$P_1 = 40 \times 4 = 160\,W$ (supply)

$P_5 = 5 \times (0.5 \times 4)i = 10\,W$ (supply)

$P_4 = 20 \times 2 = 40\,W$ (supply)

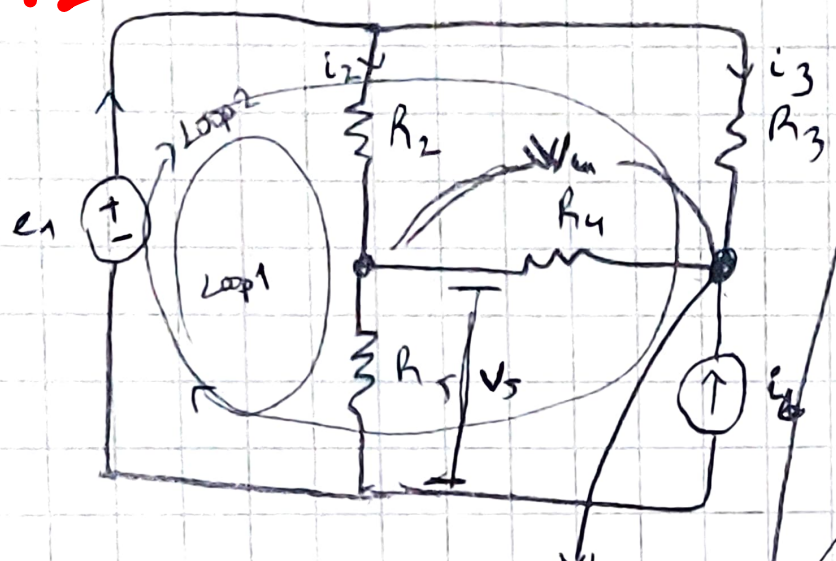
$P_2 = 15 \times 4 = 60\,W$ (absorb)

$P_3 = 25 \times \overbrace{(i + 0.5i)}^{b} = 150\,W$ (absorb)

$P_5 = P_a = 210\,W$ ✓

Q1

Q2



Loop1

$$e_1 = i_2 R_2 + (i_2 + i_3 + i_6) R_5$$

Loop2

$$e_1 = i_3 R_3 + (i_3 + i_6) R_4 + (i_2 + i_3 + i_6) R_5$$

$$e_1 = i_3 (R_3 + R_4 + R_5) + i_6 R_4 + i_2 R_5 + i_6 R_5$$

$$i_3 = \frac{1}{R_5} \left(e_1 - i_2 (R_2 + R_5) - i_6 R_5 \right)$$

$$i_2 = \frac{1}{R_5} \left(e_1 - (i_3 (R_3 + R_4 + R_5) + i_6 R_4 + i_6 R_5) \right)$$

$$V_5 - V = V_4$$

$$\frac{V_5 - e_1}{R_2} + \frac{V_5}{R_5} + \frac{V_5 - V}{R_4} = 0$$

$$\frac{V - e_1}{R_3} - i_6 + \frac{V - V_5}{R_4} = 0$$

$$-V_4 \left(\frac{1}{R_3} + \frac{1}{R_4} \right) + \frac{V_5}{R_3} = \frac{e_1}{R_2} + i_6$$

Q3

Node 1

$$\frac{V_1 - V_4}{R_5} + \frac{V_1 - V_2}{R_1} + \beta V_2 = 0$$

$$V_2 = V_1 - V_2$$

$$\frac{V_1 - V_4}{R_5} + \frac{V_1 - V_2}{R_1} + \beta (V_1 - V_2) = 0$$

$$V_1 \left[\frac{1}{R_5} + \frac{1}{R_1} + \beta\right] - V_2 \left[\frac{1}{R_1} + \beta\right] - \frac{V_4}{R_5} = 0$$

Node 2

$$\frac{V_2 - V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_3} = 0$$

$$-\frac{V_1}{R_1} + V_2 \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right] - \frac{V_3}{R_3} = 0$$

Node 3

$$V_3 = e$$

Node 4

$$-I + \frac{V_4 - V_1}{R_5} + \frac{V_4 - V_3}{R_4} = 0$$

$$-\frac{V_1}{R_5} - \frac{V_3}{R_4} + V_4\left[\frac{1}{R_4} + \frac{1}{R_5}\right] = I$$

$$\begin{bmatrix} \left(\frac{1}{R_1} + \frac{1}{R_5} + B\right) & \left(-\frac{1}{R_1} - B\right) & 0 & -\frac{1}{R_5} \\ -\frac{1}{R_1} & \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) & -\frac{1}{R_3} & 0 \\ 0 & 0 & 1 & 0 \\ -\frac{1}{R_5} & 0 & -\frac{1}{R_4} & \left(\frac{1}{R_1} + \frac{1}{R_5}\right) \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ e \\ I \end{bmatrix}$$

Mesh on i_1 and i_3 loop

$$-1 + 7(i_1 - i_2) - 3(i_3 - i_2) + 2i_3 = 0$$

$$i_3 - i_1 = 2$$

$$7i_1 - 4i_2 - i_3 = 1$$

$$7i_1 = 4i_2 - 2 - i_1 = 1$$

$$i_1 = \frac{3 + 4i_2}{6}$$

Mesh on i_2 loop

$$i_2 + 3(i_2 - i_3) + 7(i_2 - i_1) = 0$$

$$11i_2 - 3i_3 - 7i_1 = 0 \rightarrow i_3 = 2 + i_1$$

$$11i_2 - 10i_1 = 6$$

$$11i_2 - 10\frac{3 + 4i_2}{6} = 6$$

$$i_2 = 0,6226\,A$$

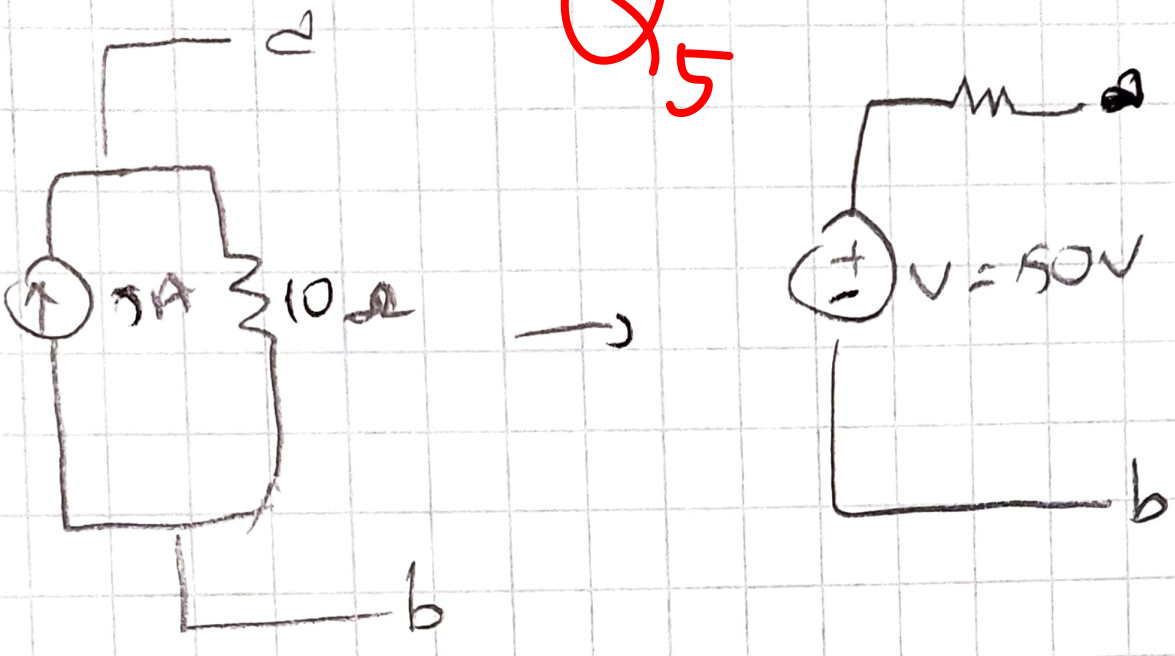
$$i_1 = \frac{3 + 4 i_2}{6}$$

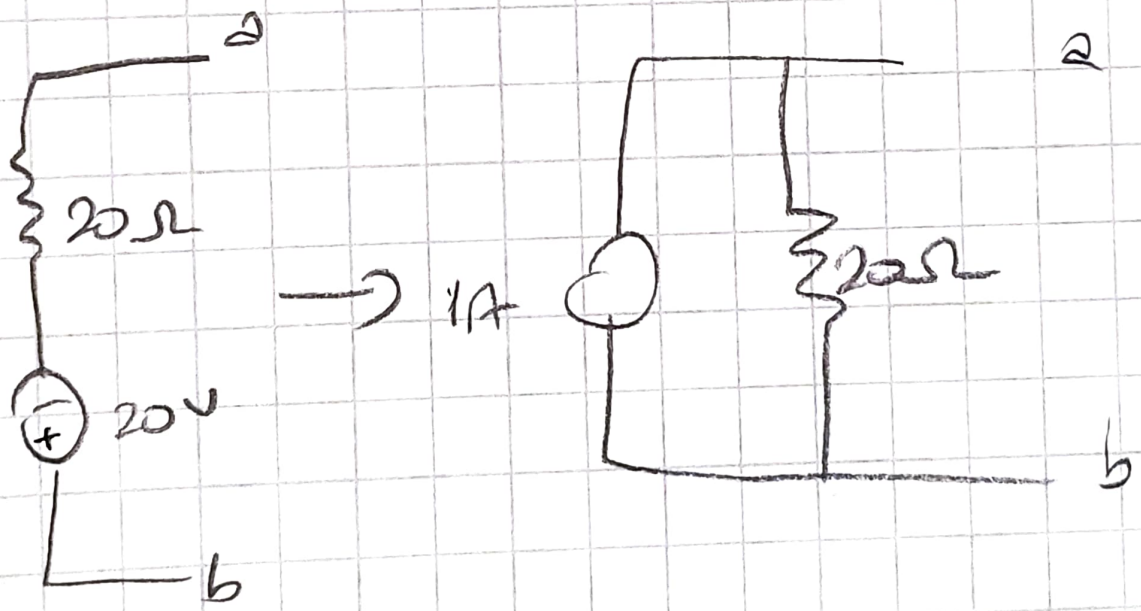
$$i_1 = 0.915\,A$$

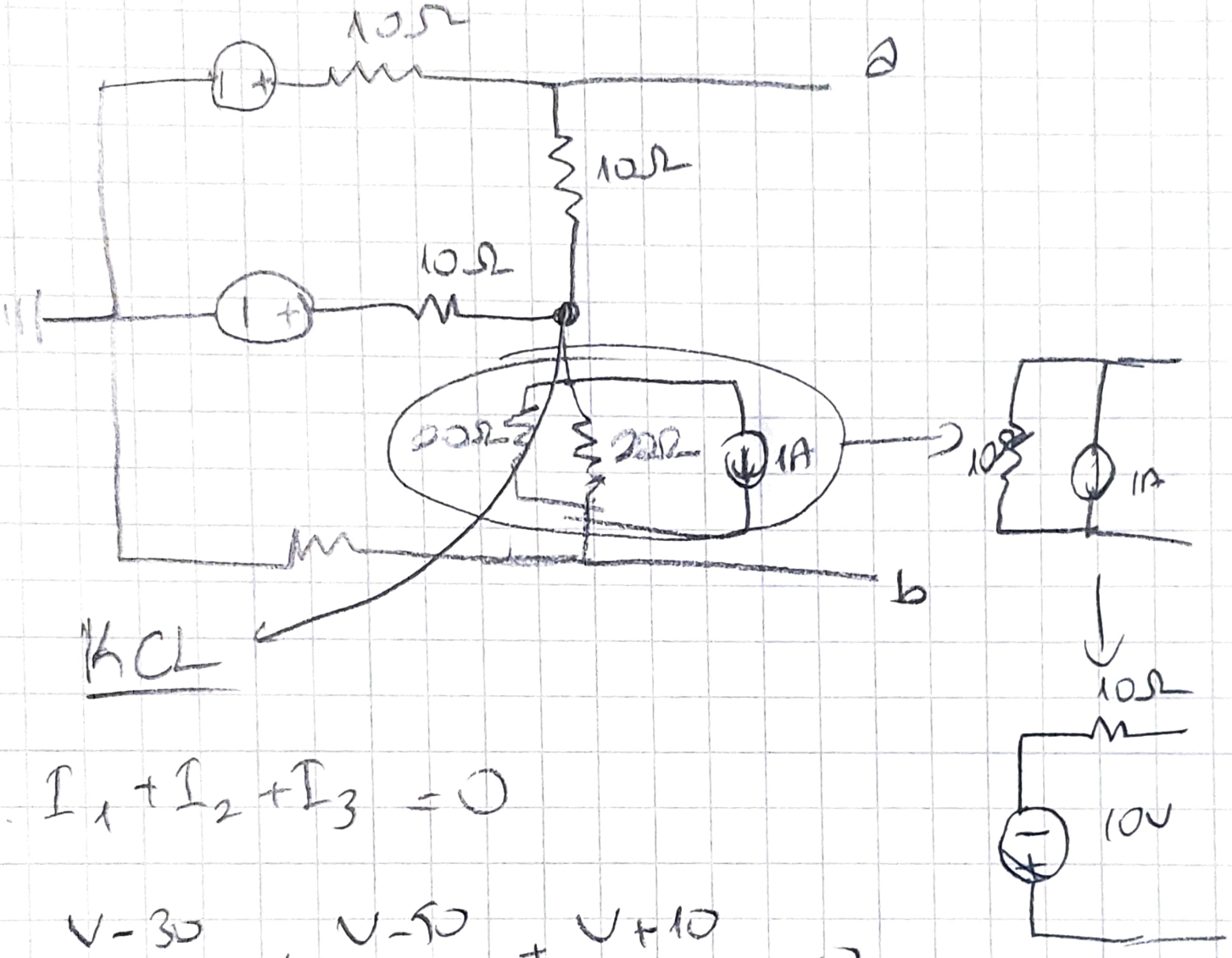
$$i_3 = 2 + i_1$$

$$i_3 = 2.915\,A$$

Q5







KCL

$$I_1 + I_2 + I_3 = 0$$

$$\frac{V-30}{20} + \frac{V-50}{10} + \frac{V+10}{20} = 0$$

$$4V = 120$$

$$V = 30 \text{ Volt}$$

$$I_1 = \frac{V - 30}{20} = \underline{\underline{0\ A}}$$

$$I_3 = \frac{30 + 10}{20} = \underline{\underline{2\ A}}$$

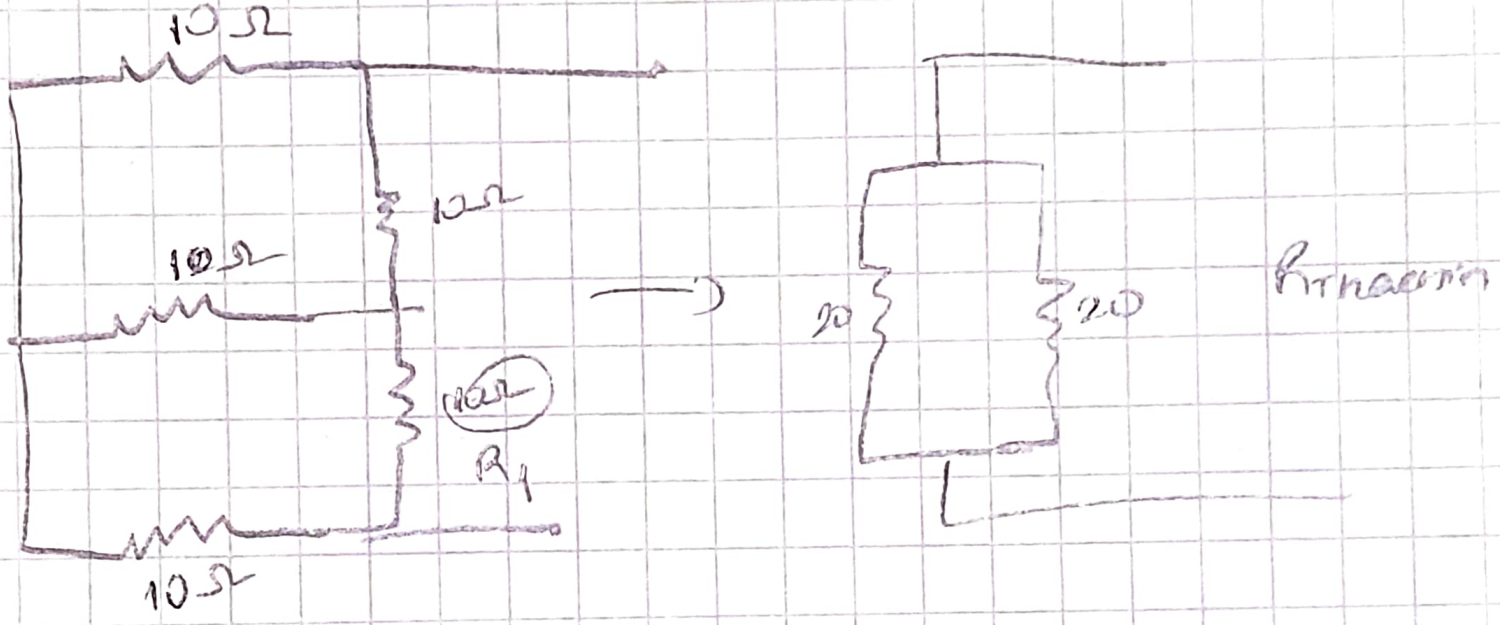
Then apply KVL to the loop on the right

$$10 - 10I_3 + 10I_1 + V_{th} = 0$$

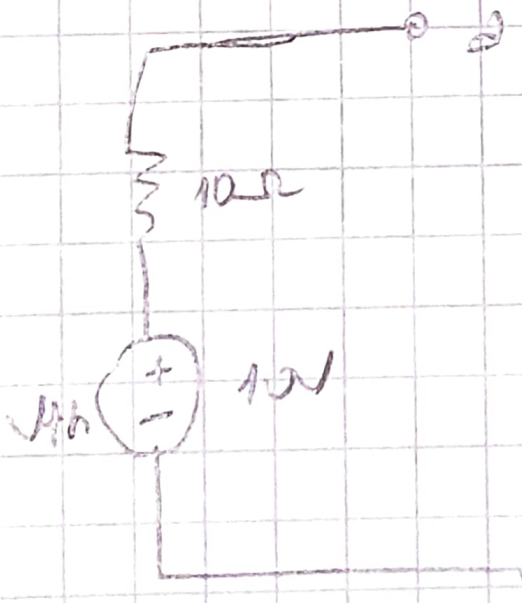
$$V_{th} = 10I_3 - 10I_1 - 10$$

$$V_{th} = 10\ Volt$$

To find $R_{Thevenin}$

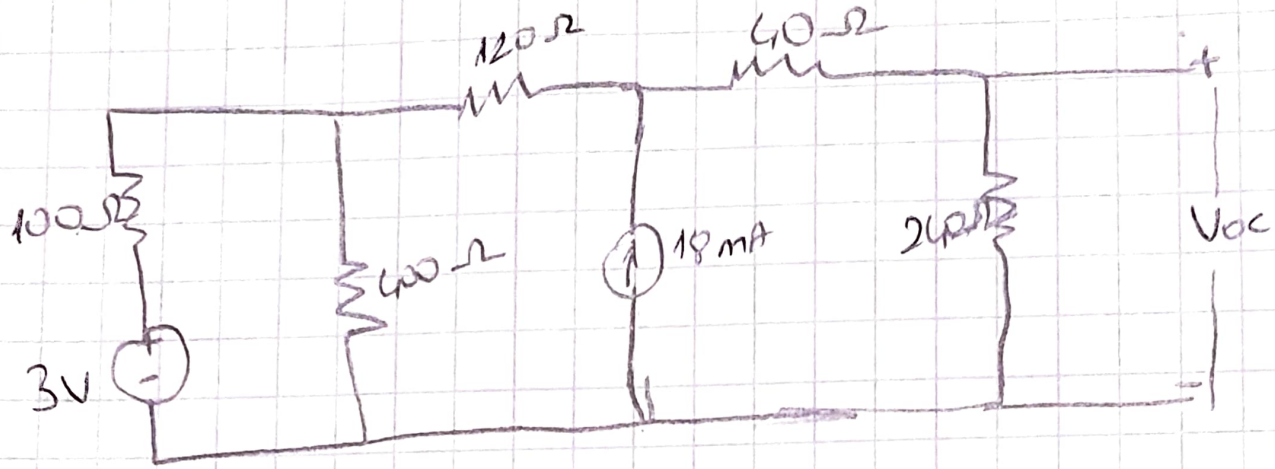


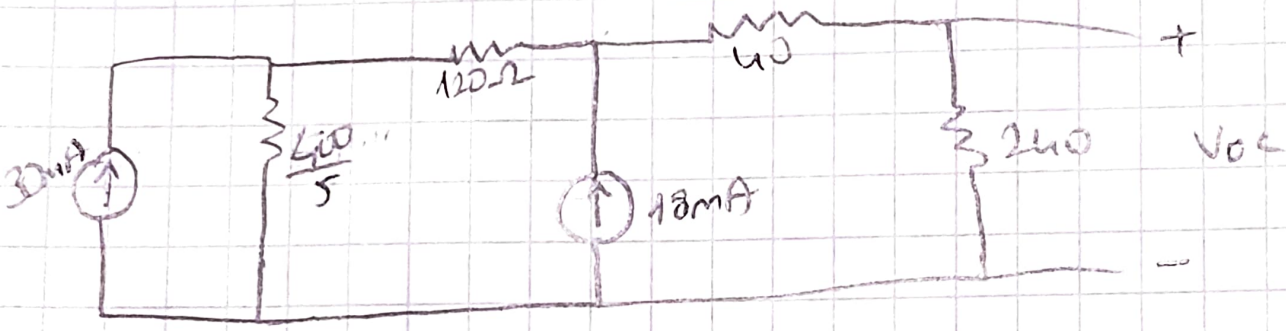
$R_{Th} = 10\ \Omega$

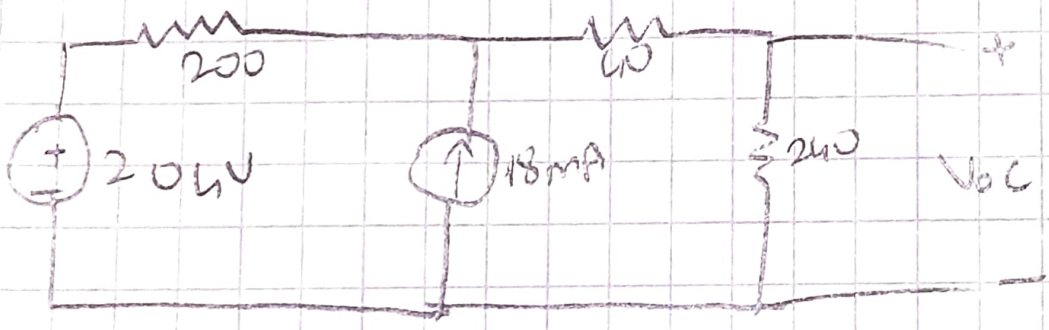


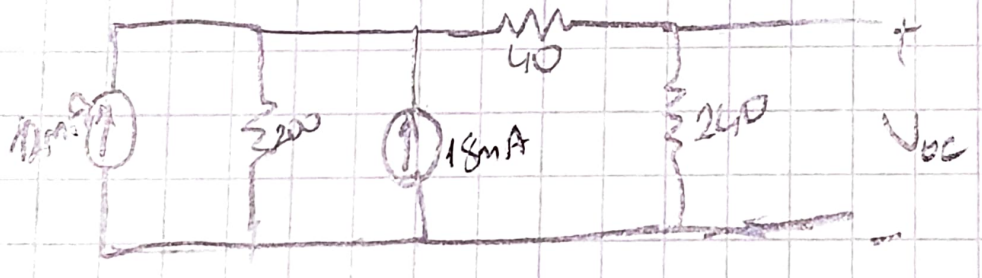
$V_{Th} = 10\ V$

$R_{Th} = 10\ \Omega$

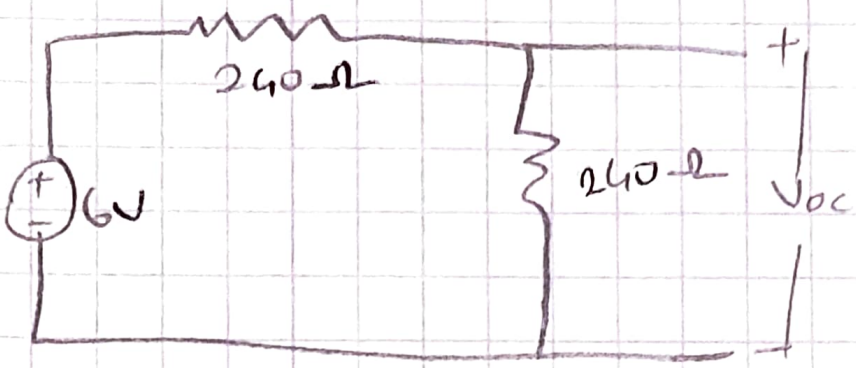

120Ω
40Ω
100Ω
400Ω
18mA
240Ω
Voc
3V
+
-


120Ω
40
400/5
240
Voc
18mA
+
-

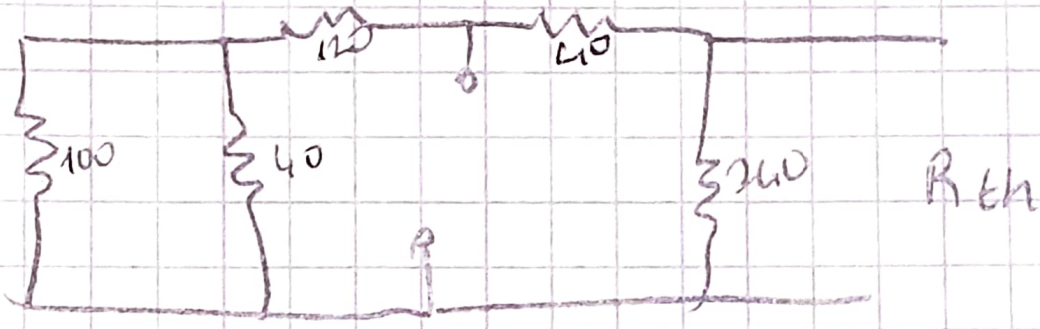

200
40
20.4V
18mA
240
Voc
+
-

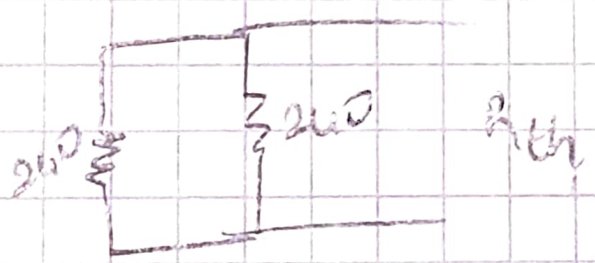

40
200
18mA
240
Voc
+
-

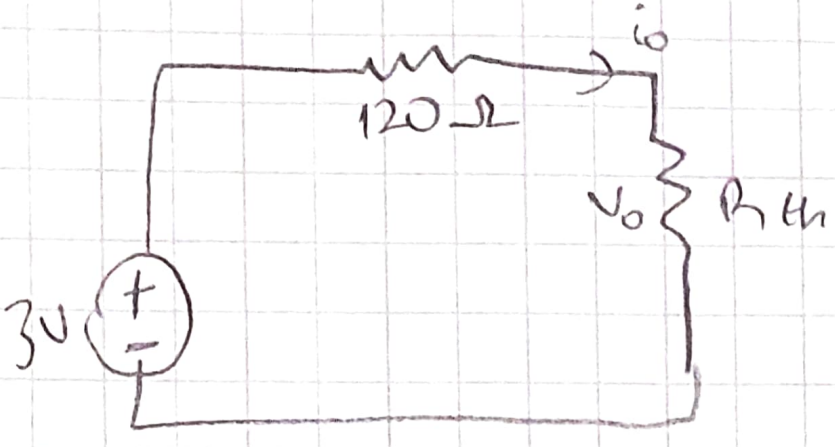
Q6



$$V_{oc} = \frac{6 \times 240}{240+200+40} = 3V$$







$$i_o = \frac{3}{120 + R_o} \qquad V_o = \frac{3R_o}{120 + R_o}$$

for $R_o = 100\,\Omega$

$i_o = 13.636\,mA$

$V_o = 1,363\,V$

Sena ERSON
0400040434
Sena

for $R_o = 200\,\Omega$

$i_o = 9,375\,mA$ $\qquad V_o = 1,875\,V$