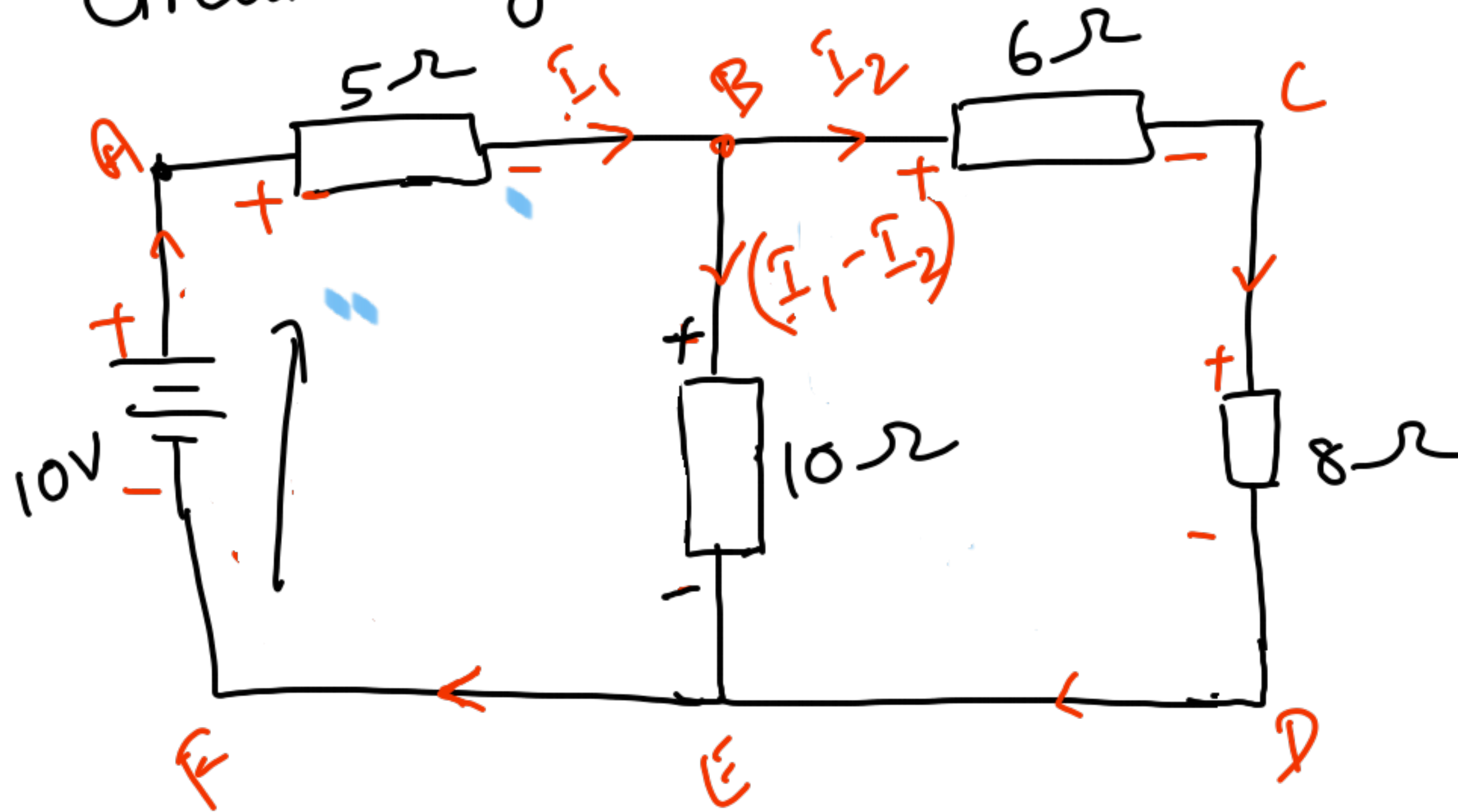


1) Determine the current across each branch in the following circuit using KVL.



Apply KVL in ABEFA

$$-5\hat{I}_1 - 10(\hat{I}_1 - \hat{I}_2) + 10 = 0$$

$$-5\hat{I}_1 - 10\hat{I}_1 + 10\hat{I}_2 + 10 = 0$$

$$-15\hat{I}_1 + 10\hat{I}_2 = -10 \quad \text{--- (1)}$$

Apply KVL in BCDEB

$$-6\hat{I}_2 - 8\hat{I}_2 + 10(\hat{I}_1 - \hat{I}_2) = 0$$

$$-6\hat{I}_2 - 8\hat{I}_2 + 10\hat{I}_1 - 10\hat{I}_2 = 0$$

$$10\hat{I}_1 - 24\hat{I}_2 = 0 \quad \text{--- (2)}$$

$$\text{eq ①} \Rightarrow -15\hat{I}_1 + 10\hat{I}_2 = -10$$

$$\text{eq ②} \Rightarrow 10\hat{I}_1 - 24\hat{I}_2 = 0$$

$$\text{eq ①} \times 2 \Rightarrow -30\cancel{\hat{I}_1} + 20\hat{I}_2 = -20$$

$$\text{eq ②} \times 3 \Rightarrow 30\cancel{\hat{I}_1} - 72\hat{I}_2 = 0$$

$$-52\hat{I}_2 = -20$$

$$\hat{I}_2 = \frac{20}{52}$$

$$\hat{I}_2 = 0.39\text{A}$$

Sub. $\hat{I}_2$ in equation ②

$$\text{②} \Rightarrow 10\hat{I}_1 - 24(0.39) = 0$$

$$10\hat{I}_1 - 9.2 = 0$$

$$\hat{I}_1 = \frac{9.2}{10}$$

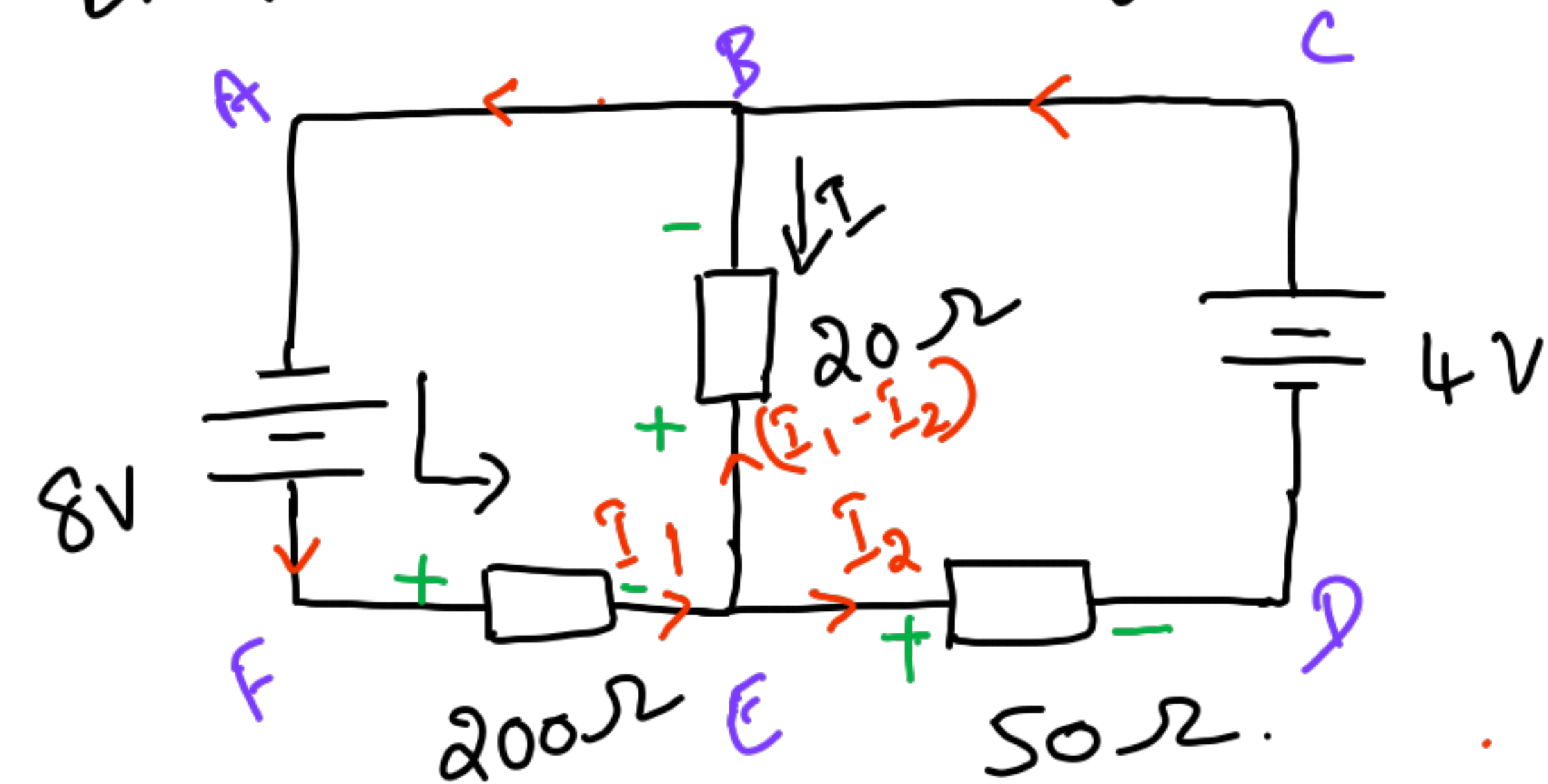
$$\hat{I}_1 = 0.92\text{A}$$

Current Across BE

$$\hat{I}_1 - \hat{I}_2 = 0.92 - 0.39$$

$$\hat{I}_1 - \hat{I}_2 = 0.53\text{A}$$

2) Determine the Current across each branch in the following circuit



Apply KVL in FEBAF

$$-200\hat{I}_1 - 20(\hat{I}_1 - \hat{I}_2) + 8 = 0$$

$$-200\hat{I}_1 - 20\hat{I}_1 + 20\hat{I}_2 = -8$$

$$-220\hat{I}_1 + 20\hat{I}_2 = -8 \quad \text{--- (1)}$$

Apply KVL in EDCBE

$$-50\hat{I}_2 + 4 + 20(\hat{I}_1 - \hat{I}_2) = 0$$

$$-50\hat{I}_2 + 20\hat{I}_1 - 20\hat{I}_2 = -4$$

$$20\hat{I}_1 - 70\hat{I}_2 = -4 \quad \text{--- (2)}$$

Solve eq (1) and (2)

$$\text{eq (1)} \Rightarrow -220\hat{I}_1 + 20\hat{I}_2 = -8$$

$$\text{eq (2)} \Rightarrow 20\hat{I}_1 - 70\hat{I}_2 = -4$$

$$\text{eq (1)} \Rightarrow \frac{-220\hat{I}_1 + 20\hat{I}_2 = -8}{+}$$

$$\text{eq (2)} \times 11 \Rightarrow 220\hat{I}_1 - 770\hat{I}_2 = -44$$

$$\frac{-220\hat{I}_1 + 20\hat{I}_2 = -8}{-750\hat{I}_2 = -52}$$

$$\hat{I}_2 = \frac{52}{750}$$

$$\hat{I}_2 = 0.07 \text{ A}$$

Sub. $\hat{I}_2$ in eq ①.

$$\text{eq ①} \Rightarrow -220\hat{I}_1 + 20(0.07) = -8$$

$$-220\hat{I}_1 + 1.4 = -8$$

$$-220\hat{I}_1 = -8 - 1.4$$

$$-220\hat{I}_1 = 9.4$$

$$\hat{I}_1 = \frac{9.4}{220} = 0.043 \text{ A}$$

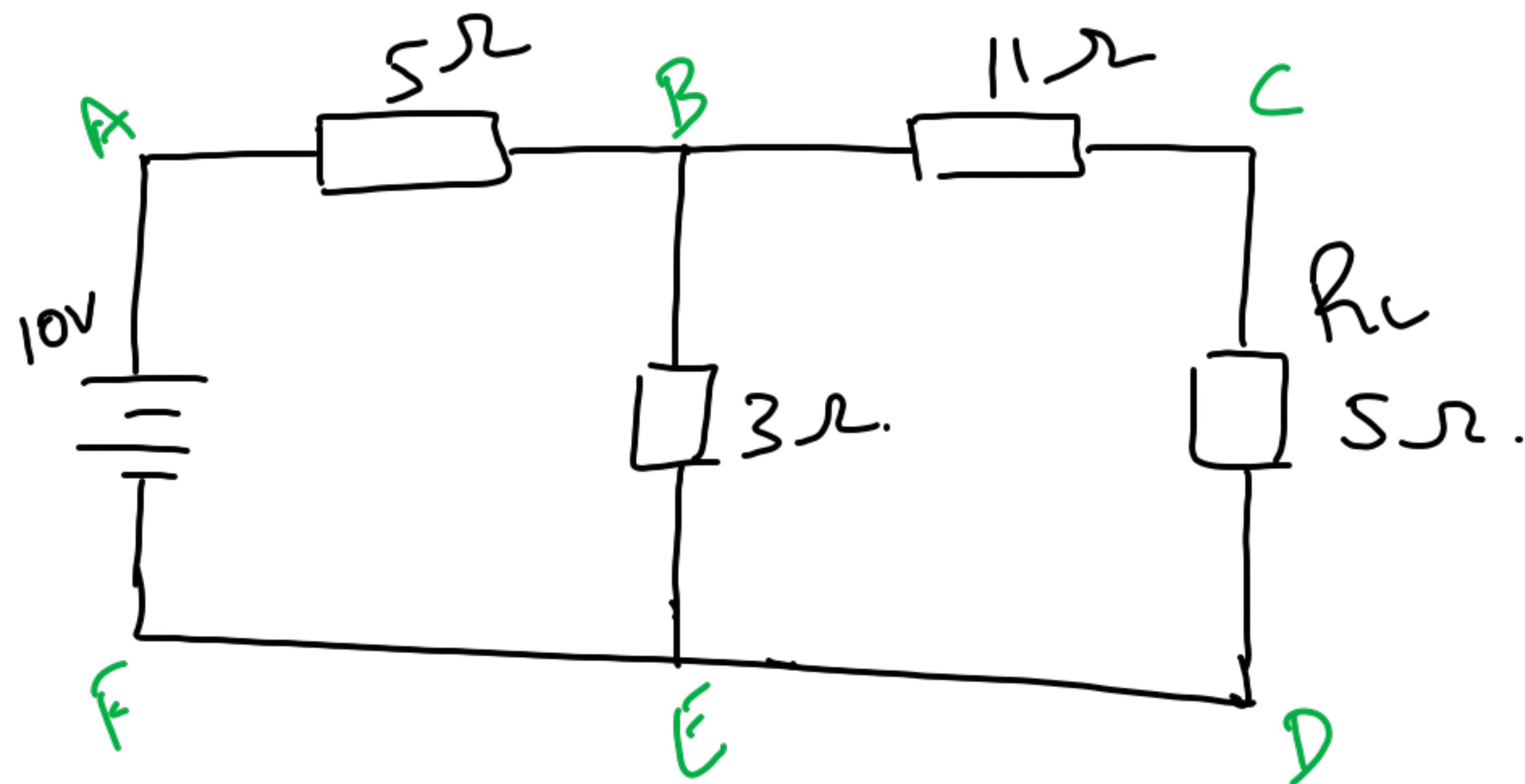
$$\hat{I}_1 - \hat{I}_2 = 0.043 - 0.07$$

$$\hat{I}_1 - \hat{I}_2 = -0.027 \text{ A}$$

Current flows from B to E.

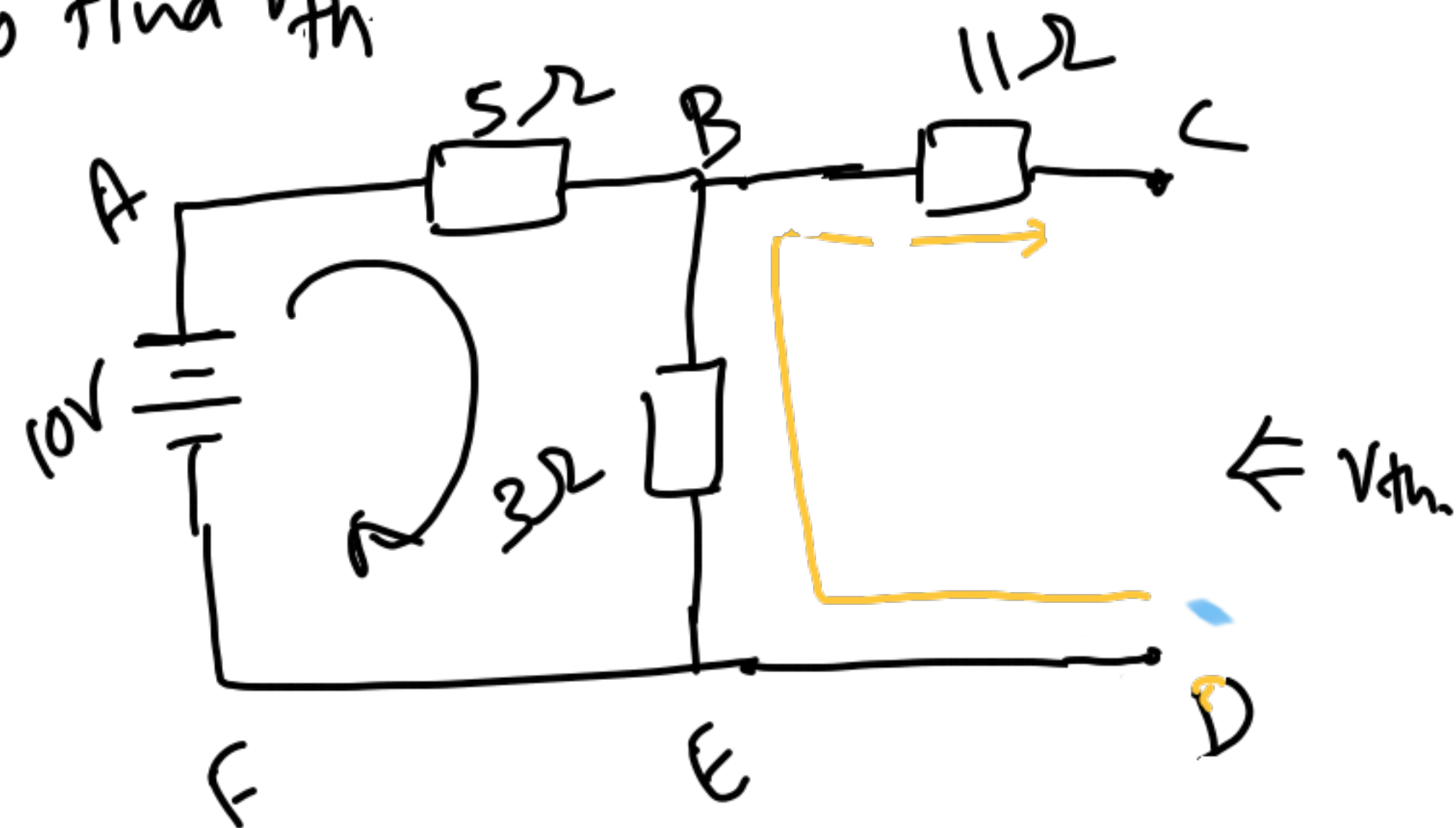
Opposite to the assumed direction.

Determine the Thevenins Voltage,
Thevenins Resistance & load Current
using Thevenins theorem.



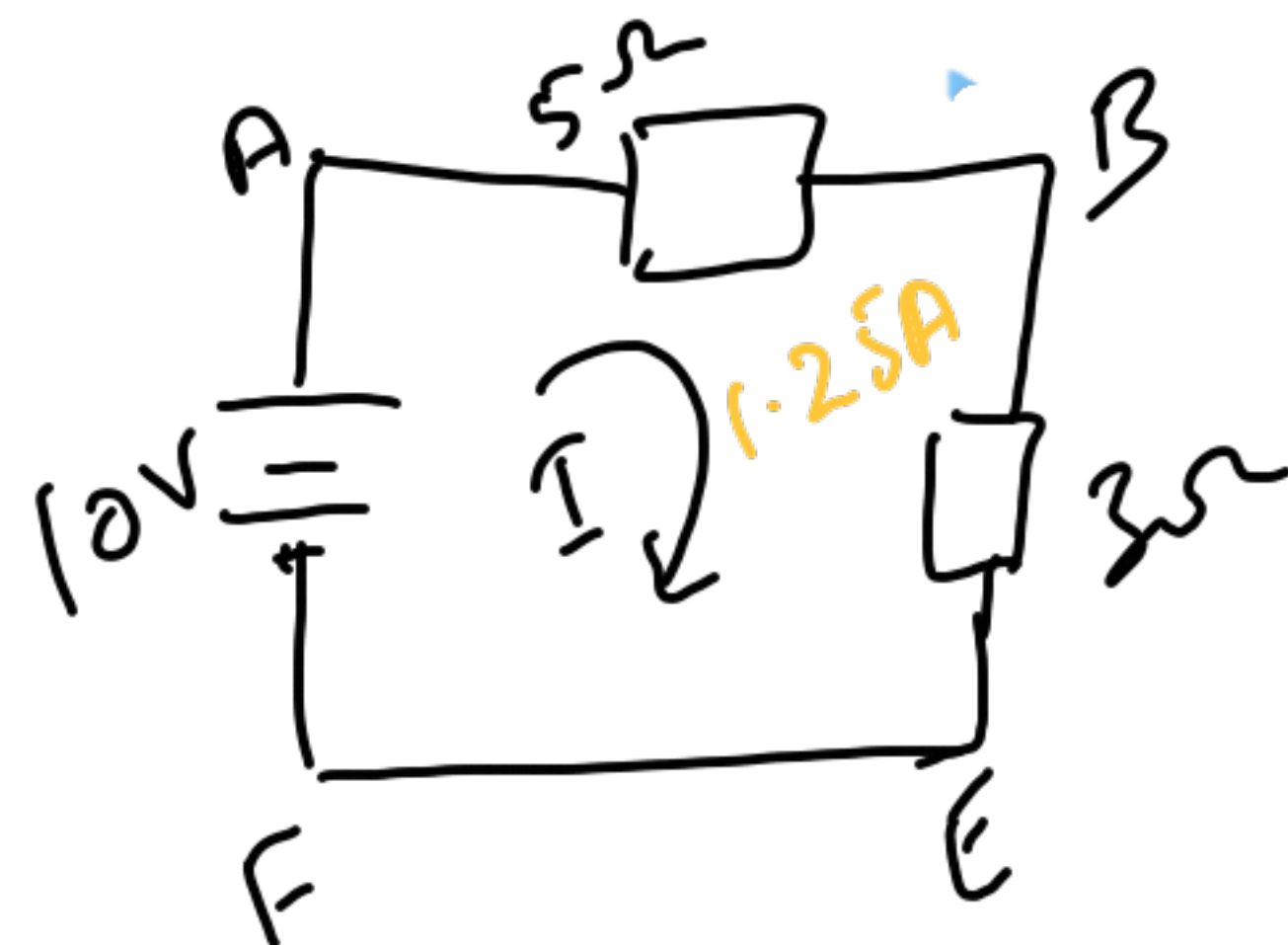
V_{th}
 R_{th}
 R_L

To find V_{th}



$$V_{th} = V_{DC} = V_{DE} + V_{EB} + V_{BC}$$

$$= 0 + V_{EB} + 0$$



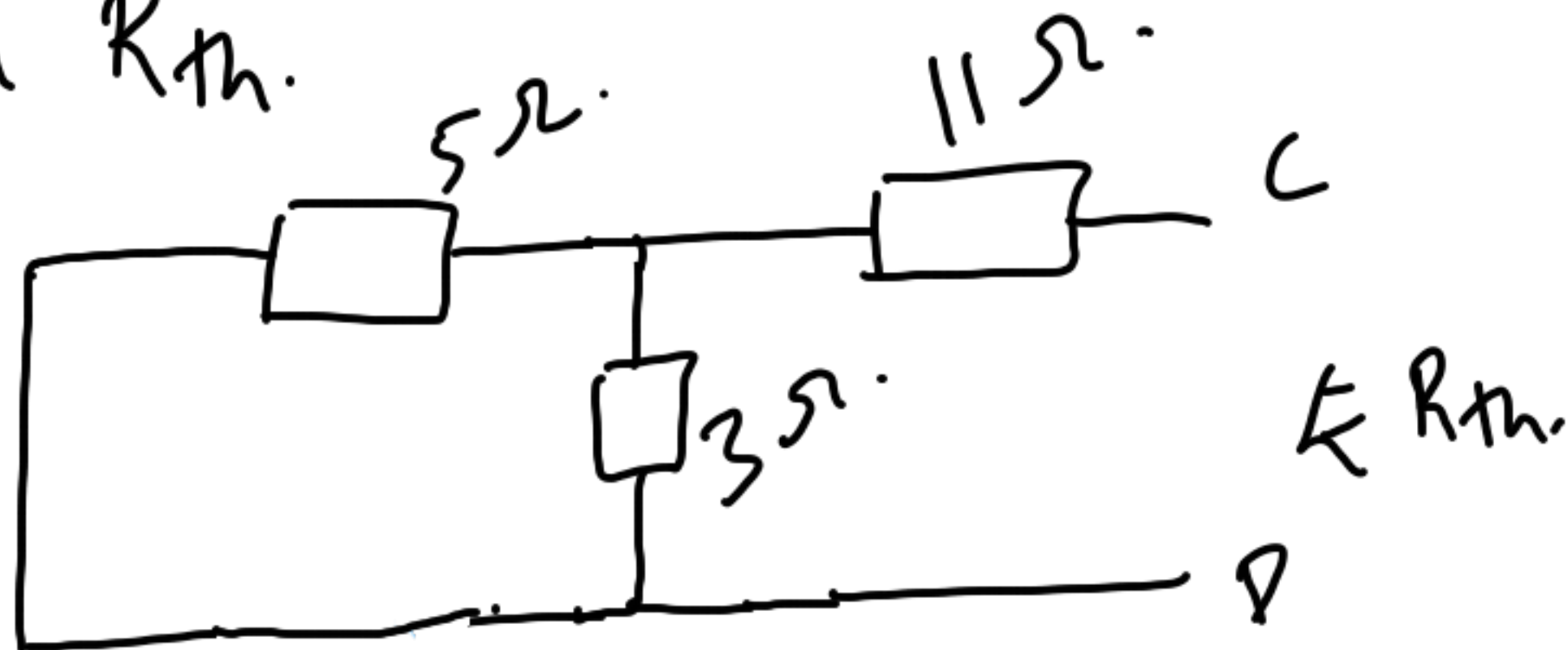
$$I = \frac{V}{R} = \frac{10}{5+3} = \frac{10}{8} = 1.25A$$

Voltage across 3Ω Resistor

$$V_{EB} = IR = 1.25 \times 3 = 3.75V.$$

$$V_{th} = V_{EB} = 3.75V$$

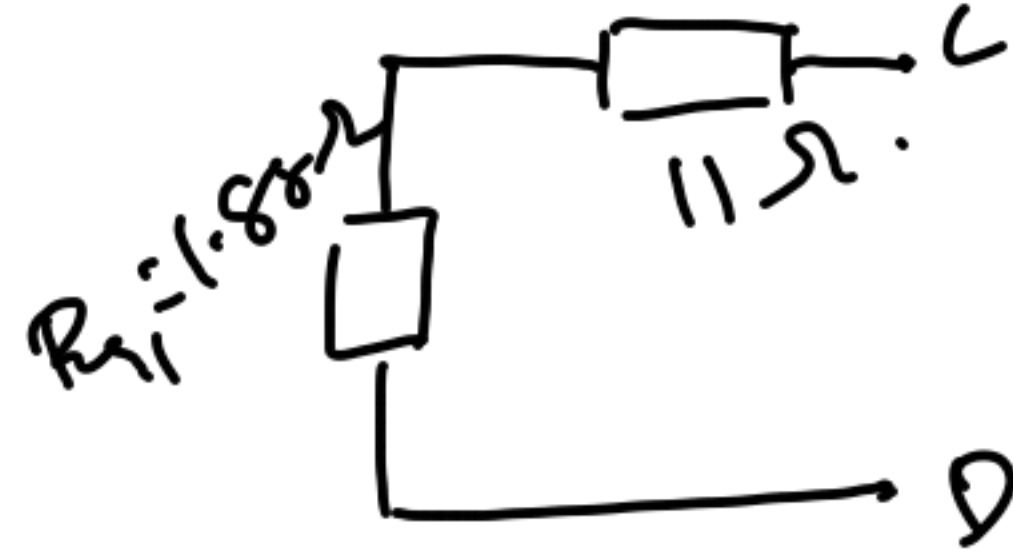
To find R_{th} .



5Ω and 3Ω in parallel.

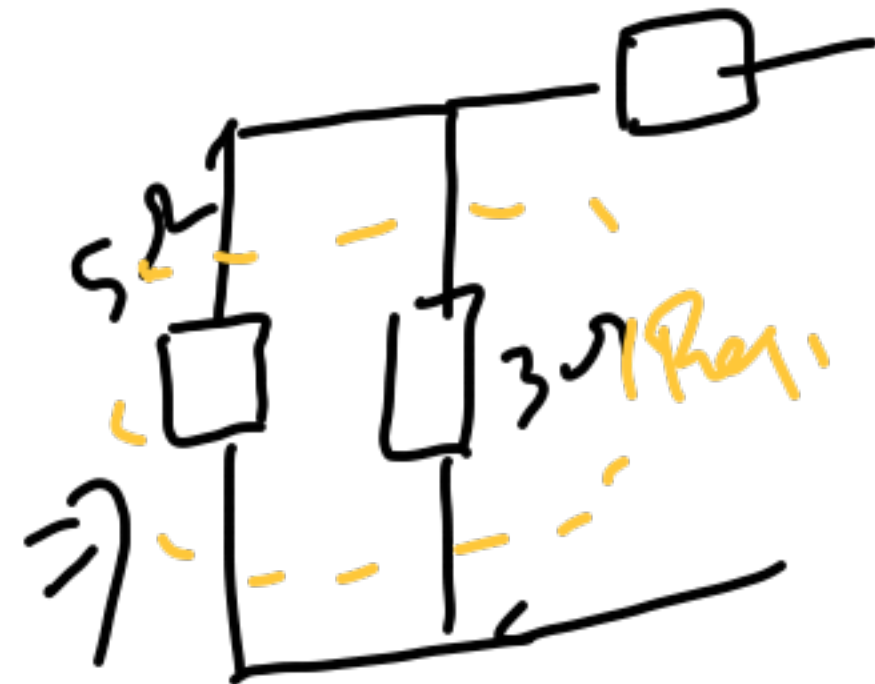
$$\frac{1}{R_{eq1}} = \frac{1}{5} + \frac{1}{3} = 0.53.$$

$$R_{eq1} = \frac{1}{0.53} = 1.88\Omega.$$

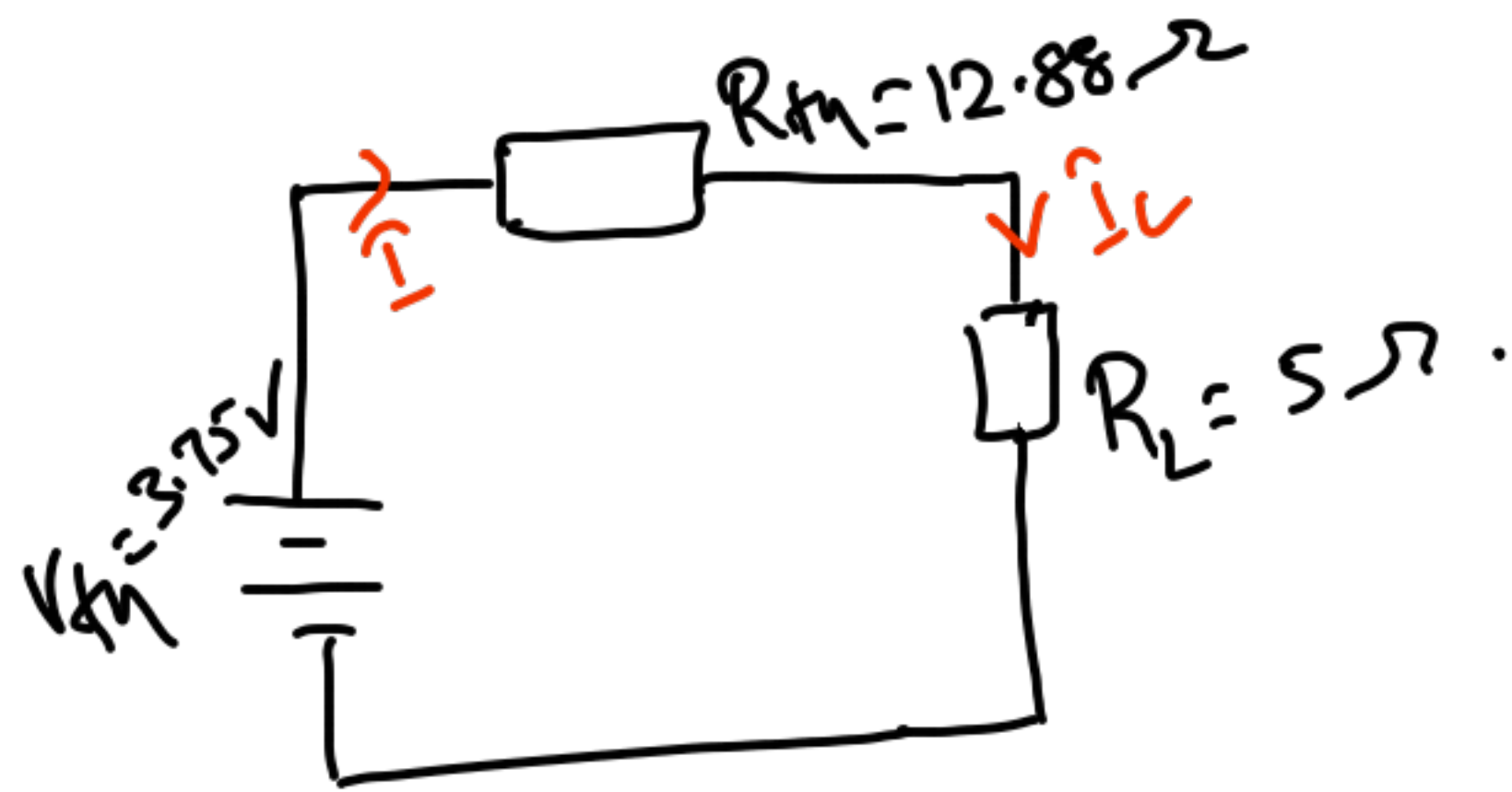


$$\Rightarrow R_{th} = 11 + 1.88$$

$$R_{th} = 12.88\Omega.$$



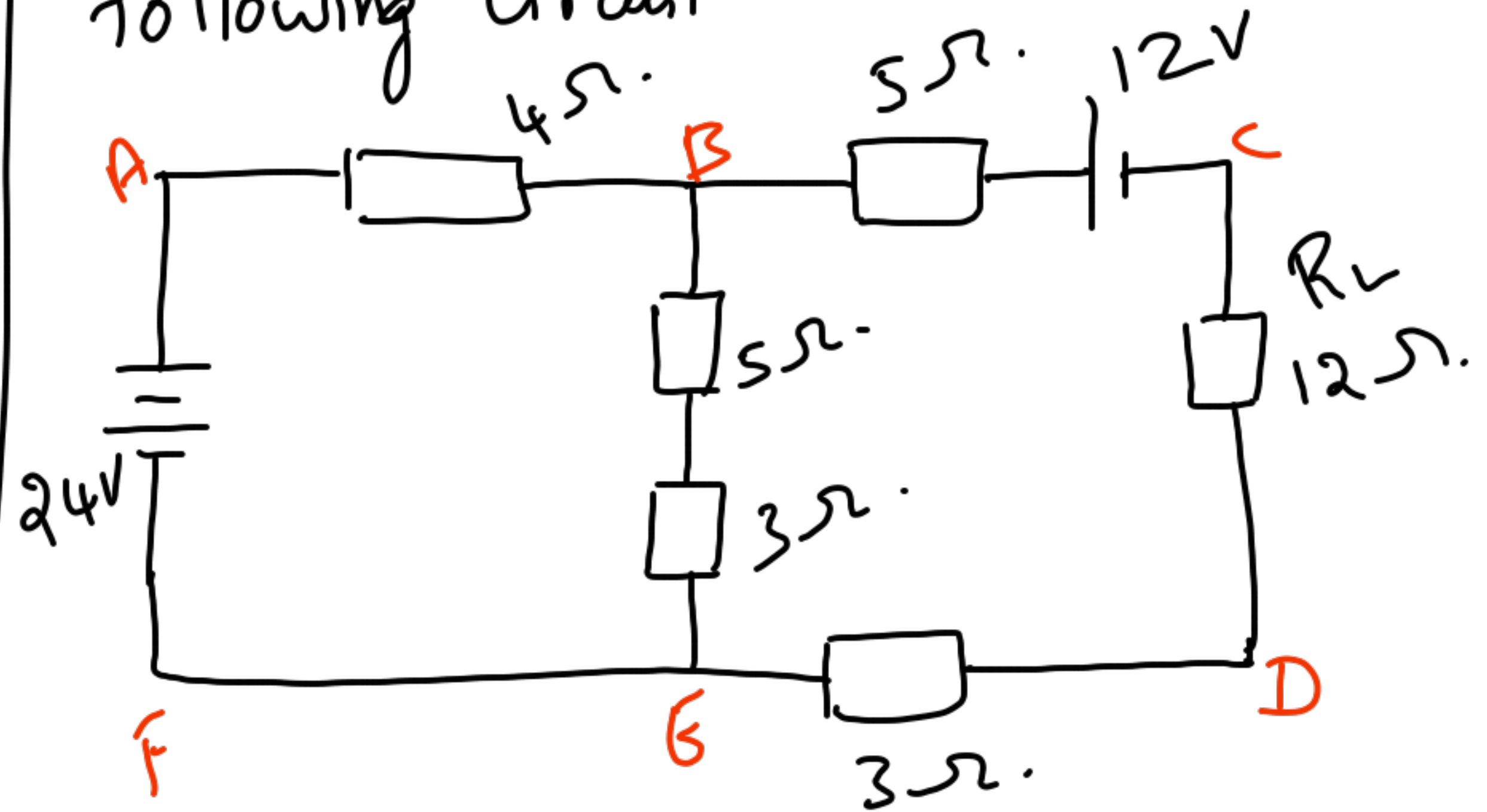
Thevenin's Equivalent circuit



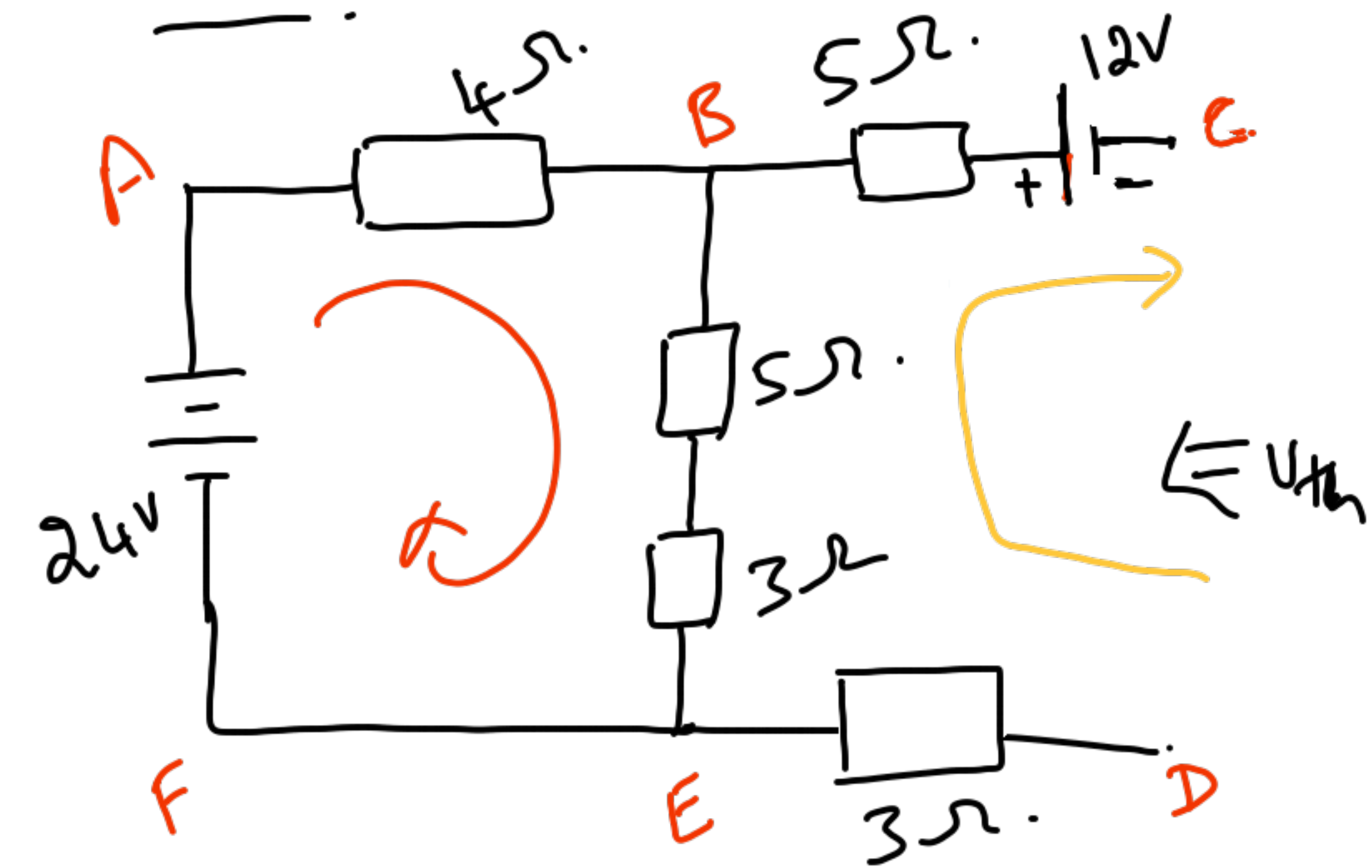
$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{3.75}{12.88 + 5}$$

$$I_L = 0.21A$$

4) Determine the load current, V_{th} and R_{th} using Thevenin's theorem for the following circuit.



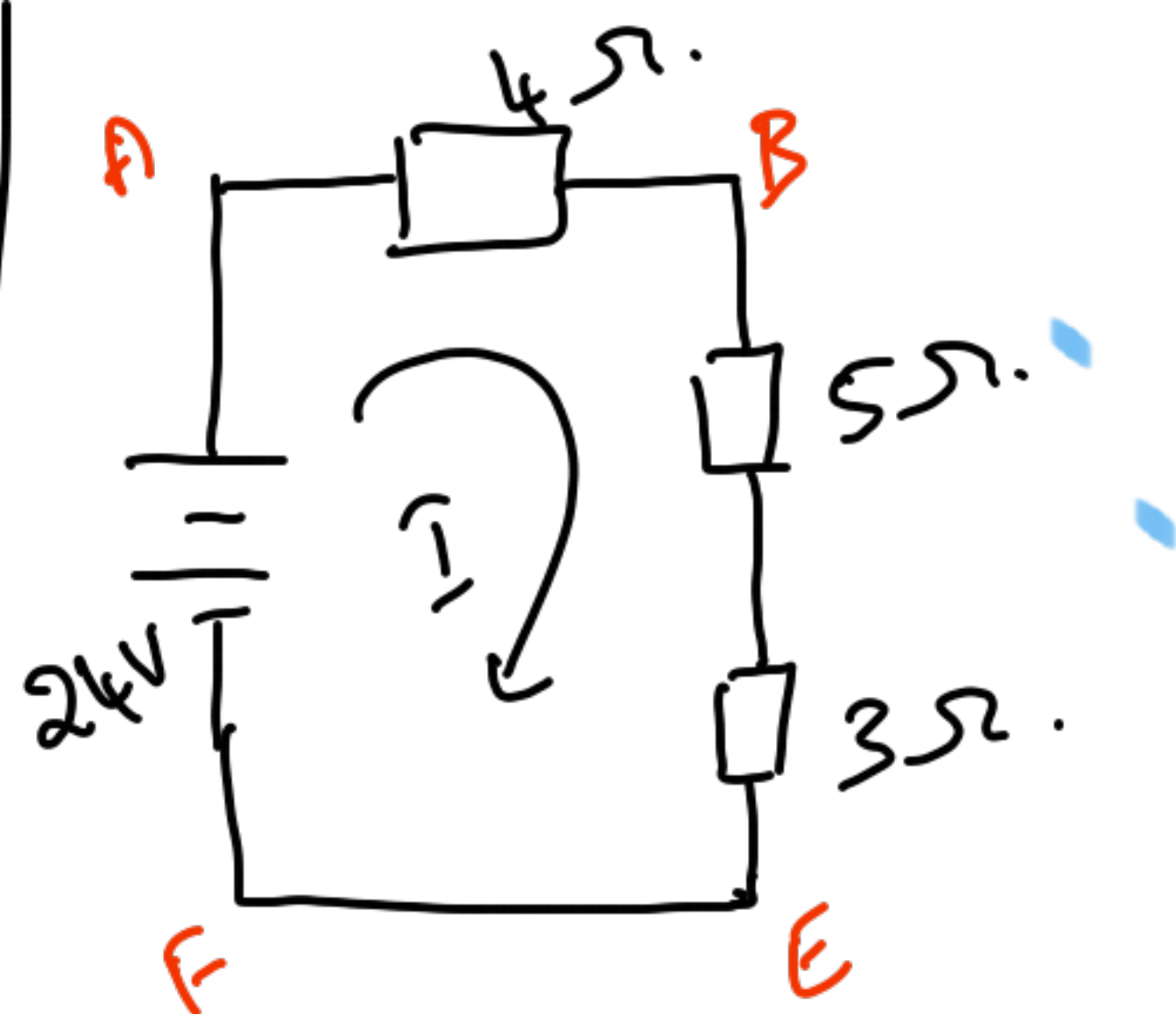
To find V_{th} :



$$V_{th} = V_{DE} + V_{EB} + V_{BC}$$

$$= 0 + V_{EB} + V_{5\Omega} + V_{12V}$$

$$V_{th} = 0 + V_{EB} + 0 - 12$$



$$I = \frac{V}{R} = \frac{24}{12} = 2A$$

Voltage across 5Ω and 3Ω Resistor.

$$V_{EB} = IR = 2(5+3)$$

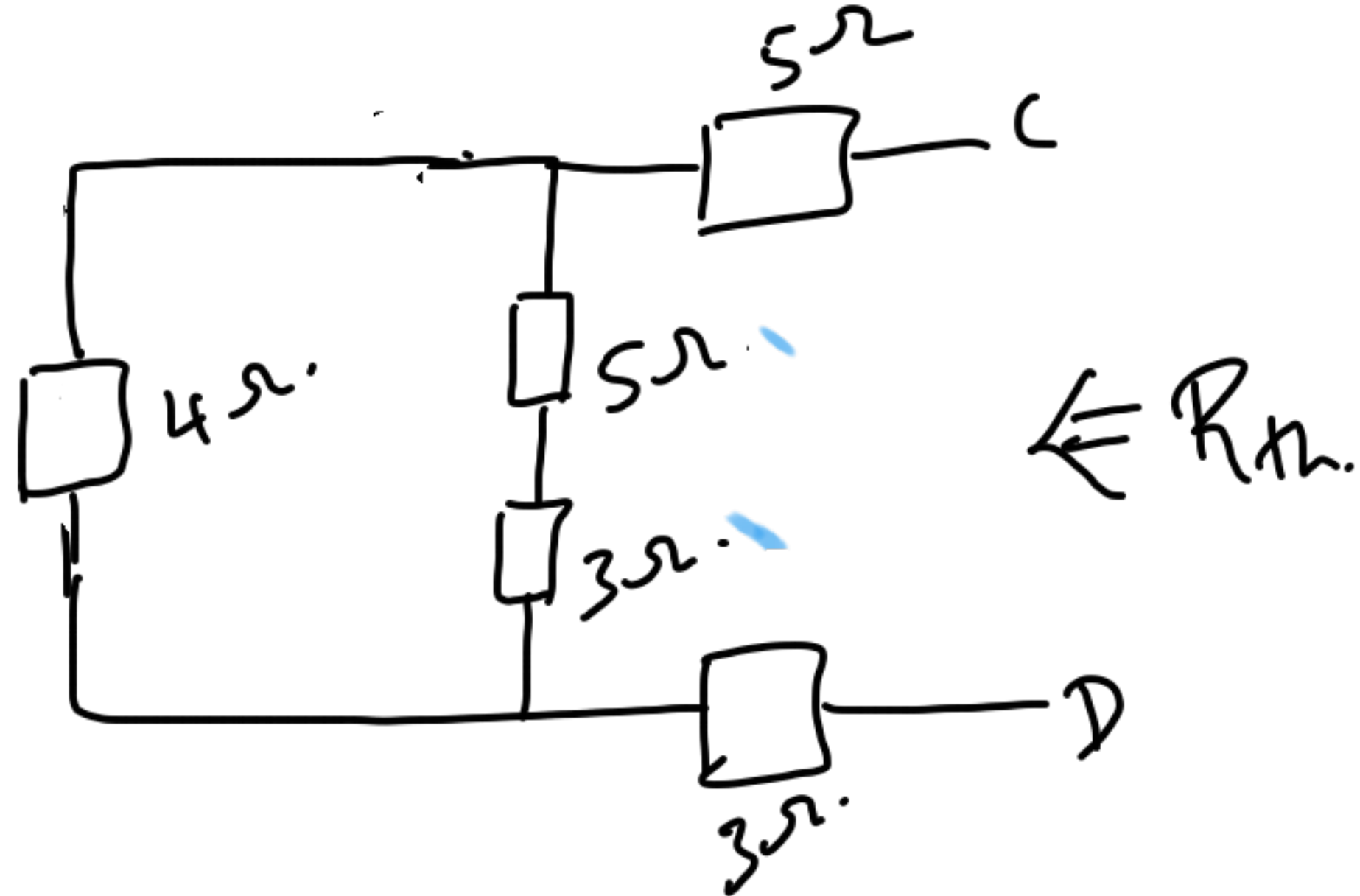
$$= 16V$$

$$V_{th} = 16 - 12 = 4V$$

R_{th}.

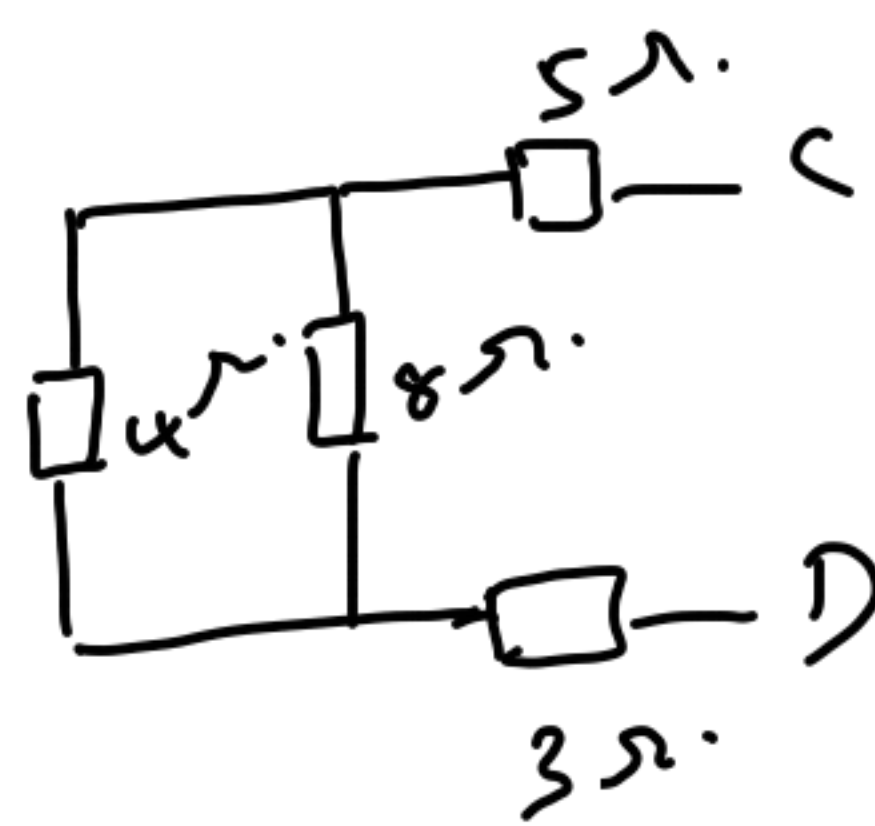
Voltage Source - Remove - Short circuit

Current Source - Remove - Open circuit



5Ω and 3Ω Resistor are in series.

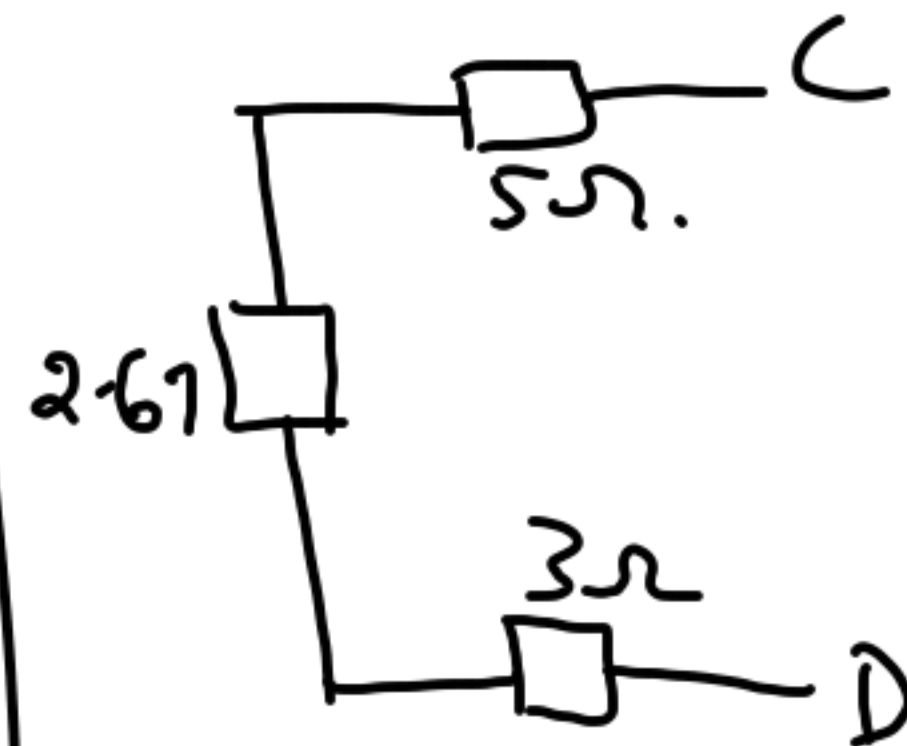
$$R_{eq1} = 5 + 3 = 8\Omega$$



4Ω and 8Ω are in parallel.

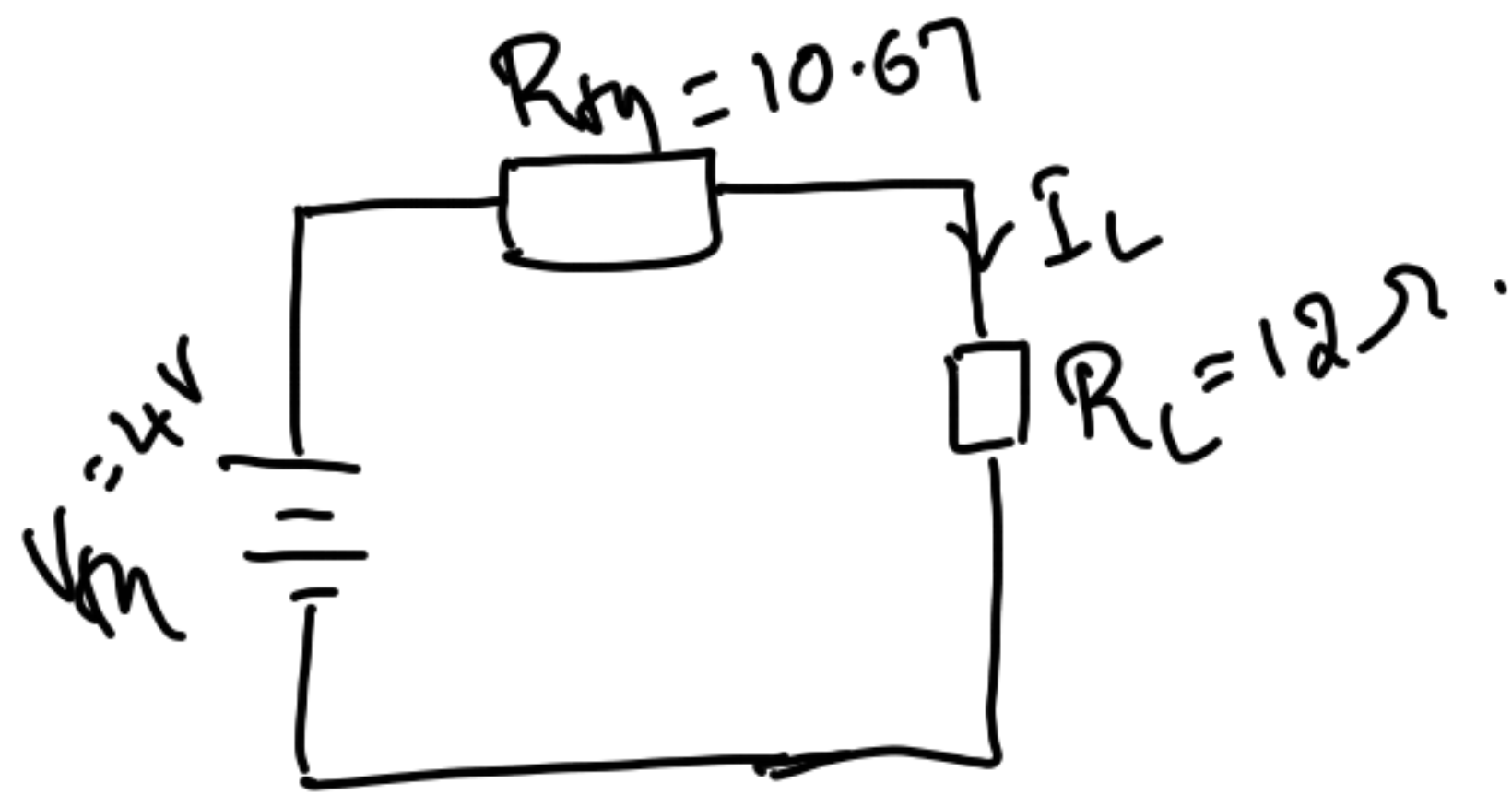
$$\frac{1}{R_{eq2}} = \frac{1}{4} + \frac{1}{8} = 0.375$$

$$R_{eq2} = \frac{1}{0.375} = 2.67\Omega$$



$$R_{th} = 5 + 3 + 2.67$$

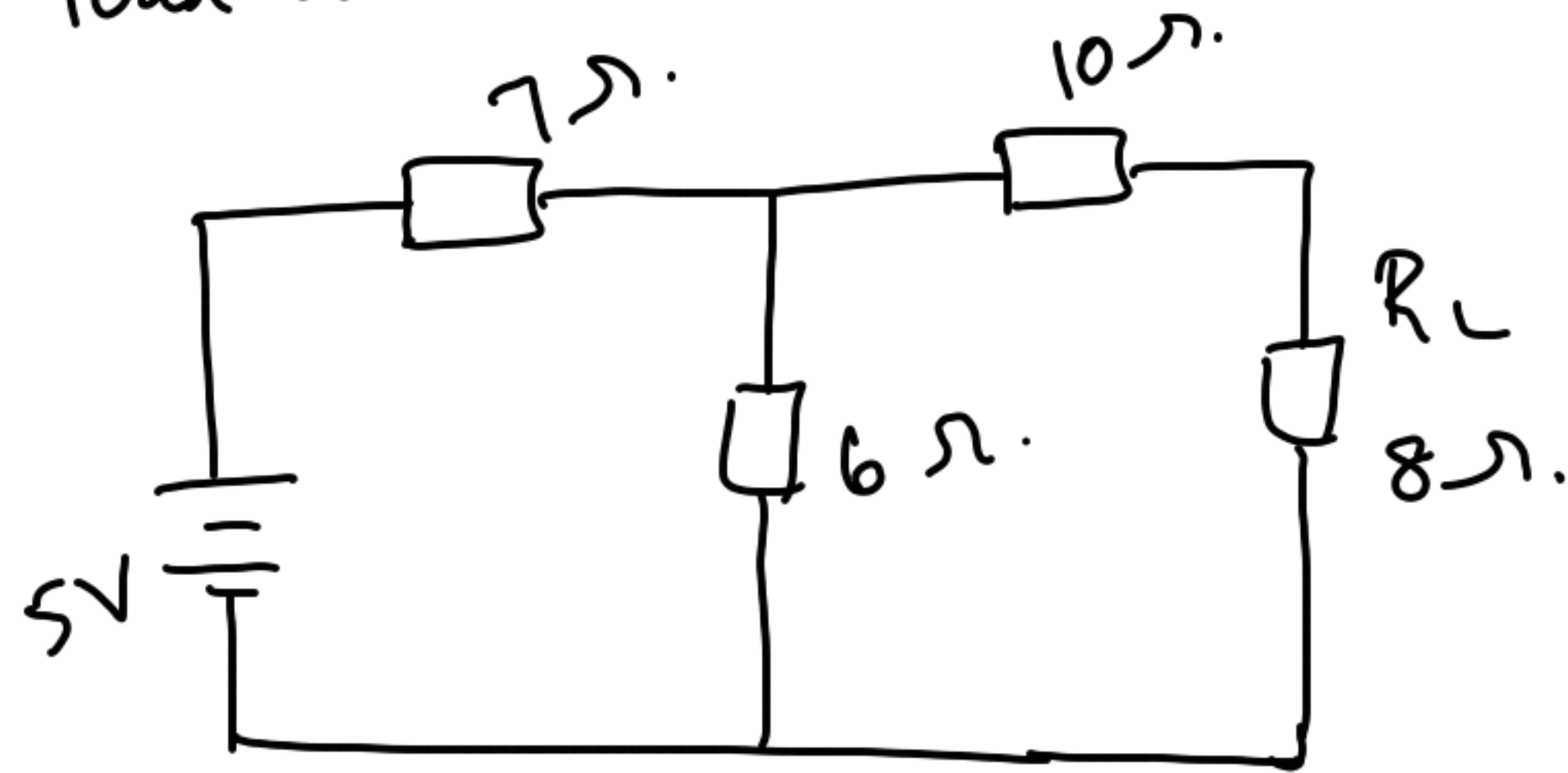
$$R_{th} = 10.67\Omega$$



$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{4}{10.67 + 12}$$

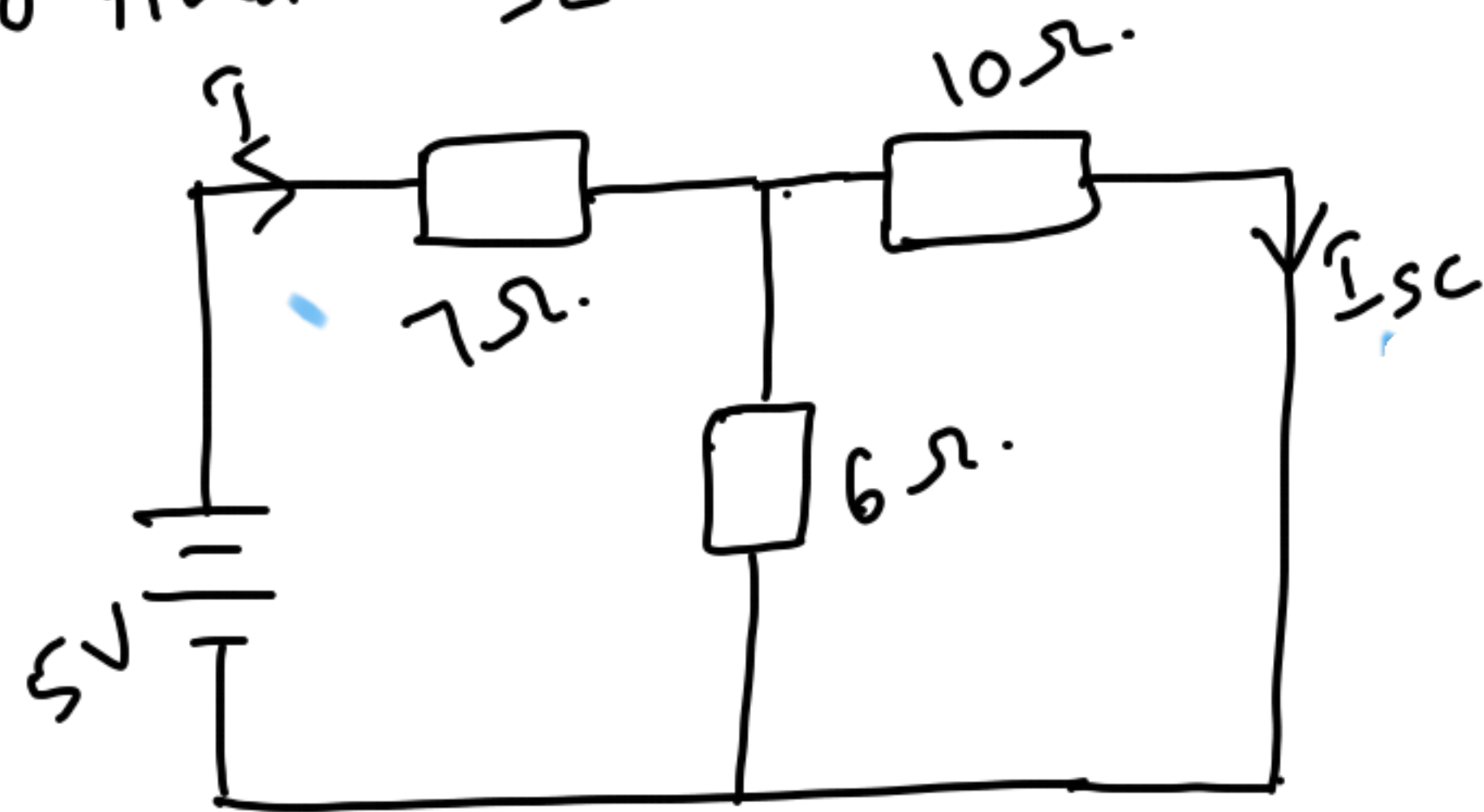
$$I_L = 0.18 \text{ A}$$

5) Determine the Nortons equivalent Circuit for the following Circuit and calculate the load current.



Soln $R_{th}, \underline{I_{sc} = I_N}, I_L$

To find I_{sc}

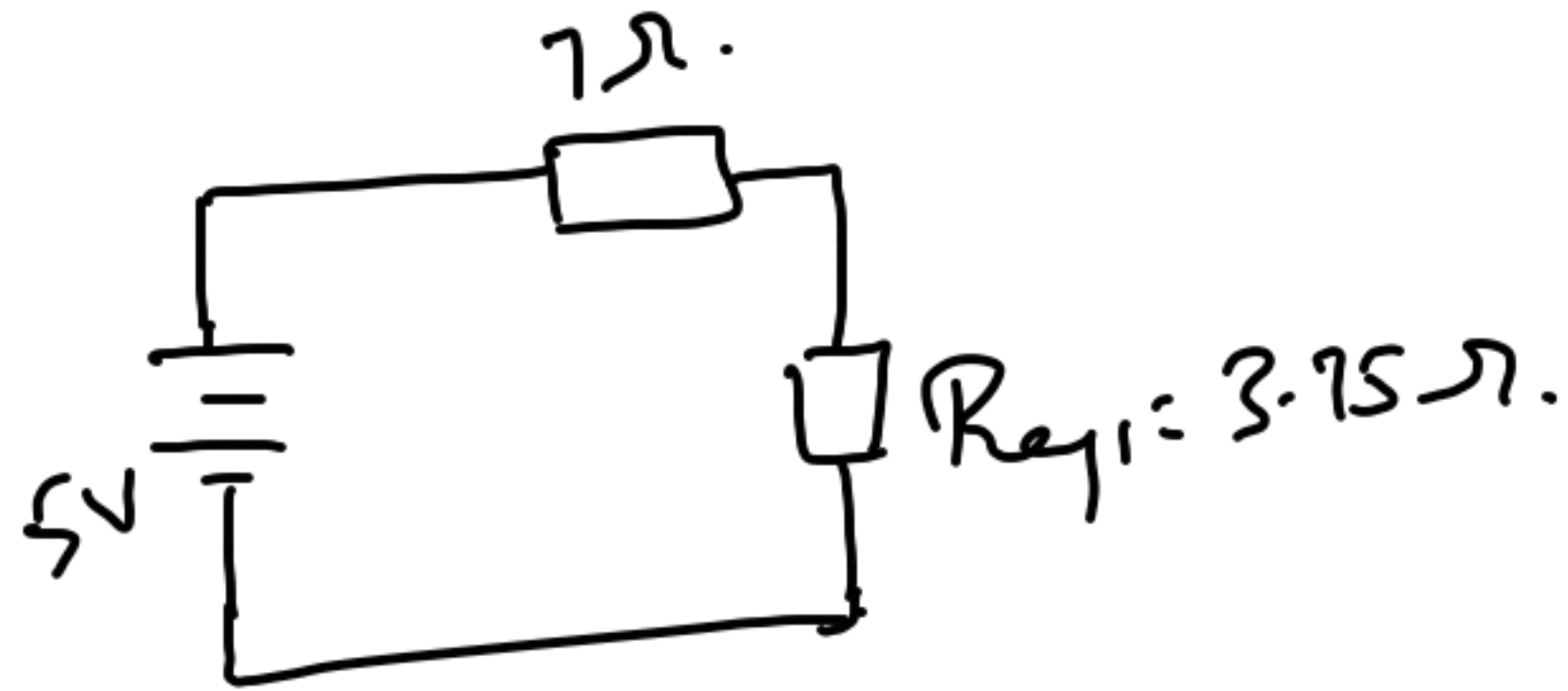


To find total Resistance:

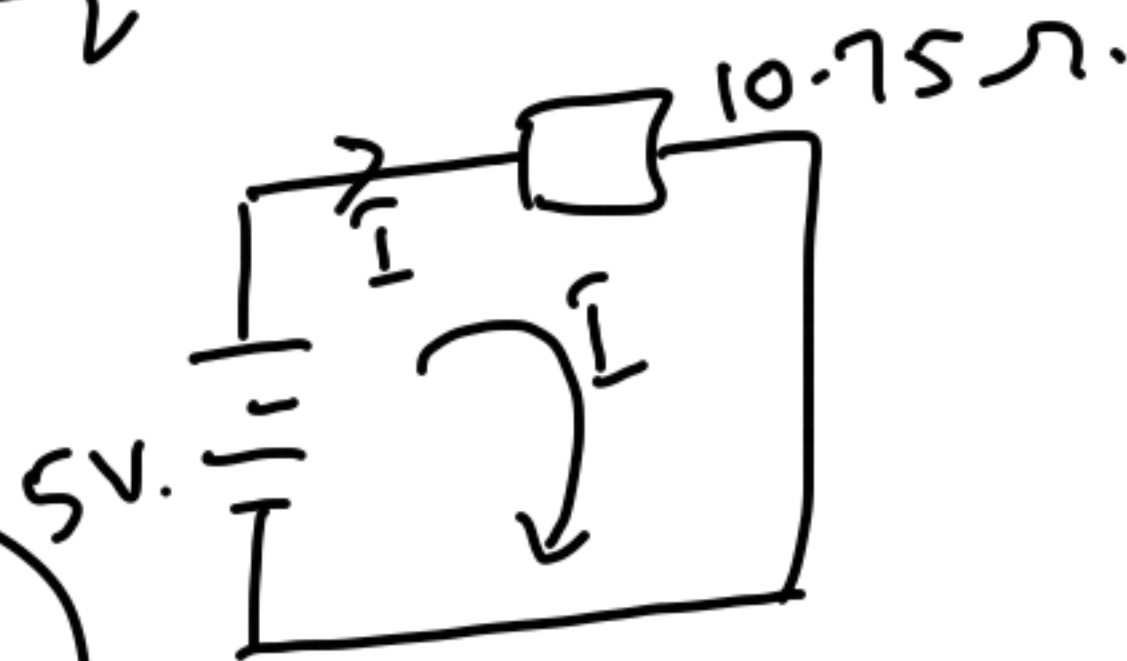
10Ω and 6Ω Resistor are in parallel.

$$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{10} = 0.267$$

$$R_{eq} = \frac{1}{0.267} = 3.75\Omega$$



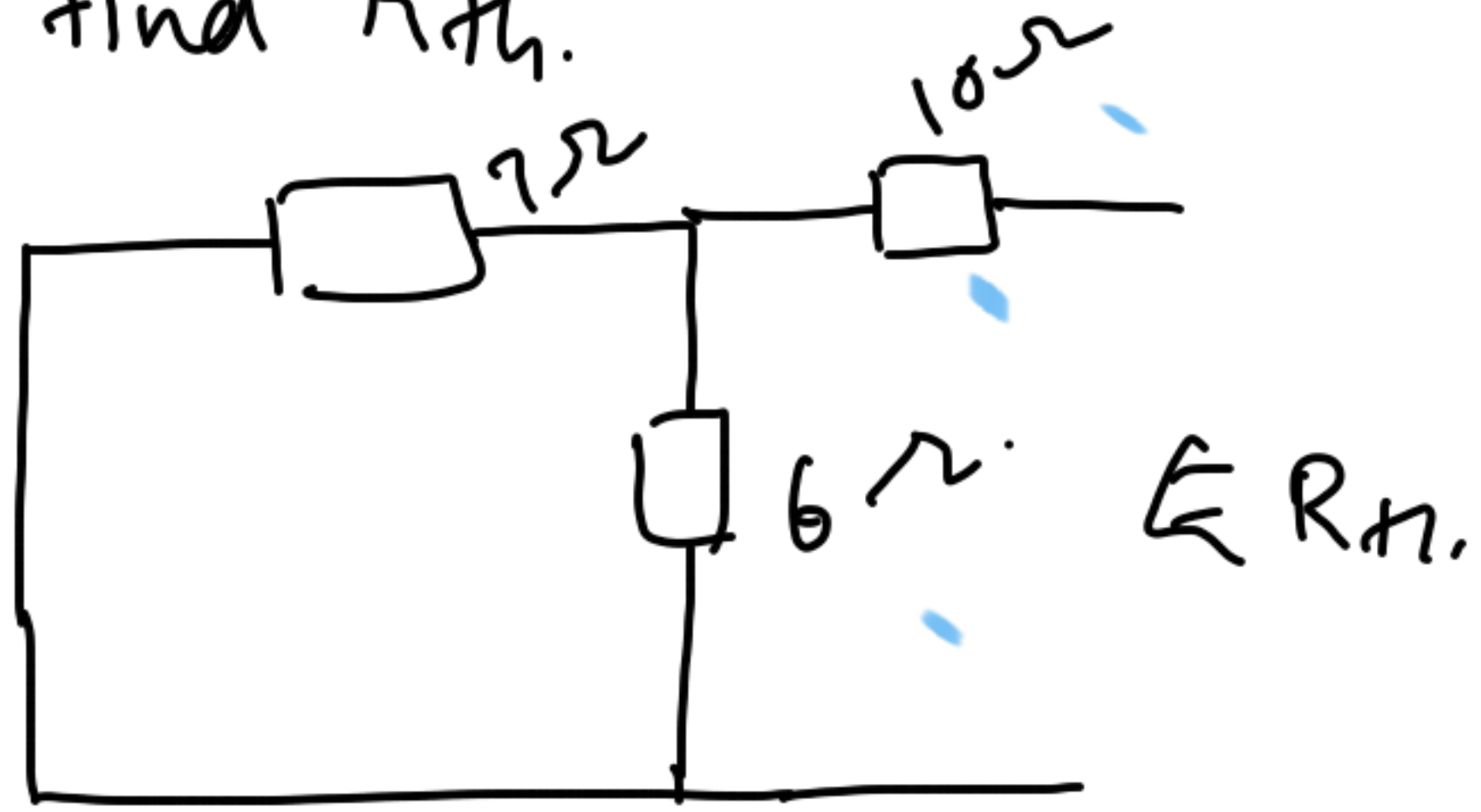
$$R_{eq} = 7 + 3.75 = 10.75\Omega$$



$$I = \frac{V}{R} = \frac{5}{10.75} = 0.465A$$

$$I_{sc} = \frac{I \cdot 6}{6 + 10} = \frac{0.465 \times 6}{6 + 10} = 0.17A$$

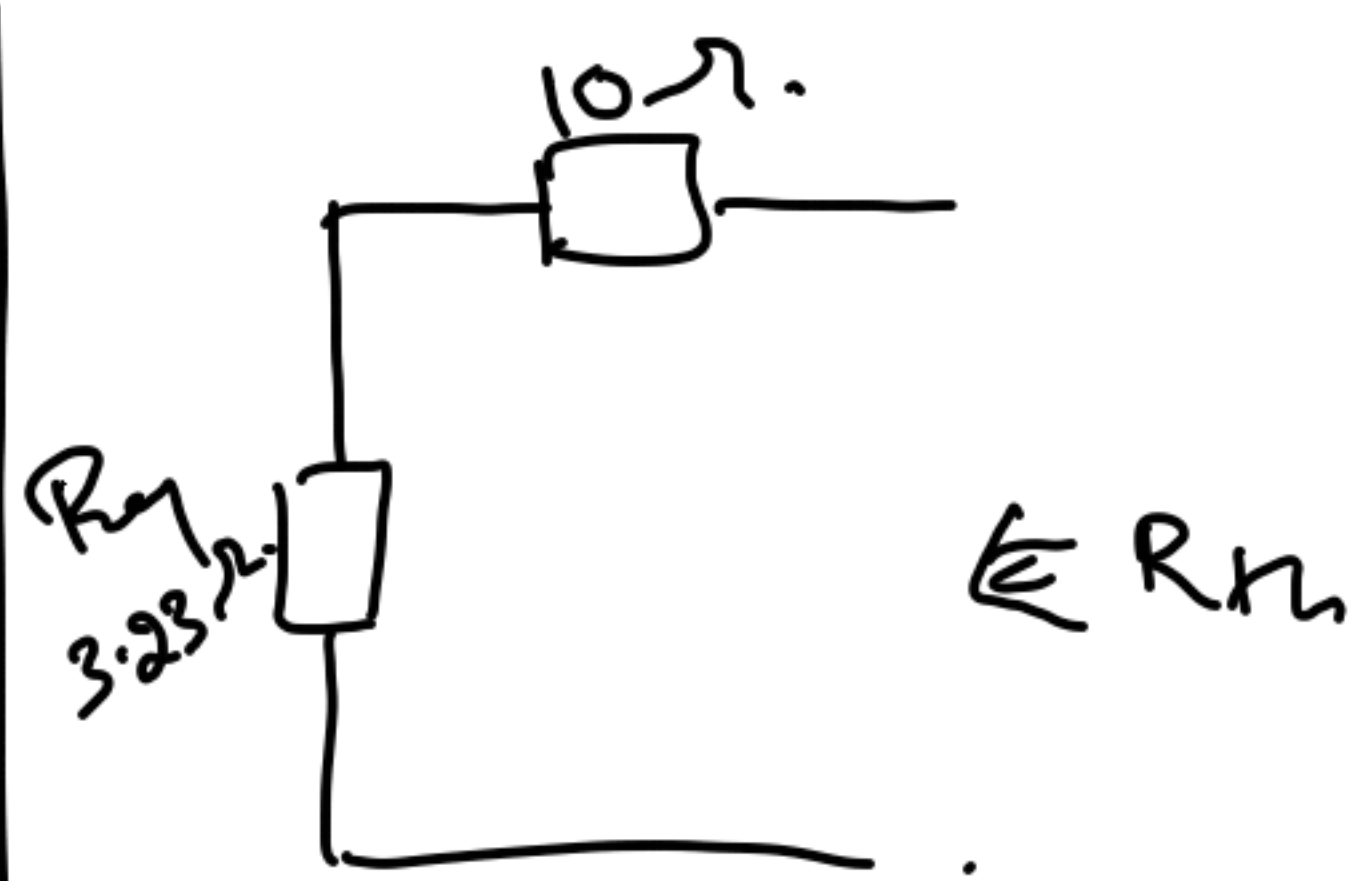
To find R_{th} .



7Ω and 6Ω are in parallel.

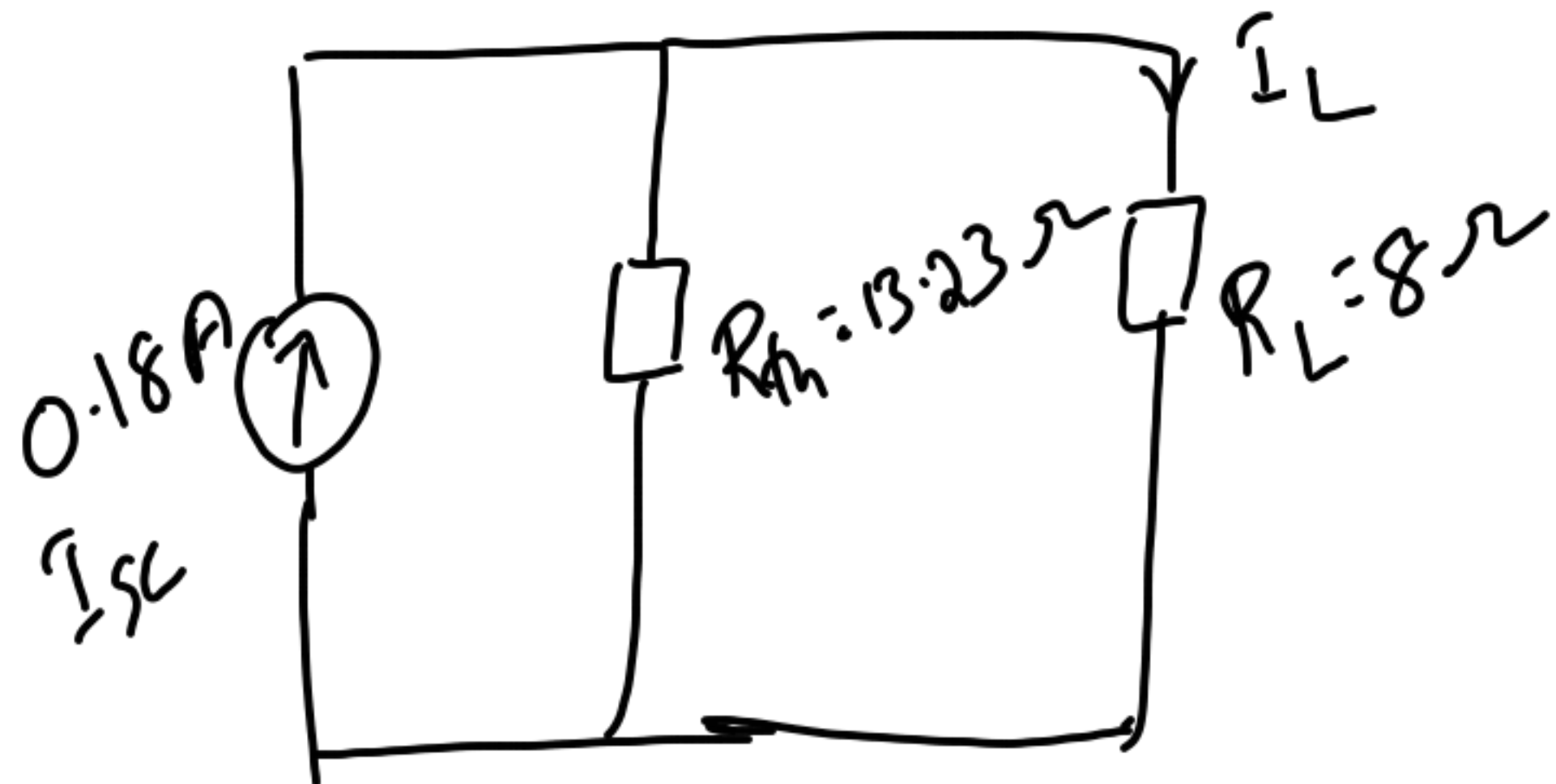
$$\frac{1}{R_{eq}} = \frac{1}{7} + \frac{1}{6} = 0.31$$

$$R_{eq} = \frac{1}{0.31} = 3.23\Omega$$



$$R_{th} = 10 + 3.23$$

$$R_{th} = 13.23\Omega$$

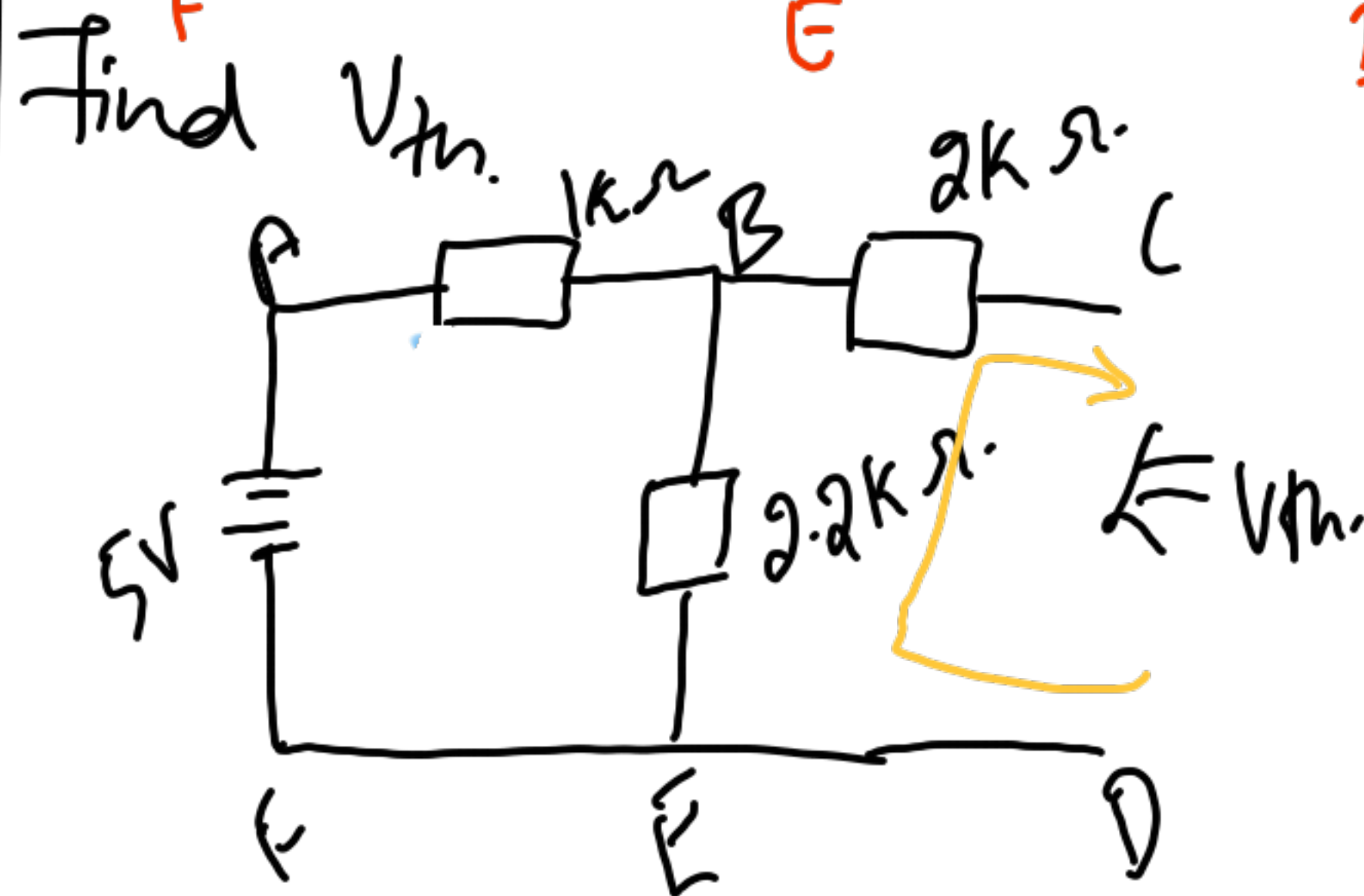
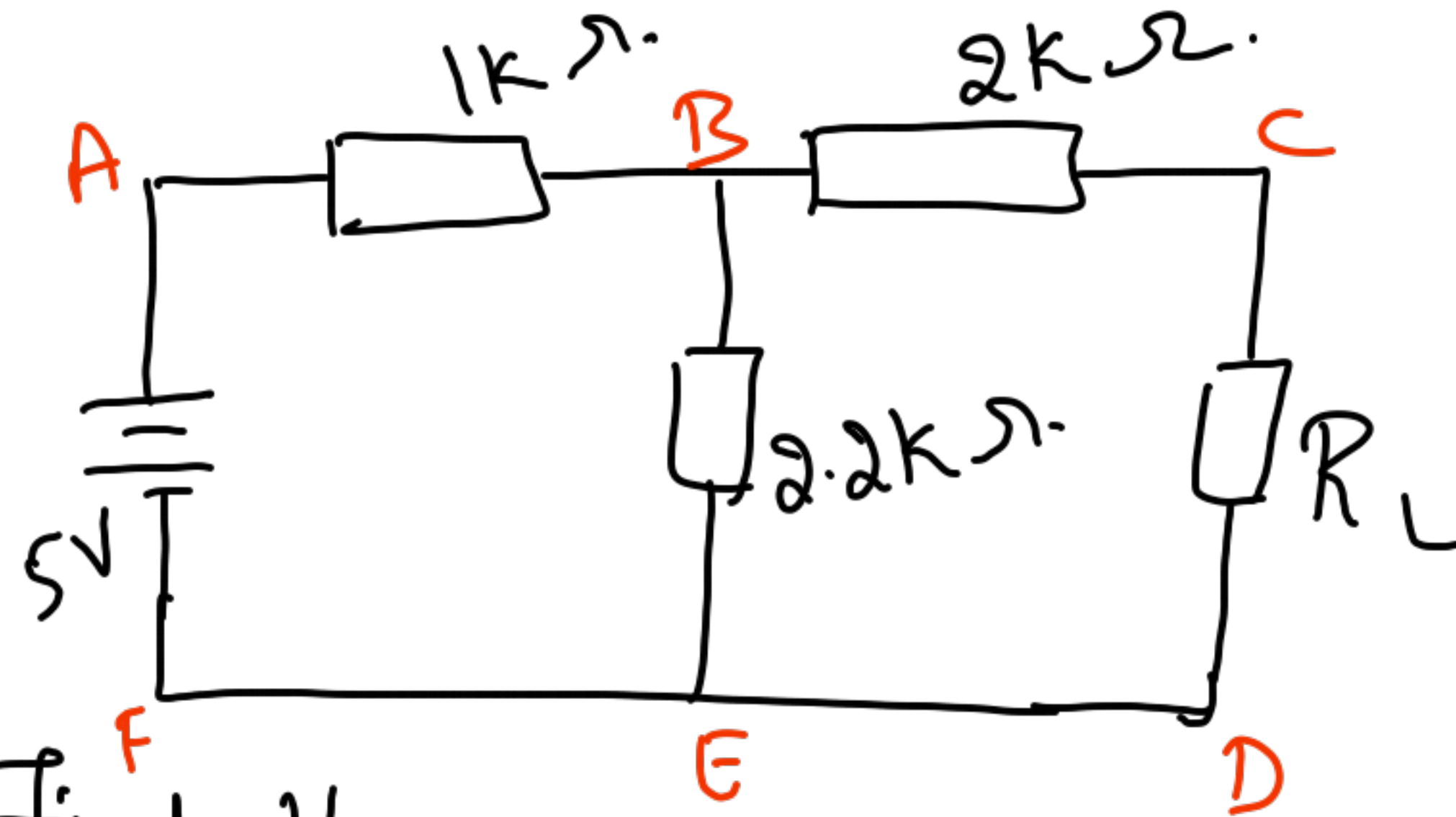


$$I_L = \frac{I_{sc} \cdot R_{th}}{R_{th} + R_L}$$

$$= \frac{0.18 \times 13.23}{13.23 + 8}$$

$$I_L = 0.11 \text{ A}$$

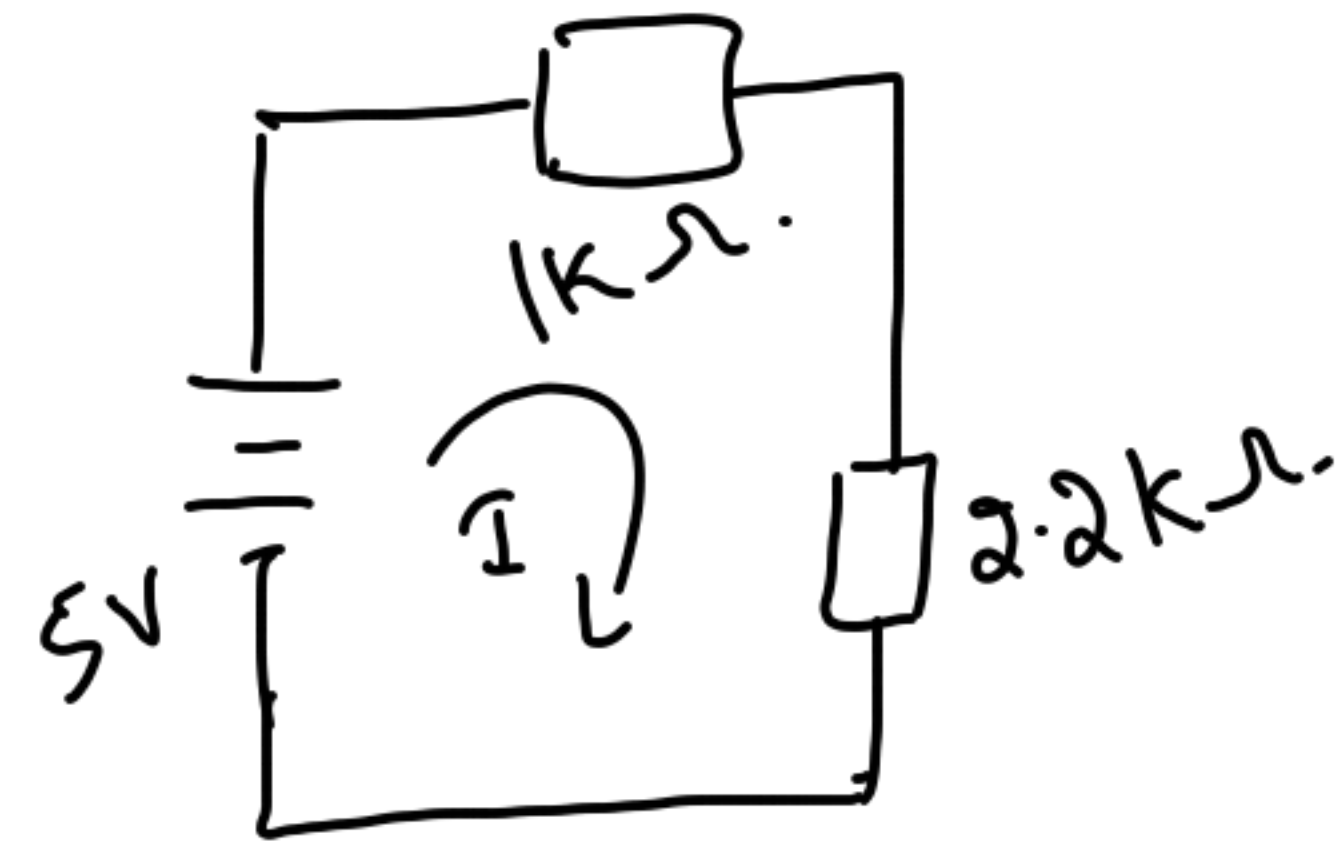
6) Determine the Value of the load Resistor when maximum power is transferred across the load. Also calculate the power transferred.



$$V_{th} = V_{DE} + V_{EB} + V_{BC}$$

$$= 0 + V_{EB} + 0$$

To find V_{EB} .



$$I = \frac{V}{R} = \frac{5}{1k + 2.2k} = \frac{5}{3.3k}$$

$$I = 1.56 \times 10^{-3} A = 1.56 mA$$

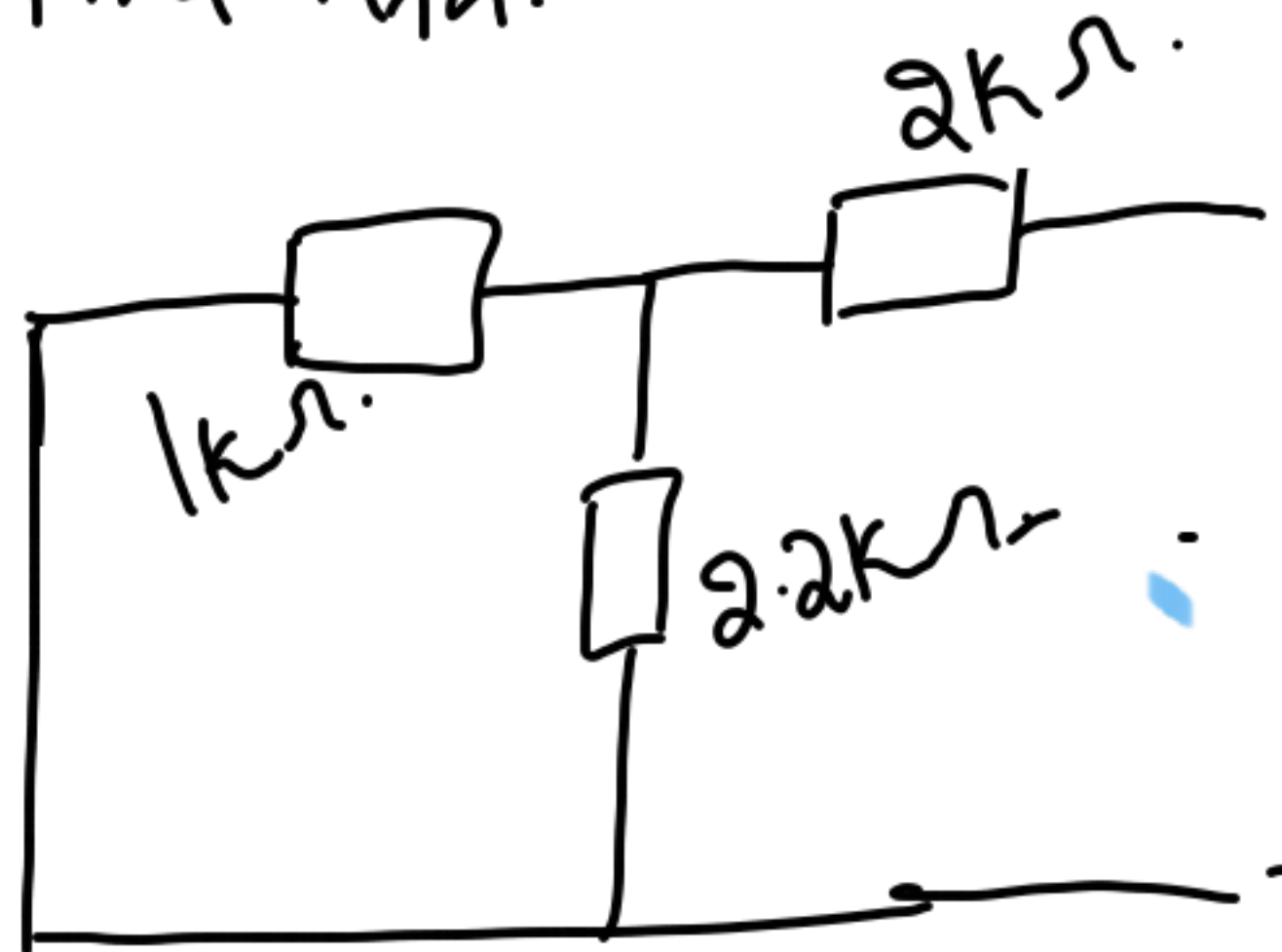
Voltage across $2.2k\Omega$.

$$V_{EB} = 2.2 \times 10^3 \times 1.56 \times 10^{-3}$$

$$V_{EB} = 3.43 V$$

$$V_{th} = V_{EB} = 3.43 V$$

To find R_{th} .



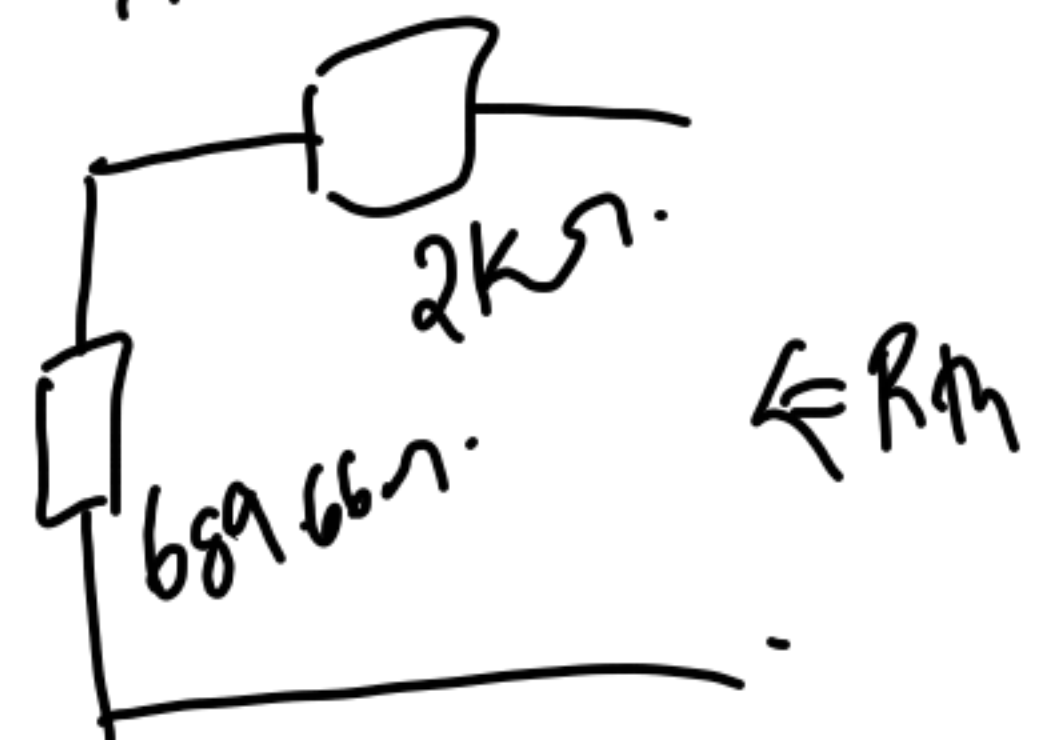
$1k\Omega$ and $2.2k\Omega$ in Parallel.

$$\frac{1}{R_{eq1}} = \frac{1}{1k} + \frac{1}{2.2k}$$

$$\frac{1}{R_{eq1}} = 1.454 \times 10^{-3}$$

$$R_{eq1} = \frac{1}{1.454 \times 10^{-3}}$$

$$R_{eq1} = 689.66 \Omega$$

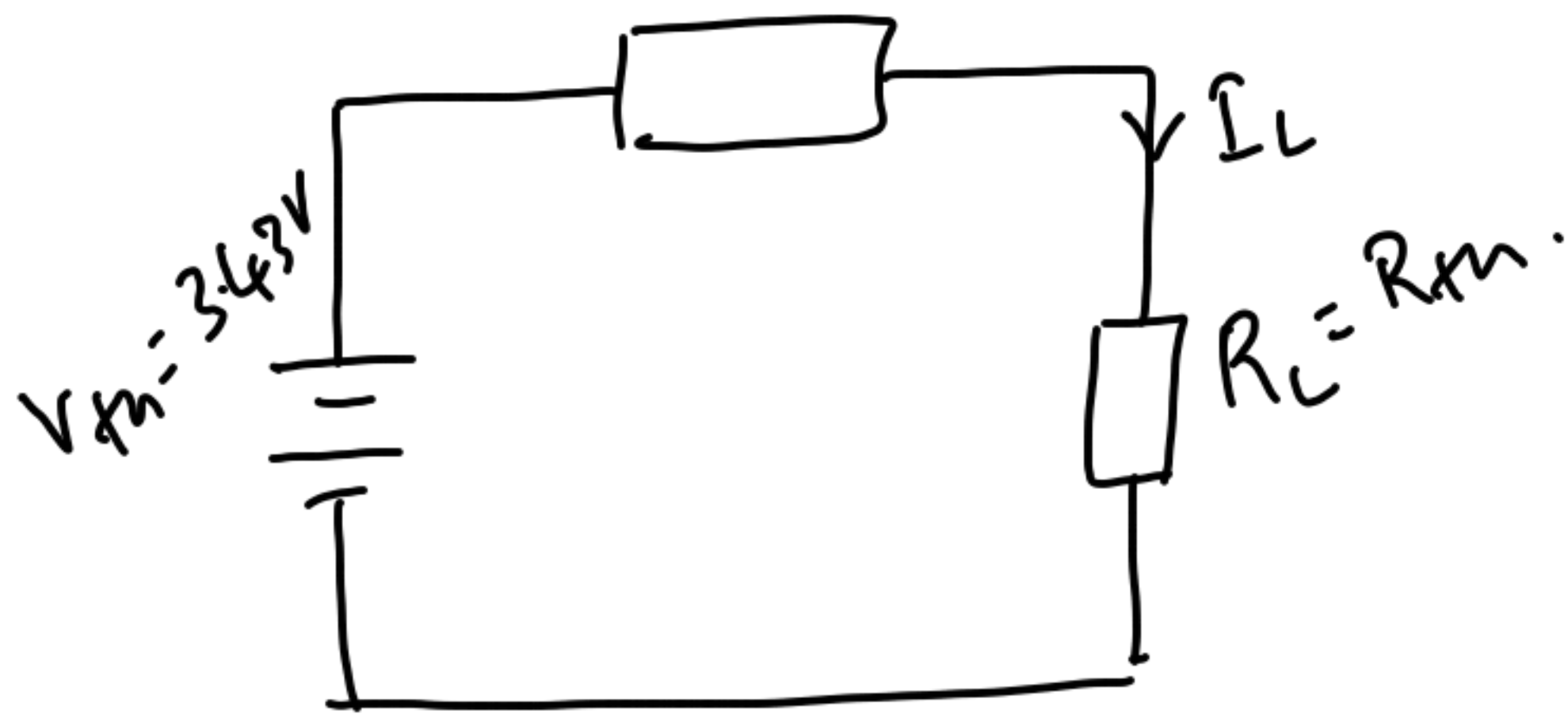


$$R_{th} = 2000 + 689.66$$

$$R_{th} = 2689.66 \Omega.$$

$$R_{th} = 2.689 k \Omega.$$

Equivalent circuit.



$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{3.43}{2.689k + 2.689k}$$

$$I_L = 0.64 \times 10^{-3} A$$

$$I_L = 0.64 mA$$

$$P_L = I_L^2 R_L$$

$$= (0.64 \times 10^{-3})^2 \times 2.689 \times 10^3$$

$$P_L = 1.1 \times 10^{-3}$$

$$P_L = 1.1 mW$$

