problem 1:

a) 3Ω OC → removed

5Ω series with $3\Omega = 8\Omega$, short circuited → remove

$3\Omega \parallel 2\Omega \parallel 6\Omega = 1\Omega$

$12\Omega \parallel 4\Omega = 3\Omega$

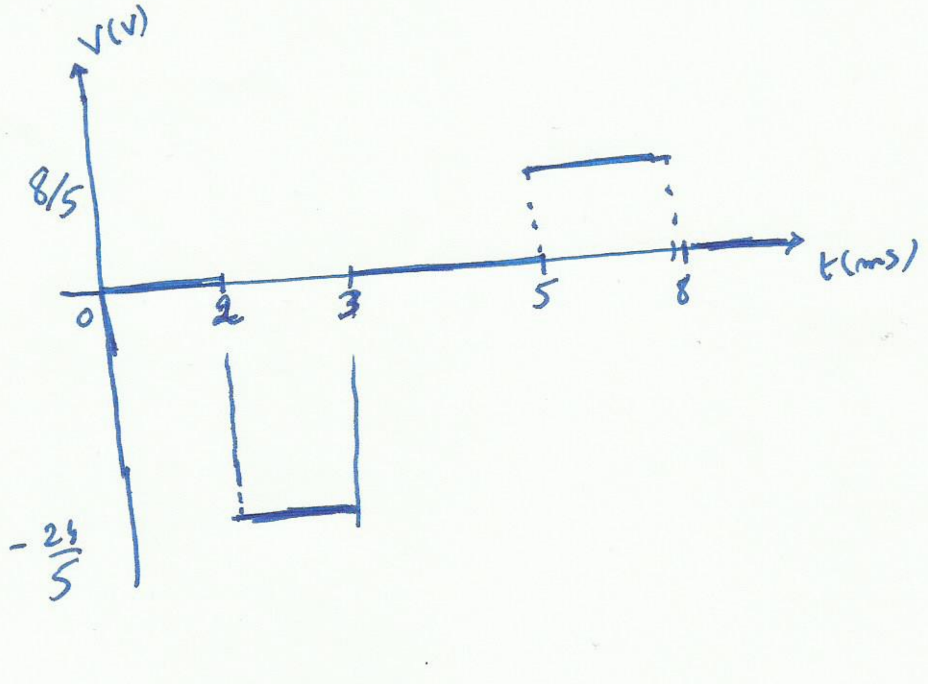
$4\Omega \parallel 8\Omega = 8/3\,\Omega$

3Ω series with $1\Omega = 4\Omega$

$4\Omega \parallel (8/3)\Omega = \frac{8}{5}\Omega$

b) $t = 2$ to 3 $\quad i = \frac{dq}{dt} = -3\,A \Rightarrow V = -3 \times \frac{8}{5} = -\frac{24}{5} V$

$t = 5$ to 8 $\quad i = 1\,A \Rightarrow V = \frac{8}{5} V$



Question 2

Use mesh analysis to calculate the power delivered by the 3mA source in the network shown in Figure 3.

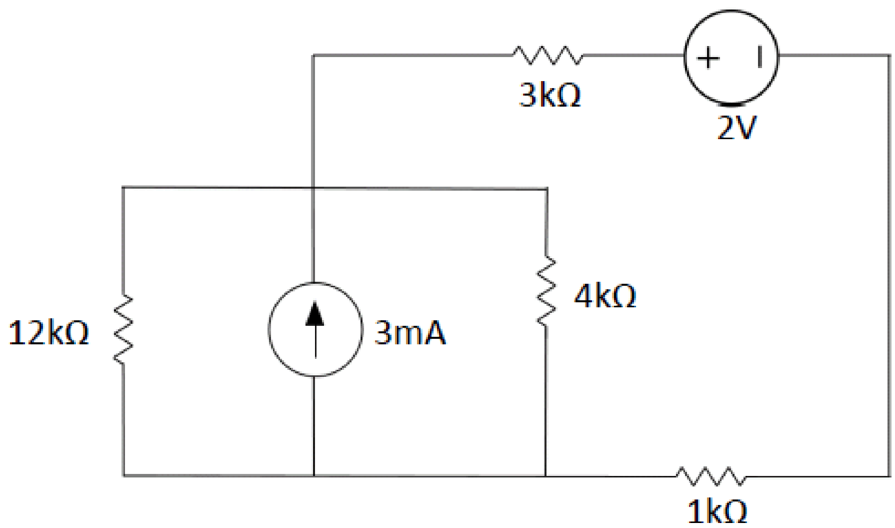
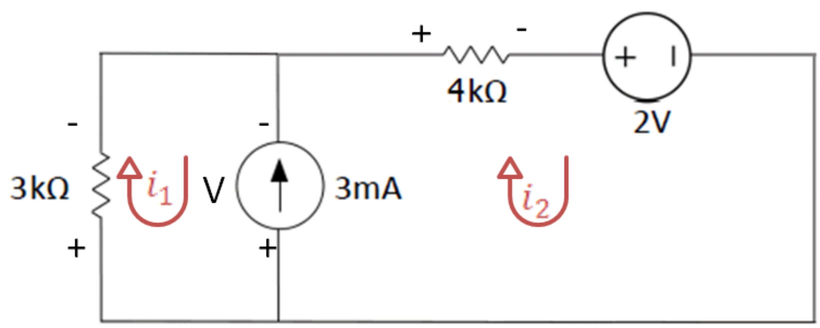


Figure 3

Solution



$$\begin{cases} 3ki_1 + 4ki_2 + 2 = 0 \\ i_2 - i_1 = \dfrac{3}{k} \end{cases} \Rightarrow i_1 = -2mA$$

Or:

$$V = 3k \times i_1 = -6V$$

And:

$$P = V \times 3mA = -18mW$$

Question 3

Use superposition to find V_0 in the network in Figure 4.

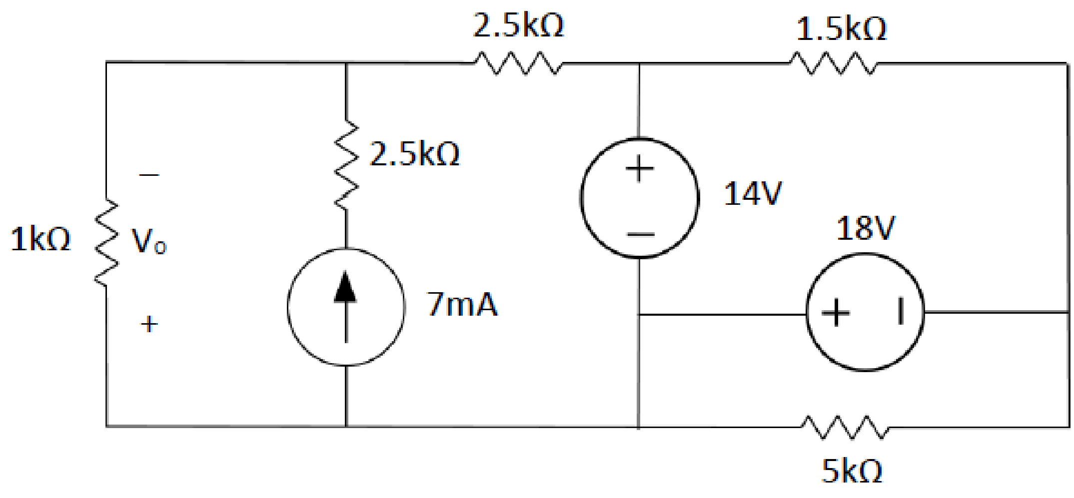
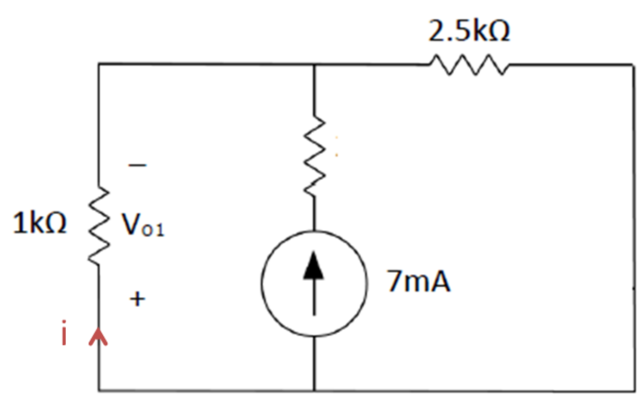


Figure 4

Solution

Short circuit 14V and 18V sources:

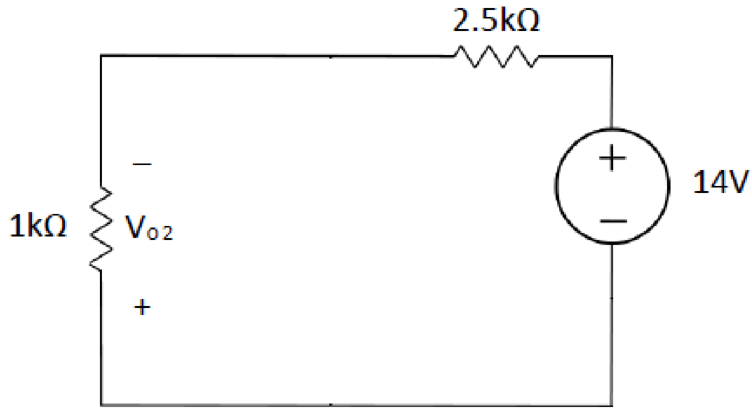


$$i = \frac{-2.5k}{2.5k + 1k} \times 7 \times 10^{-3} = -5mA$$

Therefore:

$$V_{01} = 1k \times i = -5V$$

Short circuit 18V and open circuit 7mA sources:



$$V_{02} = \frac{-1k}{2.5k + 1k} \times 14 = -4V$$

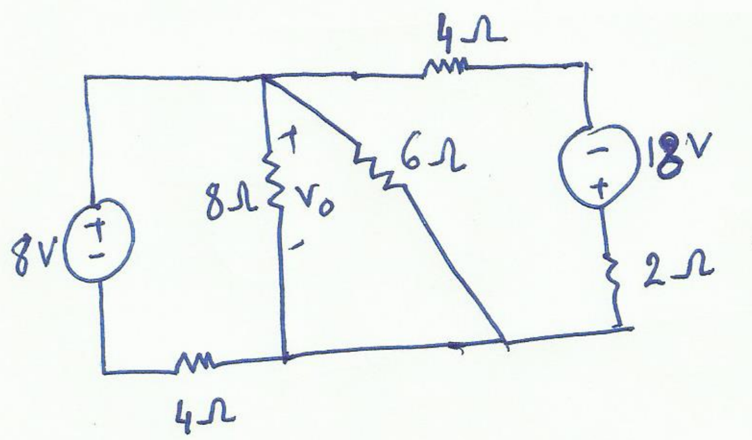
Short circuit 14V and open circuit 7mA sources:

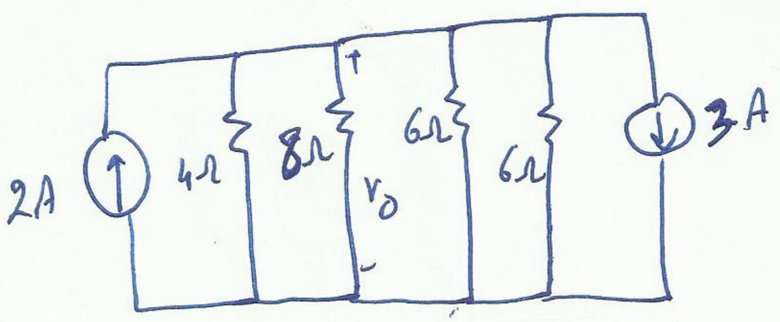
$$V_{03} = 0$$

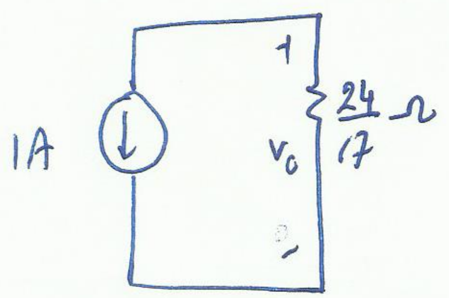
Finally:

$$V_0 = V_{01} + V_{02} + V_{03} = -5 - 4 + 0 = -9V$$

Question 4 :

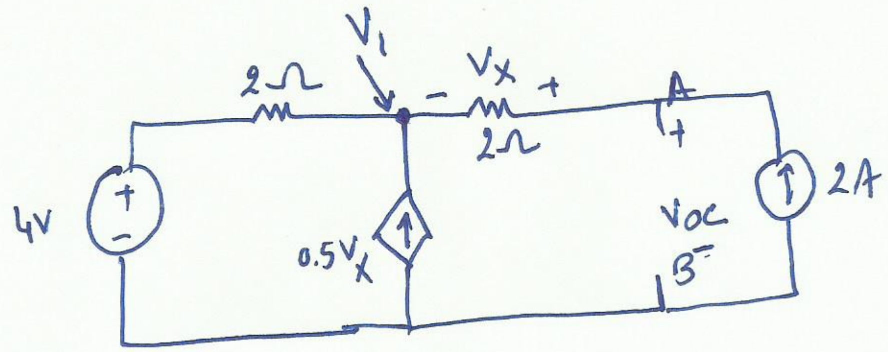






$$\Longrightarrow \boxed{V_o = -\frac{24}{17}\,V}$$

Question 5



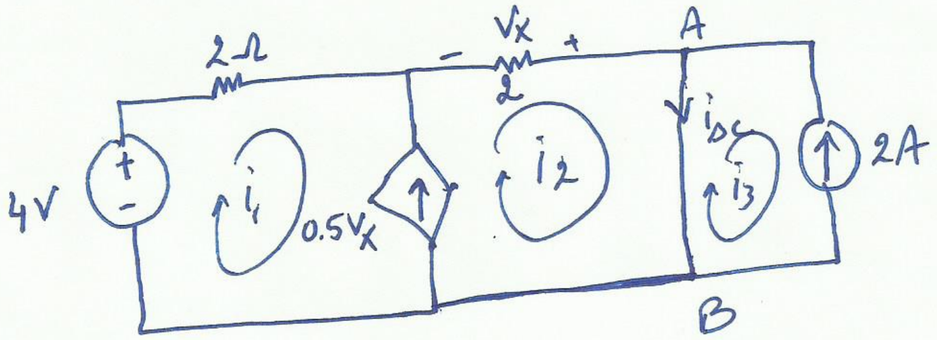
To Find V_{oc}, use node-voltage analysis:

KCL @ node 1 ⟹

$$\left.\begin{array}{l} \frac{V_1-4}{2} = 0.5V_x + 2 \\ \text{and} \\ V_x = 2 \times 2 = 4\ V \end{array}\right\} \Rightarrow V_1 = 12V$$

Now $V_{OC} = V_x + V_1 = 4 + 12 = 16V$

$$\boxed{V_{Th} = V_{OC} = 16V}$$



Use Mesh analysis:

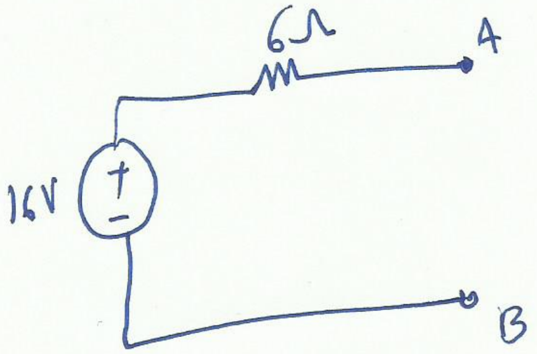
$$\left.\begin{array}{ll} \text{super mesh 1 and 2} \Rightarrow & -4 + 2i_1 - V_x = 0 \\ \text{mesh 3} \Rightarrow & i_3 = -2A \\ \text{and} & 0.5V_x = i_2 - i_1, \quad V_x = -2i_2 \end{array}\right\} \Rightarrow \begin{array}{l} 2i_1 + 2i_2 = 4 \\ i_1 - 2i_2 = 0 \\ i_3 = -2A \end{array}$$

Then $i_1 = \frac{4}{3} A$, $i_2 = \frac{2}{3} A$, $i_3 = -2 A$

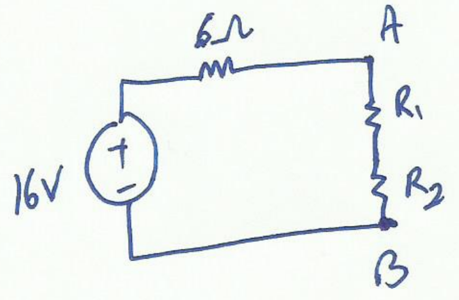
$$i_{sc} = i_2 - i_3 = \frac{2}{3} + 2 = \frac{8}{3} A$$

Therefore $R_{Th} = \frac{V_{oc}}{i_{sc}} = \frac{16}{\frac{8}{3}} = 6\,\Omega$

The Thevenin equivalent is



b)



In order to ensure a maximum power transfer to R_2, we need to find the R_{Th} of the Thevenin equivalent as seen by the resistance R_2. This gives

$$R'_{Th} = R_1 + 6$$

For maximum power transfer to R_2, we must have $\boxed{R_2 = R'_{Th} = R_1 + 6}$