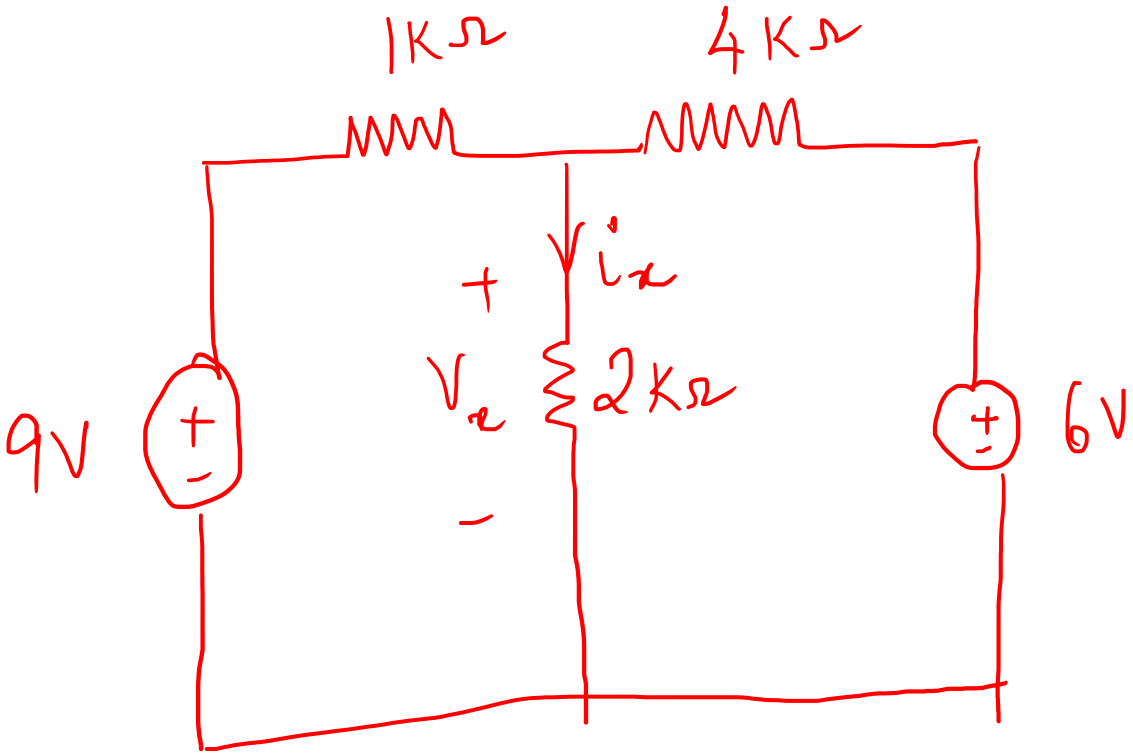
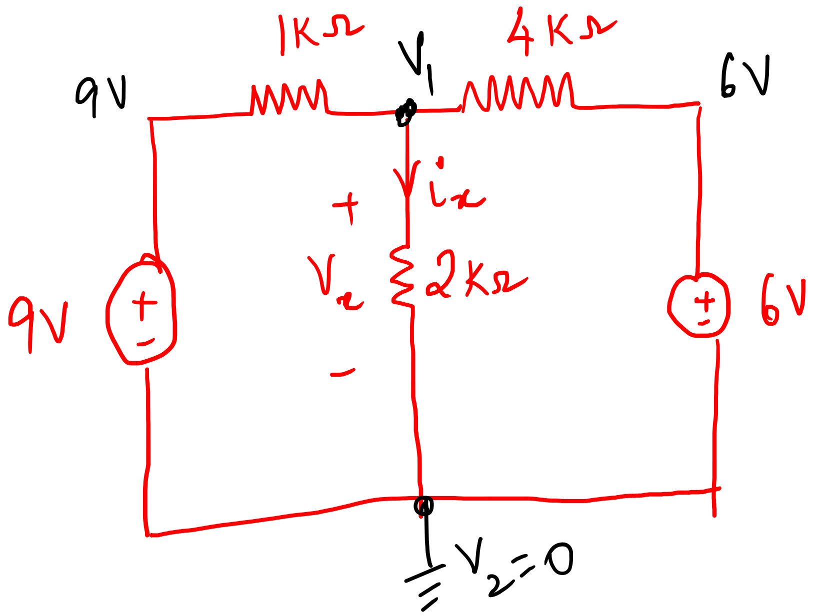
For the circuit given below, determine the current flowing through and voltage across the $2k\Omega$ resistor using the following methods

- Nodal analysis
- Mesh analysis
- Thevenin's theorem
- Norton's theorem
- Superposition theorem
- Source transformation



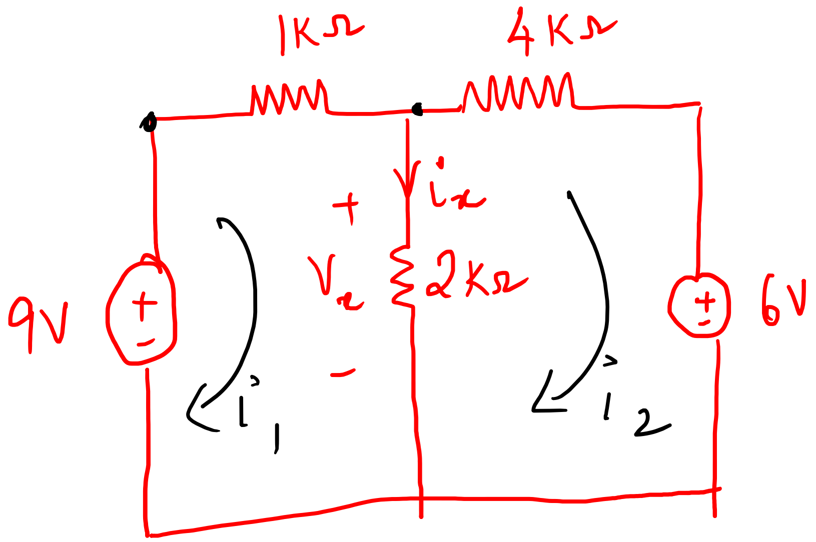


Nodal Analysis

$$\frac{V_1-9}{1K}+\frac{V_1-0}{2K}+\frac{V_1-6}{4K}=0$$

$$\underline{V_1=6V}$$

$$i=\frac{V_1}{2K}=\frac{6V}{2K}=\underline{3mA}$$



Mesh 1 :

$$i_1(1K) + 2K(i_1 - i_2) - 9 = 0$$

$$3i_1 - 2i_2 = 9 \quad - \text{(1)}$$

Mesh 2 :

$$4K(i_2) + 6 + 2K(i_2 - i_1) = 0$$

$$-2i_1 + 6i_2 = -6 \quad - \text{(2)}$$

Solving Eqn (1) & (2)

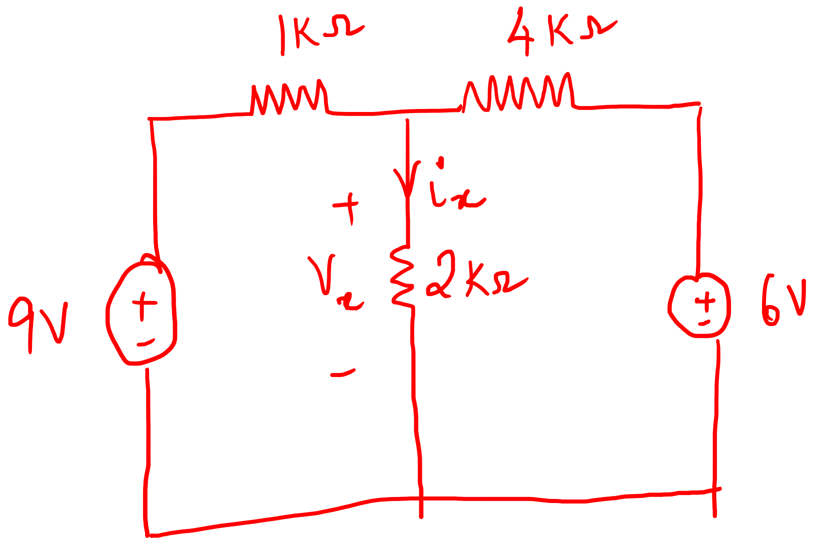
$i_1 = 3mA$

$i_2 = 0$

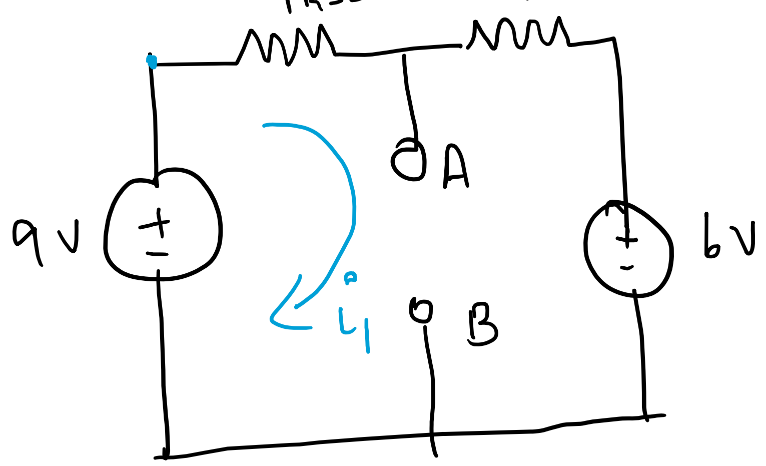
$i_x = i_1 - i_2 = \underline{3mA}$

$\underline{V_{2K} = 6V}$

Thevenin's Theorem



V_{th}:



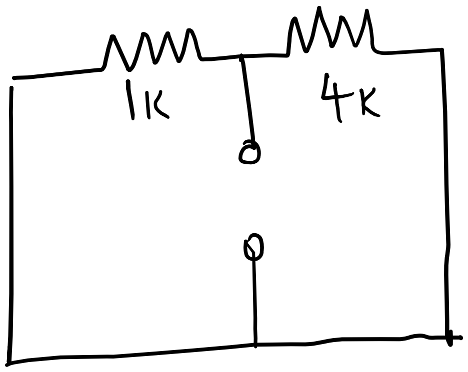
$$i_1(1K) + V_{AB} - 9 = 0$$

$$V_{AB} = 9 - 1K(i_1)$$

$$= \underline{8.4V}$$

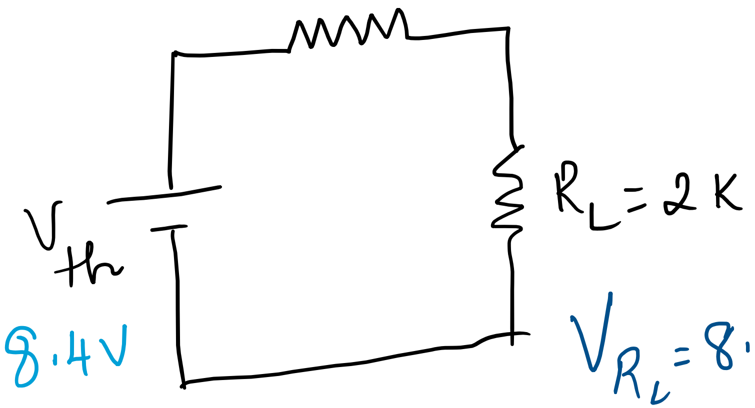
$$i_1 = \frac{9-6}{1+4} = \frac{3}{5} = 0.6mA$$

R_{th}:



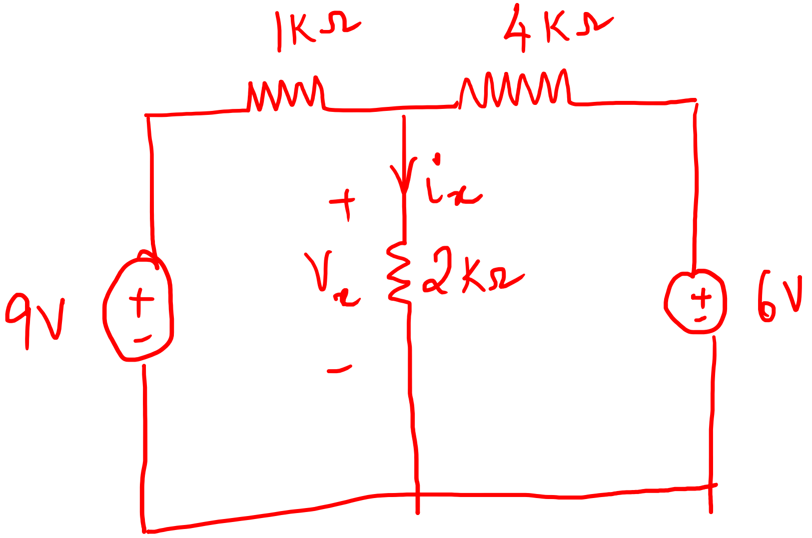
$$R_{th} = 1 \| 4 = 0.8K\Omega$$

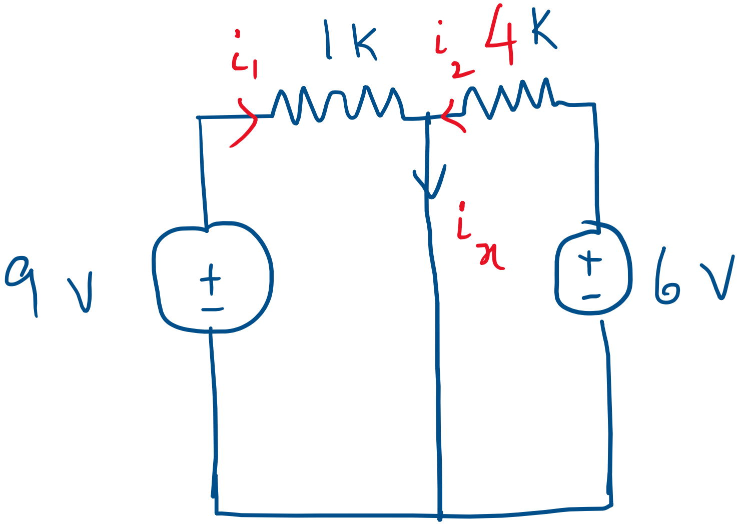
$$R_{th} = 0.8K\Omega$$



$$V_{R_L} = 8.4 \times \frac{2K}{2.8K} = \underline{6V}$$

$$i_{2K} = \frac{6}{2K} = \underline{3mA}$$





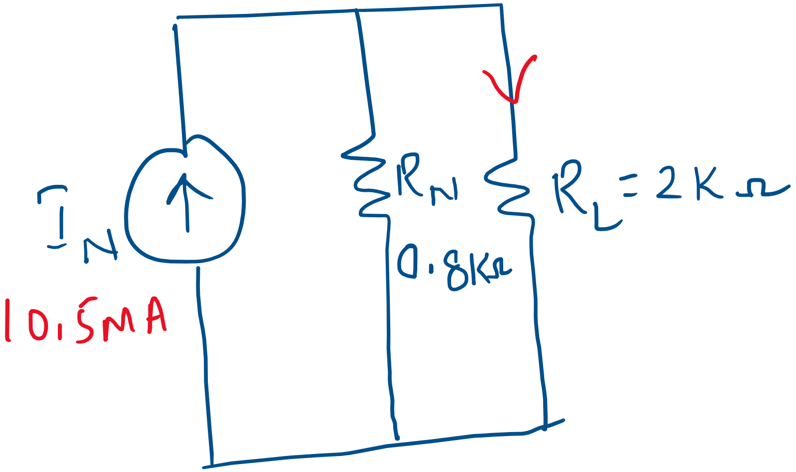
Norton's theorem

$$i_x = i_1 + i_2$$

$$= \frac{9}{1K} + \frac{6}{4K}$$

$$= (9 + 1.5) = \underline{10.5mA}$$

$R_N = R_{th} = 0.8K\Omega$
(Solved in Previous slide)

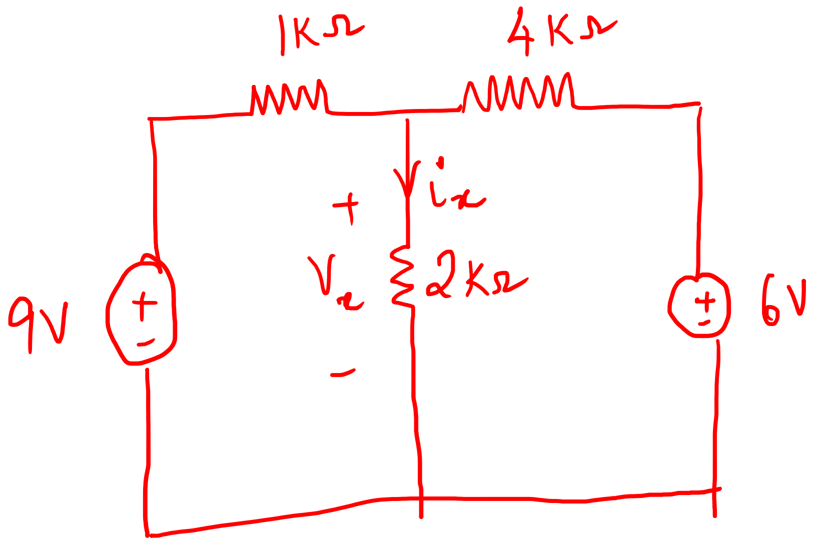


$V_{2K} = 3mA \times 2K\Omega$

$\underline{V_{2K} = 6V}$

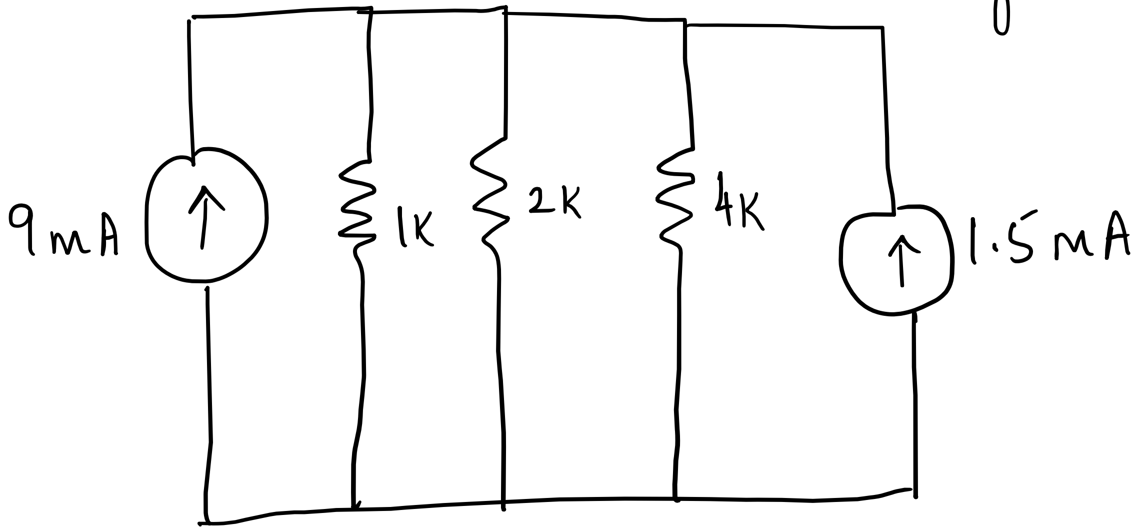
$$i_{R_L} = 10.5 \times \frac{0.8}{2.8}$$

$$i_{2K} = \underline{3mA}$$

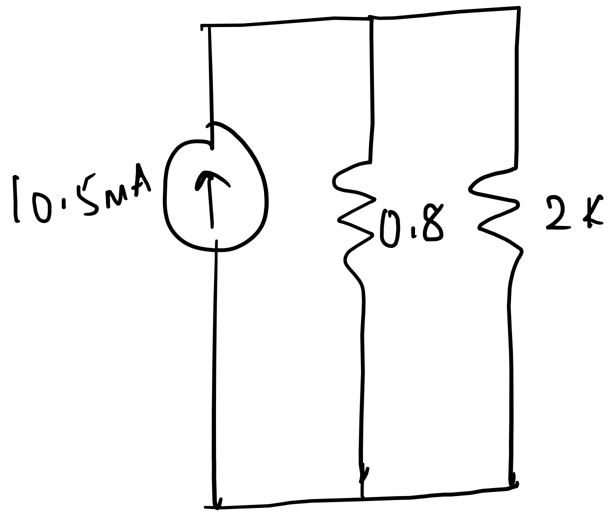


$\Rightarrow$

Source Transformation



$\Downarrow$



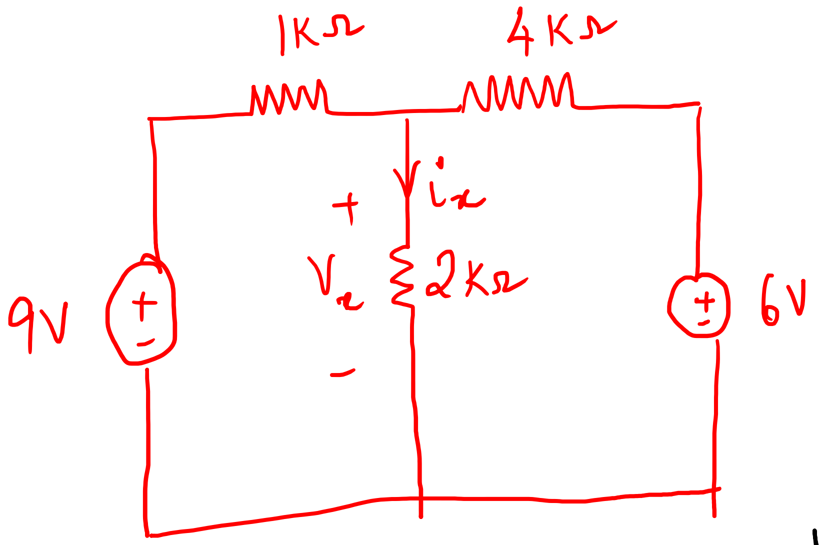
$$i_{2K} = 10.5 \times \frac{0.8}{2.8}$$

$$= \underline{3mA}$$

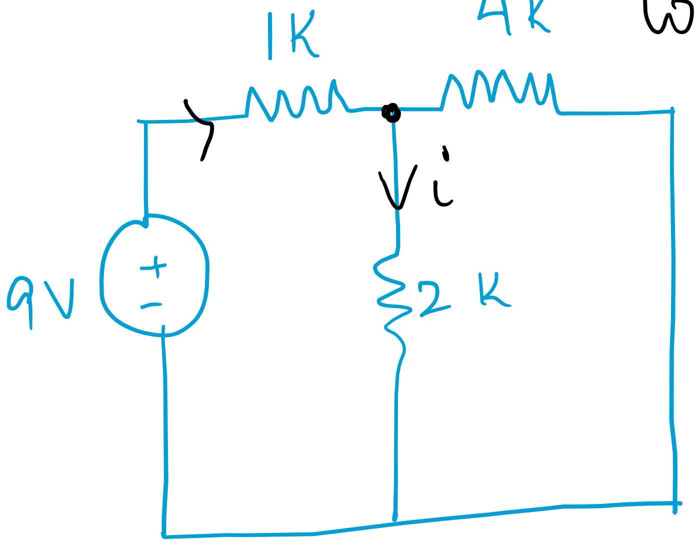
$$V_{2K} = 3mA \times 2K$$

$$= \underline{6V.}$$

Superposition Theorem



Consider 9V source



$$i_{2K} = 3.86 \times \frac{4}{2+4}$$

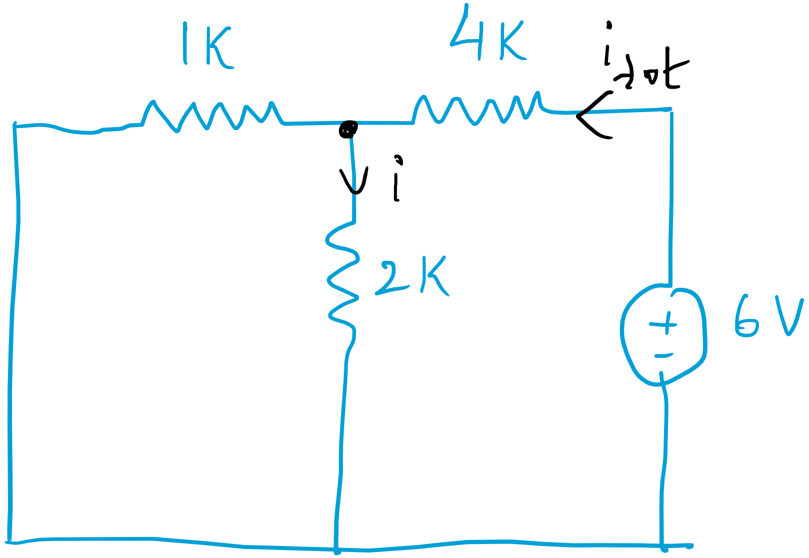
$$i_{2K}^{(1)} = 2.57 mA$$

$$i_{tot} = \frac{9}{1+(2\|4)} = 3.86 mA$$

$$i_{2K} = i^{(1)} + i^{(2)}$$

$$V_{2K} = 3 \times 2 = 6V \quad = 2.57 + 0.43 = 3 mA$$

Consider 6V source



$$i_{tot} = \frac{6}{4+(2\|1)} = 1.28 mA$$

$$i_{2K}^{(2)} = 1.28 \times \frac{1K}{3K} = 0.43 mA$$