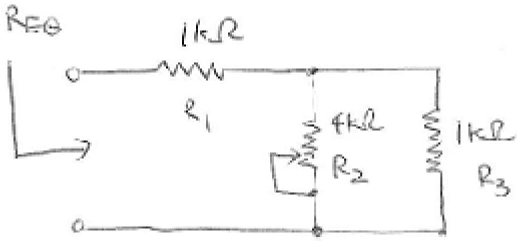
$\boxed{2.39}$

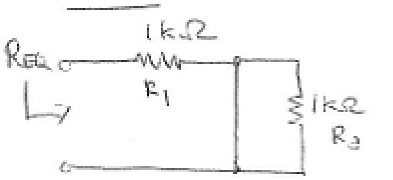


What is the range of REQ?

Analysis

Since R_2 is a variable resistor, its resistance can vary between 0 and 4kΩ.

① $R_2 = 0\,\Omega$

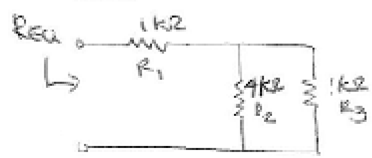


∵ In this case, no current passes through R_3.

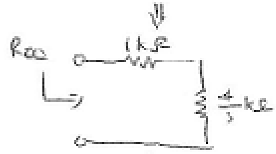
∴

$\Rightarrow R_{EQ} = 1\,k\Omega$

② $R_2 = 4\,k\Omega$

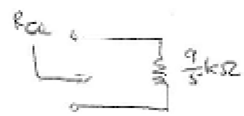


⇓



$R_{EQ} = \left(\frac{1}{1} + \frac{1}{4}\right)^{-1} = \frac{4}{5}\,k\Omega$

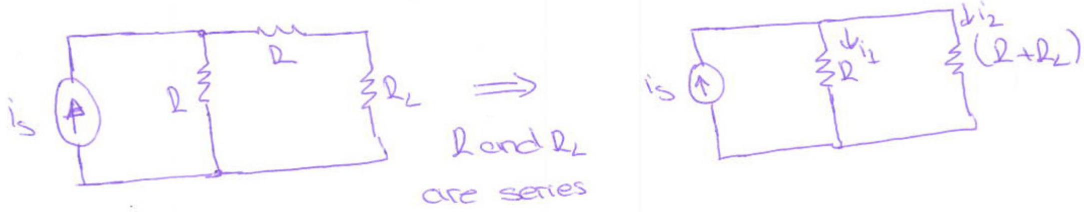
⇓



$R_{EQ} = 1 + \frac{4}{5} = \frac{9}{5}\,k\Omega$

$\boxed{\therefore \text{ Range of } R_{EQ}: 1\,k\Omega \sim \frac{9}{5}\,k\Omega}$

2-42) Use current division in figure to obtain an expression for V_L in terms of R, R_L and is.



we can use two-path divider circuit rule.

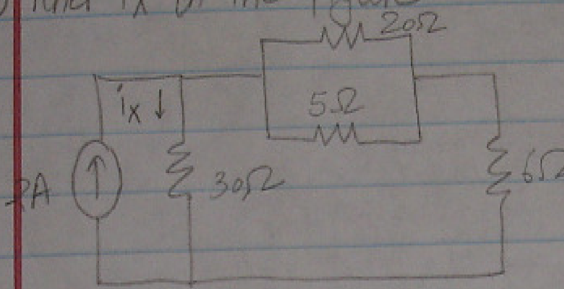
Then $i_2 = \dfrac{R}{(2R+R_L)} \, is$

i_2 is the current which passes on the resistance "R_L"

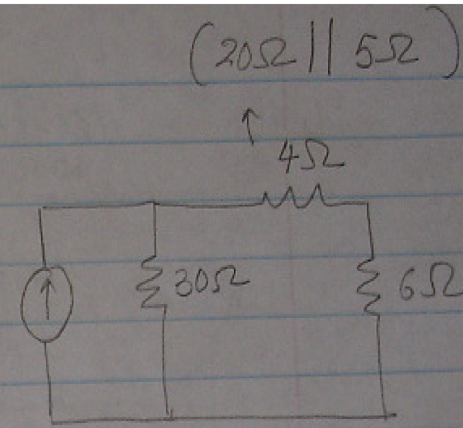
Then we can calculate V_L by using Ohm's Law.

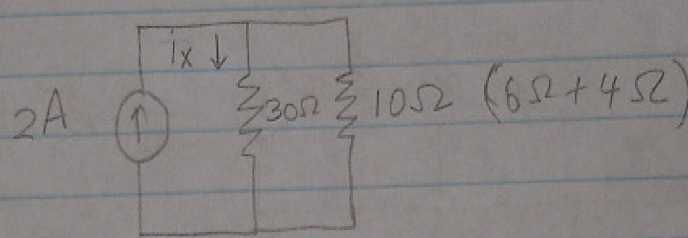
$$V = I R \Rightarrow V_L = \frac{R \cdot is}{(2R+R_L)} R_L$$

2.43 Find i_x in the figure



$\cong$



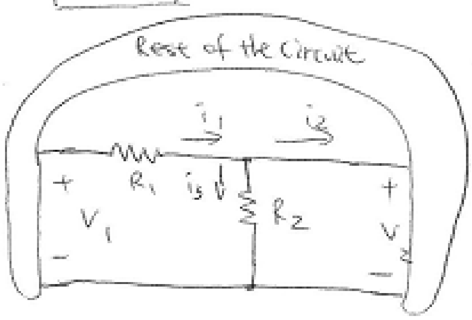


Now, using current division

$$i_x = \frac{10}{30+10}(2A) = \frac{10}{40}(2A) = 0.5A$$

$$\boxed{i_x = 0.5A}$$

2.46



a) When $i_1 = 0$, relationship between V_1 & V_2?

$\Rightarrow \boxed{V_1 = V_2}$ (The voltage across R_2, V_1, and V_2 are all equal)

b) When $i_2 = 0$, relationship between V_1 & V_2?

$\Rightarrow$ Voltage division leads to

$$\boxed{V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_1}$$

c) When $V_1 = 0$, relationship between i_1 & i_2?

$\because V_1 = 0$,

$i_1 - i_2 - i_3 = 0 \Rightarrow i_3 = i_1 - i_2$

$i_1 R_1 + i_3 R_2 = 0 = V_1$

$i_1 R_1 + (i_1 - i_2) R_2 = 0$

$i_1 (R_1 + R_2) - i_2 R_2 = 0$

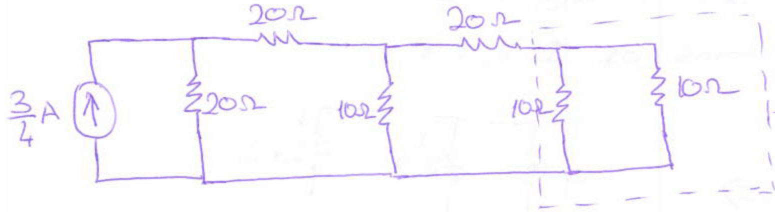
$$\boxed{\therefore i_1 = \frac{R_2}{R_1 + R_2} i_2}$$

d) When $V_2 = 0$, relationship between i_1 & i_2?

if $V_2 = 0$, no current flows through the resistor R_2.

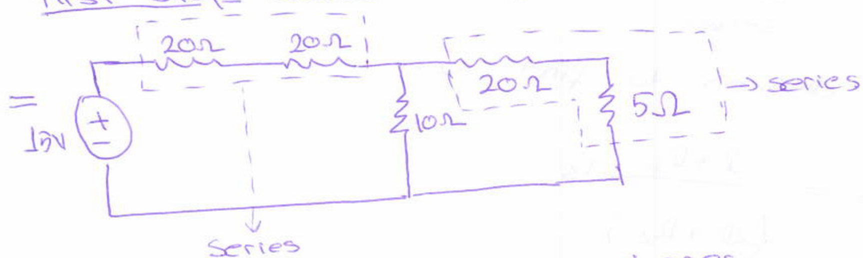
$\therefore$ KCL : $\boxed{i_1 = i_2}$

2-53) Use circuit reduction to find V_x in figure

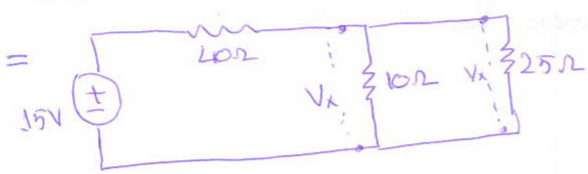


→ These two resistances are parallel.

First step: Source transformation and parallel resistances

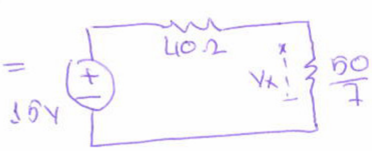


Second step: Two series resistances



Resistance 10Ω and 25Ω are parallel so the potential difference Then we can reduce them into one resistance still have same potantial difference V_x.

Third step: Parallel Resistances

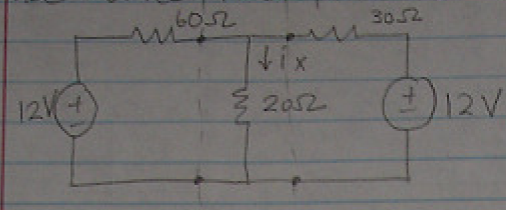


Fourth step: Voltage division

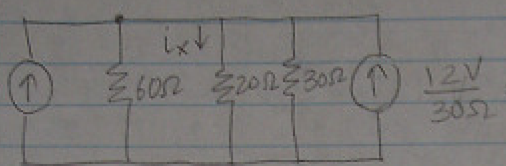
$$V_x = \frac{\frac{50}{7}}{\left(40 + \frac{50}{7}\right)} \cdot 15 = \frac{5\cancel{0}}{\frac{3\cancel{3}\cancel{0}}{11}} \cdot 1\cancel{5}^{5} = \frac{25}{11}\text{ V}$$

P.S.: You can solve this question in different way. For example, you can transform the source after second step and apply current division and ohm's Law

2.56 Use source transformation to find i_x.

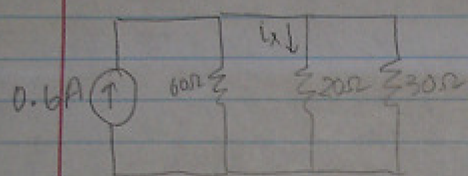


$\frac{12V}{60\Omega} = 0.2A$

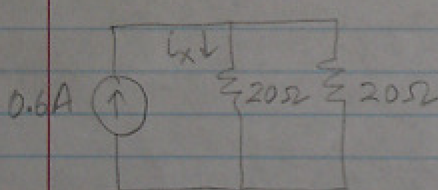


$\frac{12V}{30\Omega} = 0.4A$

Combining the two current sources (added since they enter the same node)



Since we need to find i_x, we leave the 20Ω resistor as it is and combine the other two resistors 60Ω and 30Ω (60Ω ∥ 30Ω)

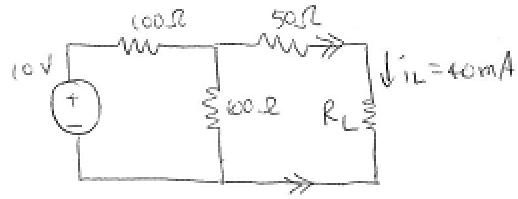


Using current division,

$$i_x = \frac{20}{20+20}(0.6) = \frac{20}{40}(0.6) = 0.3A$$

$$\boxed{i_x = 0.3A}$$

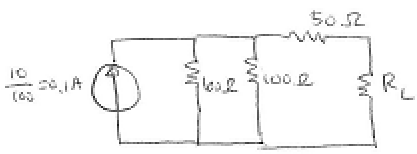
$\boxed{2.58}$



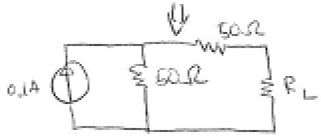
Find R_L.

Analysis

Source transformations:

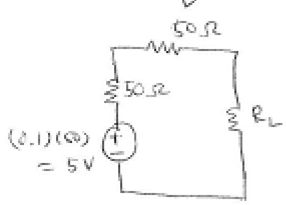


⇓



$$R_{eq} = \frac{(100)(100)}{100+100} = 50\Omega$$

⇓



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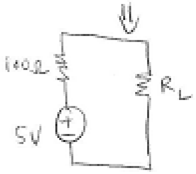


$$i = 40\times10^{-3}A = \frac{5V}{(100\Omega + R_L)}$$

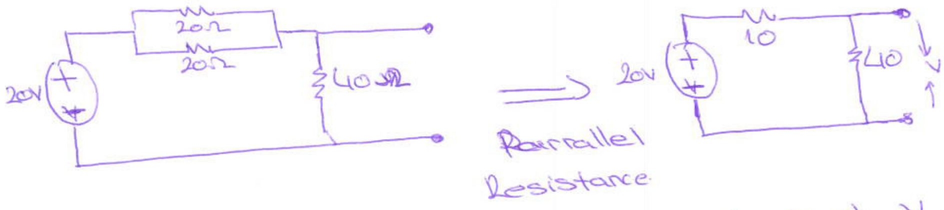
$$5 = 4 + 40\times10^{-3} R_L$$

$$\therefore \boxed{R_L = 25\Omega}$$

3.37) Find Thévenin equivalent circuit seen by R_L in figure. Find voltage accross the load when $R_L = 5\Omega$, 10Ω and 50Ω.

Remember Open circuit yield Thévenin Voltage.

Then: <u>first step</u>: Draw the circuit as an open circuit



<u>Second step:</u> Use Voltage division to find V.

$$V_T = \frac{40}{(10+40)} \cdot 20\,V = 16\,V$$

<u>Third Step</u>: Calculate Norton current (short circuits yields Norton current)

$$i_N = \frac{20\,V}{10\,\Omega} = 2A$$ (by applying Ohm's Law)

<u>Fourth Step</u>: Calculate $R_T = V_T / i_N = 16\,V / 2A = 8\,\Omega$

Then Thévenin equivalent circuit is

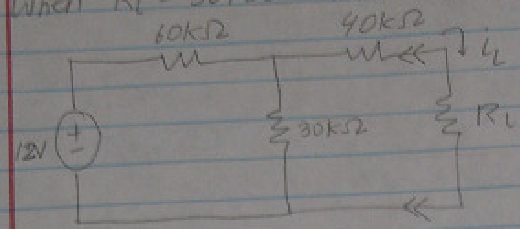
<u>Fifth Step</u>: Apply Loads and calculate voltage (Voltage Division)

Apply $5\Omega \Rightarrow V = \frac{5}{(8+5)}\, 16 = \frac{80}{13}$

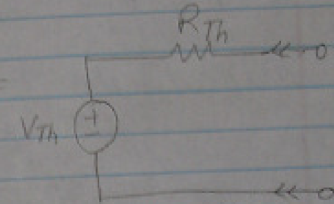
$10\Omega \Rightarrow V = \frac{10}{(8+10)} \cdot 16 = \frac{80}{9}$

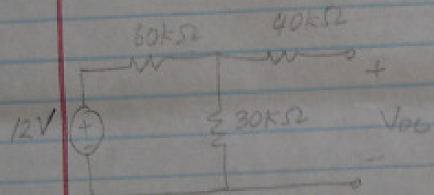
$50\Omega \Rightarrow V = \frac{50}{(8+50)} \cdot 16 = \frac{400}{29}$

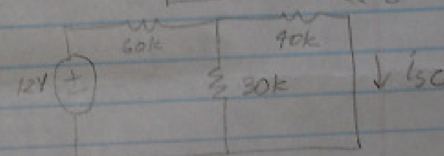
3.39) Find the thevenin equivalent seen by R_L in the figure below. Find the power delivered to the load when $R_L = 50k\Omega$ and $200k\Omega$



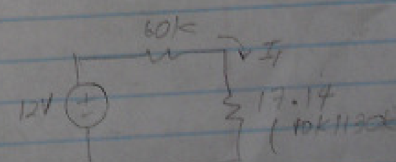
Thevenin Equivalent circuit =







$$V_{oc} = \frac{30k}{30k+60k}(12V) = 4V$$



$$I_1 = \frac{12V}{77.14K} = 0.16\ mA$$

$$i_{sc} = \frac{30k}{30k+40k}(I_1)$$

$$= \frac{30k}{70k}(0.16mA)$$

$$= 0.069\ mA$$

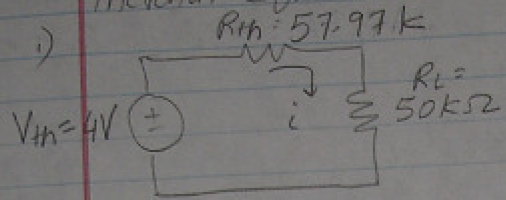
$$R_{th} = \frac{V_{oc}}{i_{sc}} = \frac{4V}{0.069mA}$$

$$= 57.971mA$$

Power $P = I^2 R$

Thevenin Equivalent circuit

i)



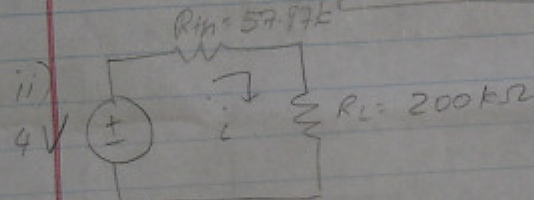
$$i = \frac{V_{th}}{R_{th} + R_L} = \frac{4}{57.97 + 50k} = 0.037\ mA$$

Power delivered $P = i^2 R$

$$= (0.037mA)^2 (50k)$$

$$\boxed{P = 0.068\ mW}$$

ii)



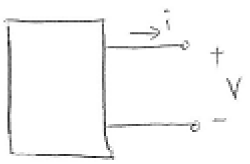
$$i = \frac{4V}{57.97 + 200k} = 0.0155mA$$

$$P = i^2 R$$

$$= (0.0155mA)^2 (200k)$$

$$\boxed{P = 0.048\ mW}$$

$\boxed{3.43}$



i-v characteristic:

$5v + 500i = 60$

Find the output voltage when a 500Ω resistive load is connected across the two accessible terminals.

Analysis

$\because \quad i = \left(-\frac{1}{R_T}\right)v + \left(\frac{v_T}{R_T}\right) \qquad (Eq\ 3\text{-}29)$

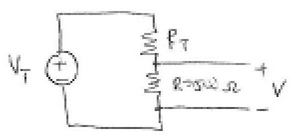
$5v + 500i = 60$

$i = -\frac{5}{500}v + \frac{60}{500}$

$= \left(-\frac{1}{100}\right)v + \left(\frac{3}{25}\right)$

$= \left(-\frac{1}{100}\right)v + \left(\frac{12}{100}\right)$

$\therefore R_T = 100\Omega, \quad v_T = 12\,V$



Voltage division:

$V = \frac{R}{R_T + R} v_T$

$= \left(\frac{500}{100+500}\right)12$

$= \left(\frac{5}{6}\right)12$

$= \boxed{10\,V}$