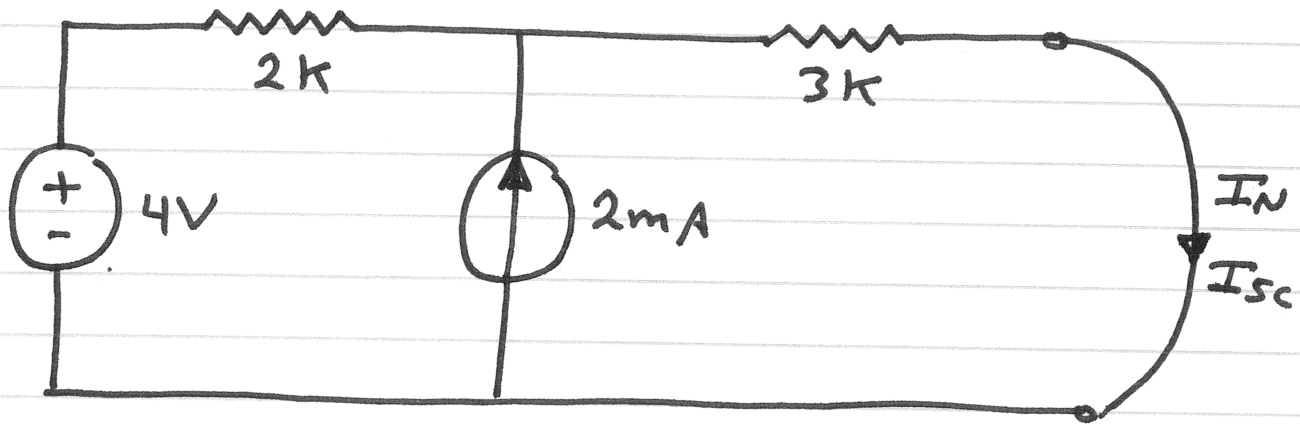


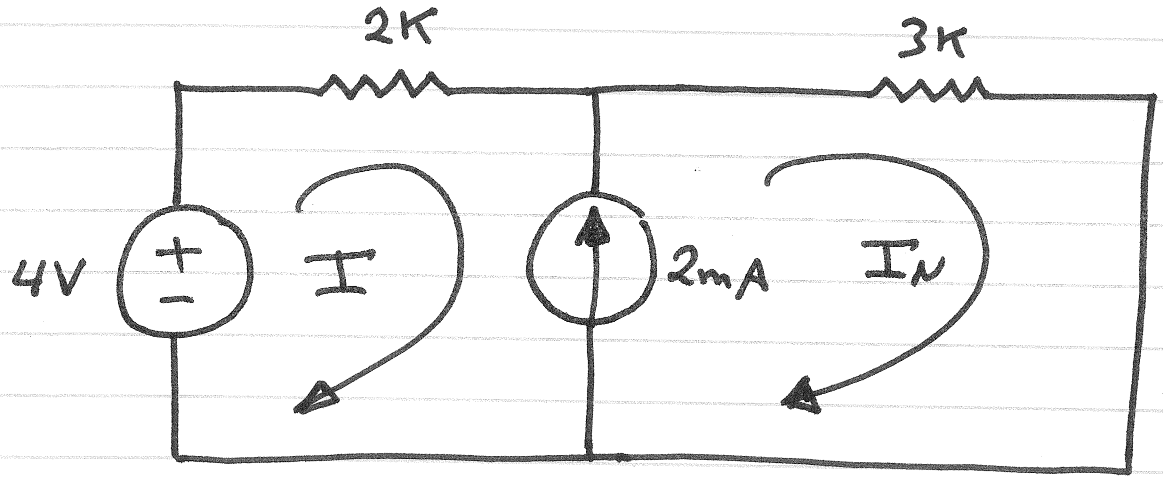


$$V_o = (R_N \| 5k) I_N$$

1) To find I_N

$I_N = I_{sc}$





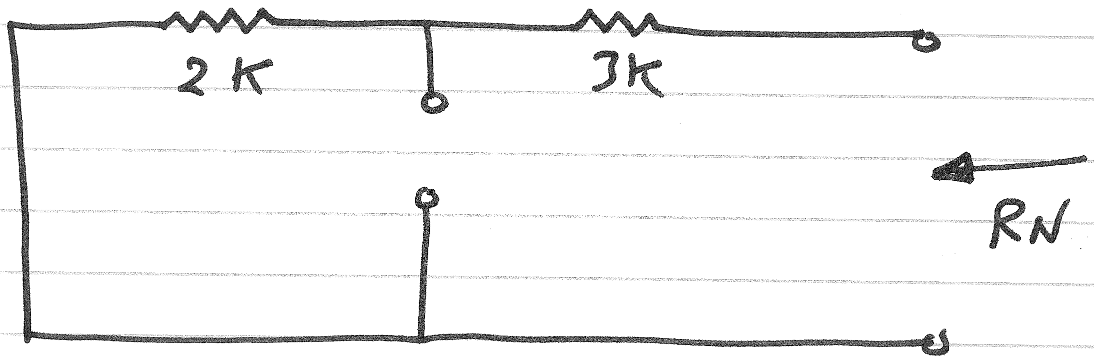
$2mA = I_N - I$ Constrain equation

$4 = (2K)I + (3K)I_N$ Supermesh equation

$\therefore \; I_N = 1.6mA$

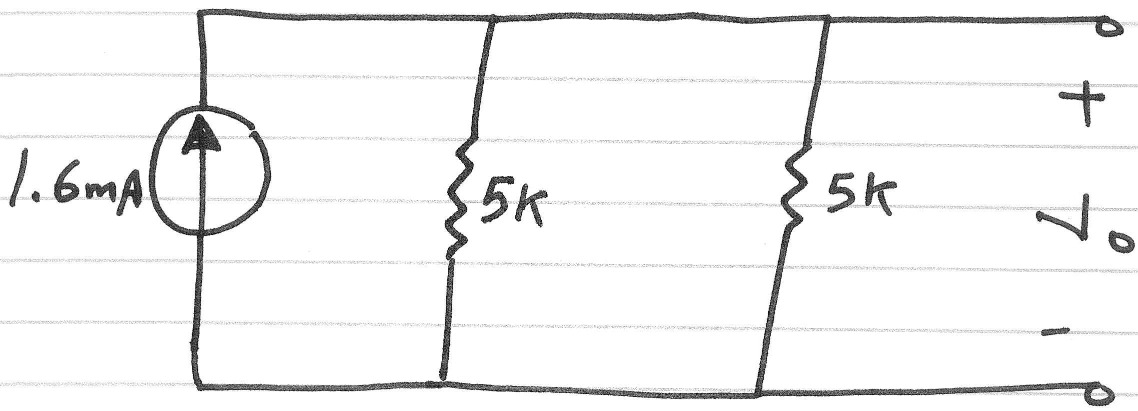
2) To find $R_N = R_{TH}$

turn off all the independent sources



$R_N = 3K + 2K = 5K$

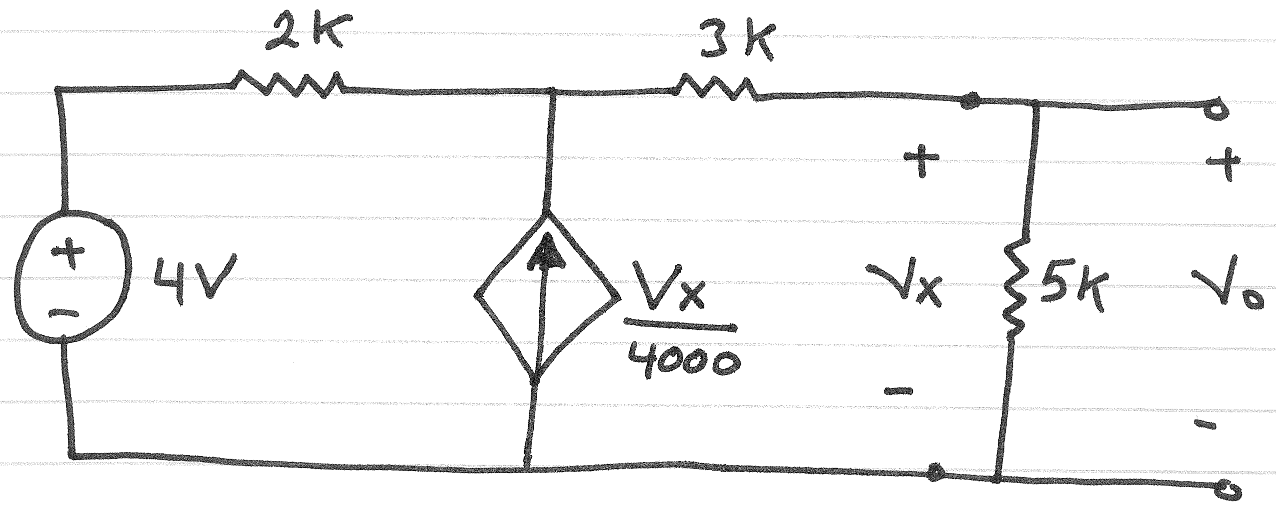
3) To find V_o

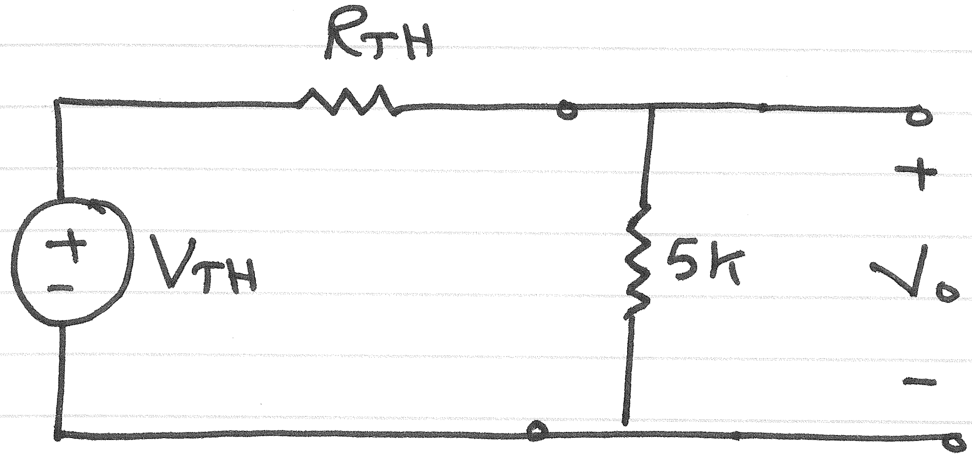


$V_o = (5K \| 5K)(1.6mA)$

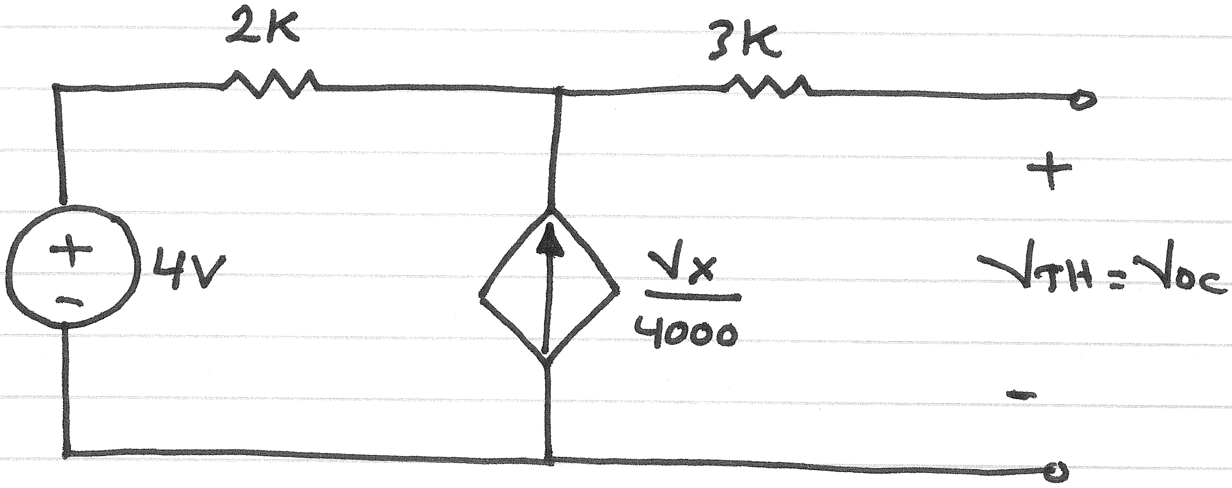
$V_o = 4V$

Find V_o using thevenin's theorem





1) To find V_{TH}



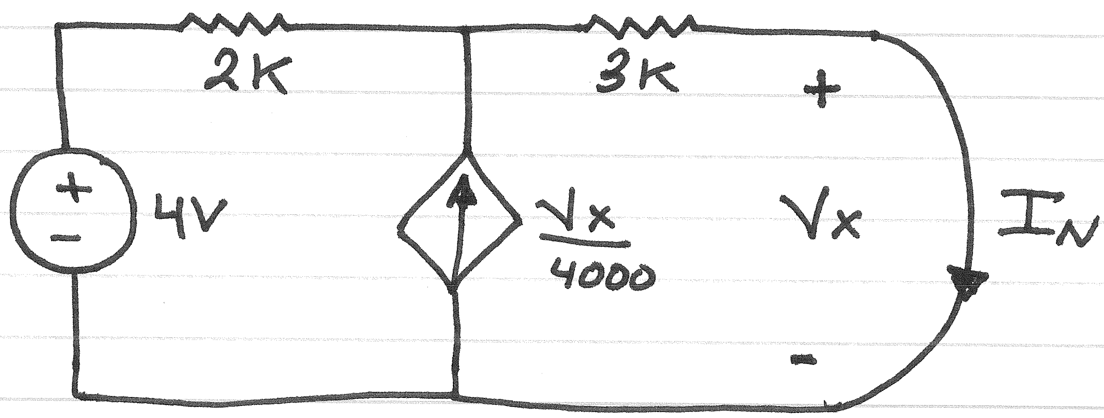
$$V_{TH} = (2K)\left(\frac{Vx}{4000}\right) + 4$$

$$Vx = V_{TH}$$

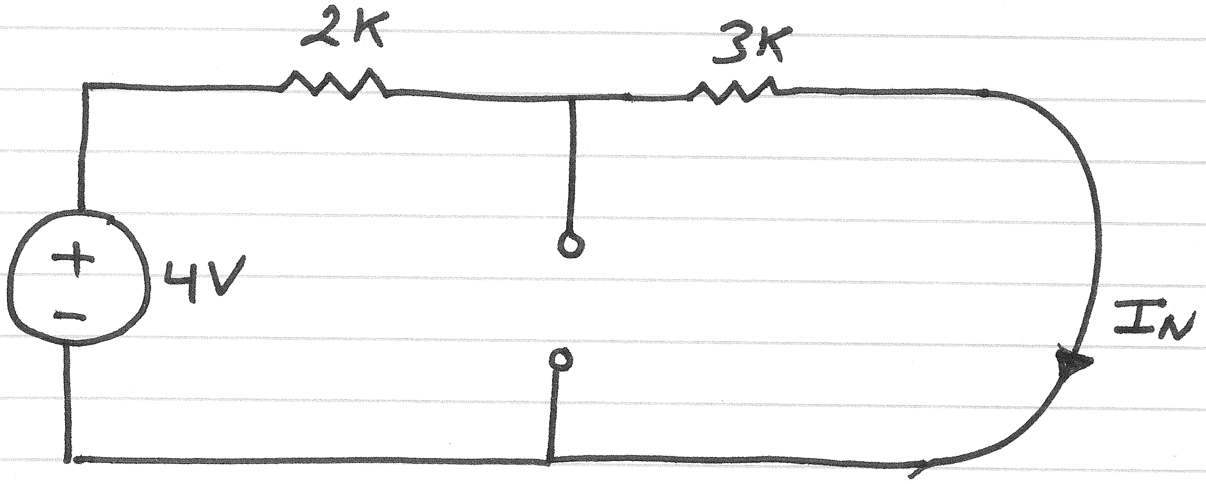
$$\therefore \; V_{TH} = 8V$$

2) To find R_{TH}

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



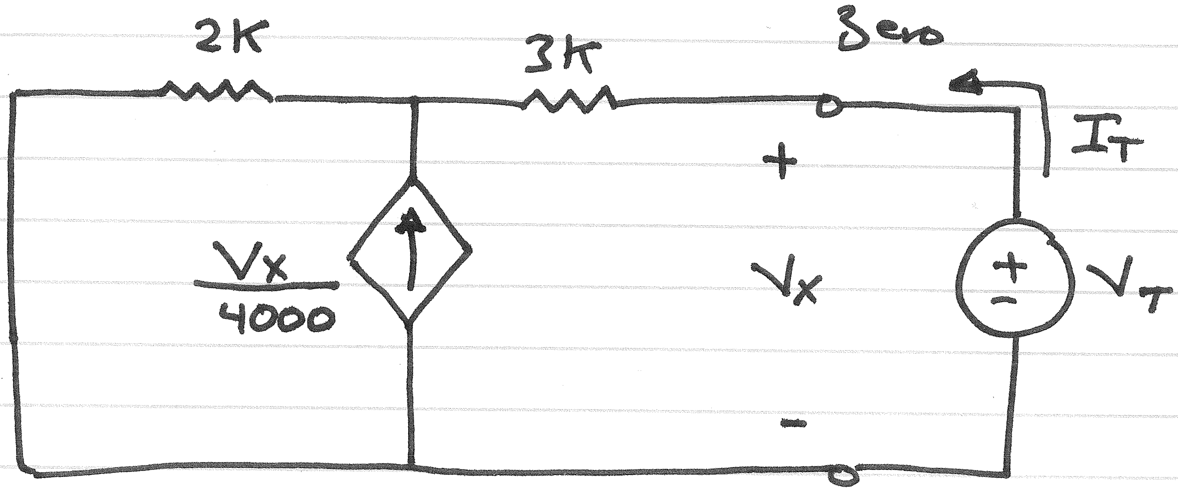
$Vx = 0 \longrightarrow \frac{Vx}{4000} = 0 \longrightarrow$ open Circuit

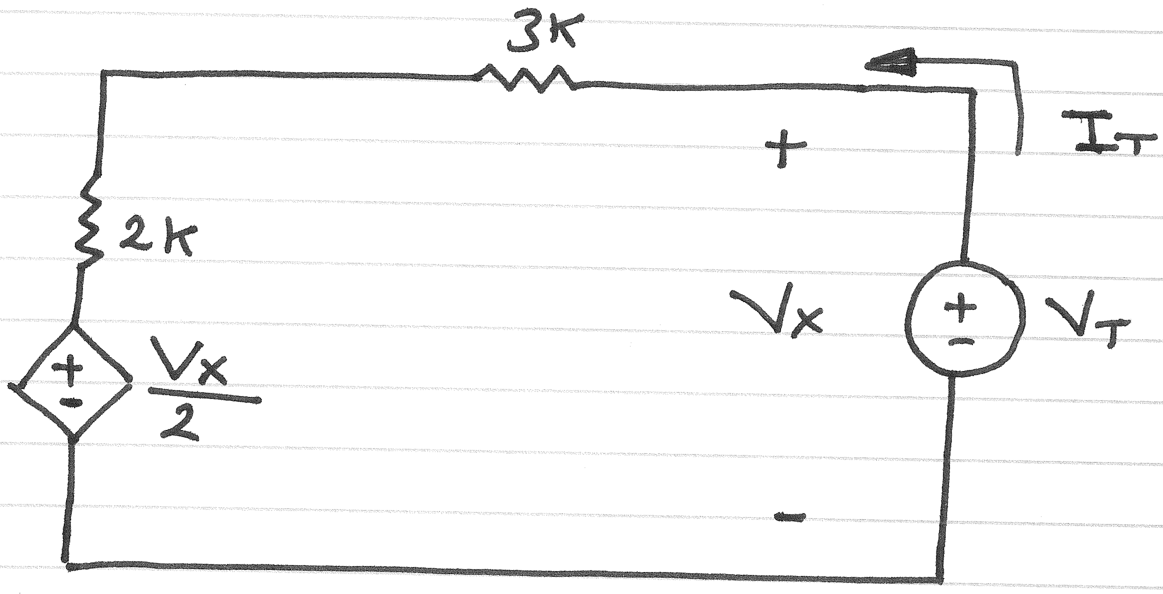


$$I_N = \frac{4V}{5K} = 0.8\,mA$$

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

b) method 2 : $R_{TH} = \dfrac{V_T}{I_T}\Bigg|$ all independent sources set to zero



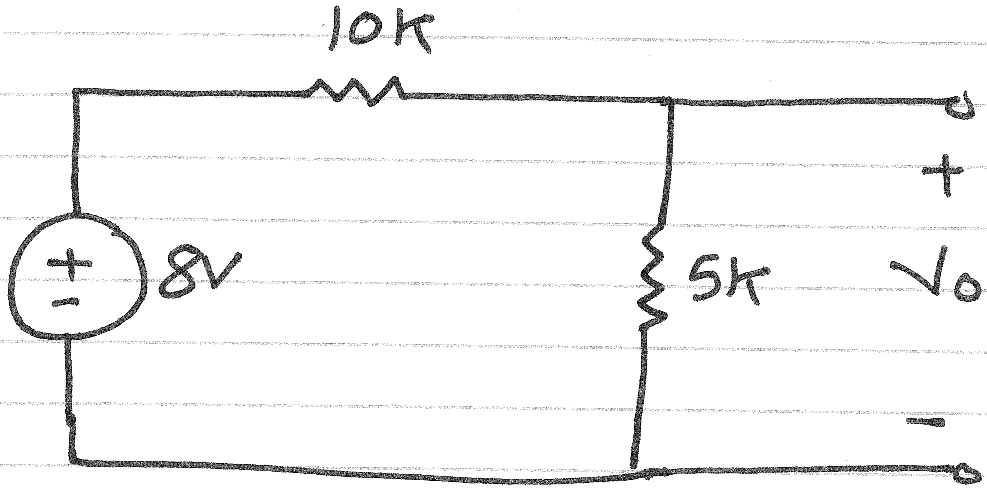


KVL :

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

$$V_x = V_T$$

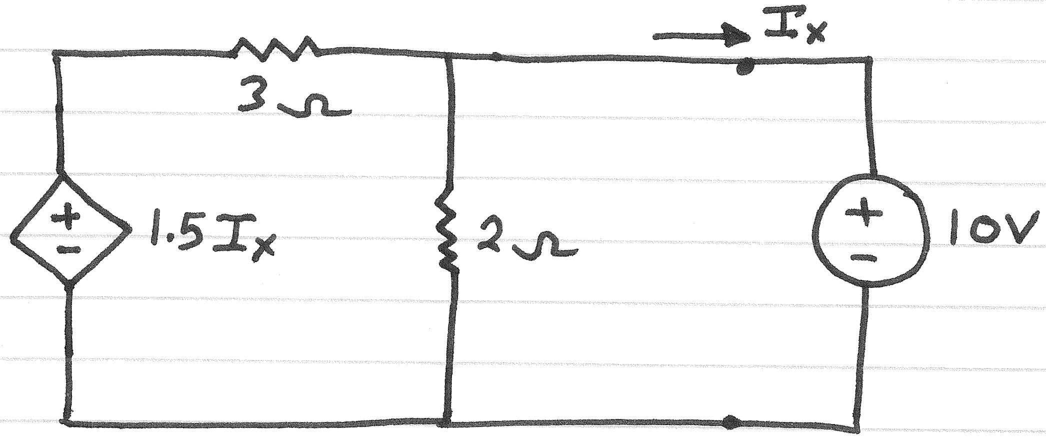
$$\therefore \quad R_{TH} = \frac{V_T}{I_T} = 10K$$

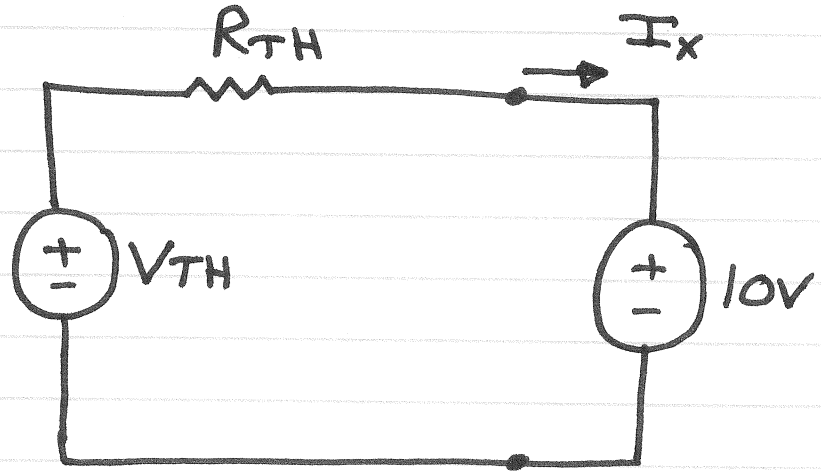


$$V_o = \frac{5k}{5k+10k}(8V)$$

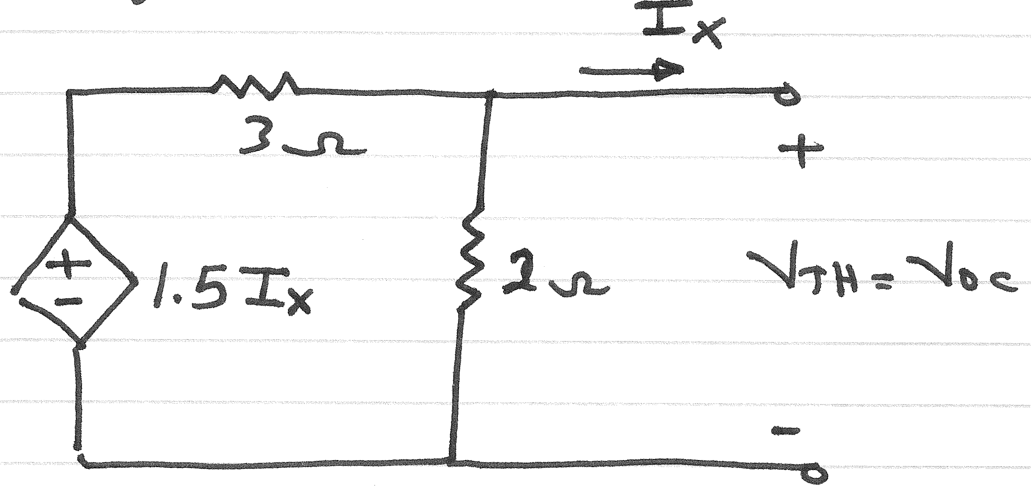
$$V_o = \frac{8}{3}\,V$$

Find I_x using thevenin's theorem





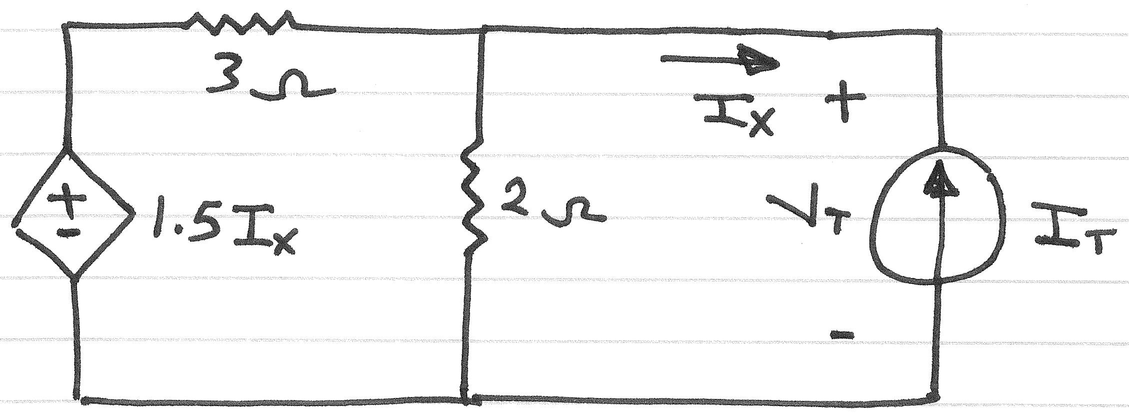
1) To find V_{TH}

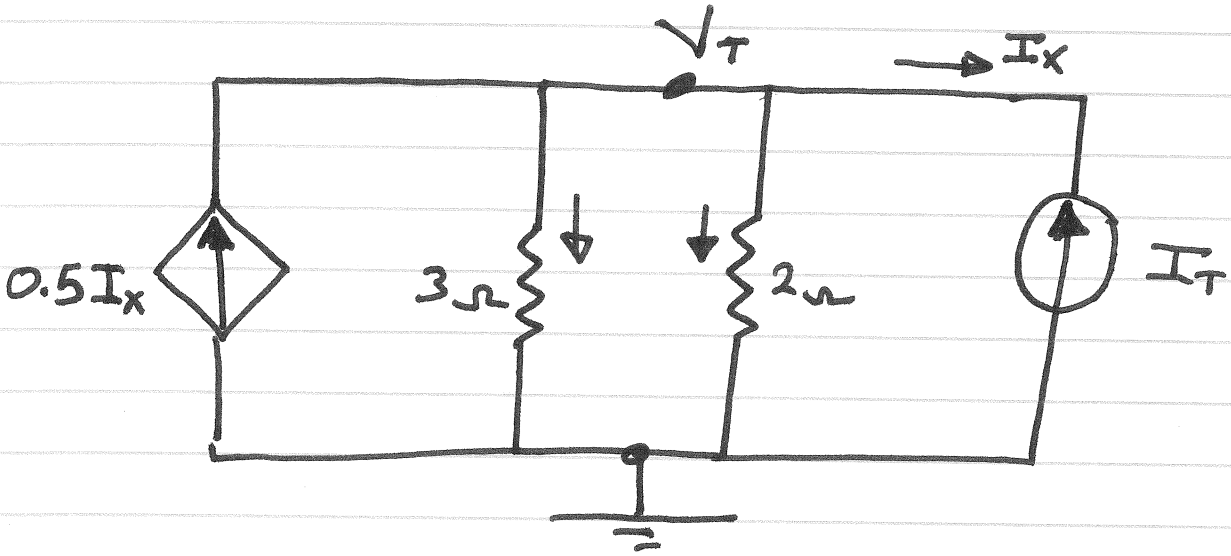


Since there is no independent sources

$\therefore V_{TH} = 0$

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



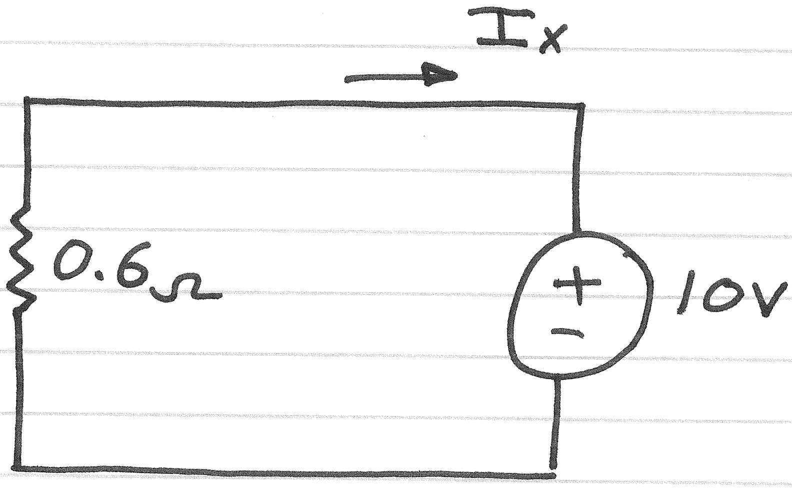


KCL :

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

$$I_x = -\,I_T$$

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



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