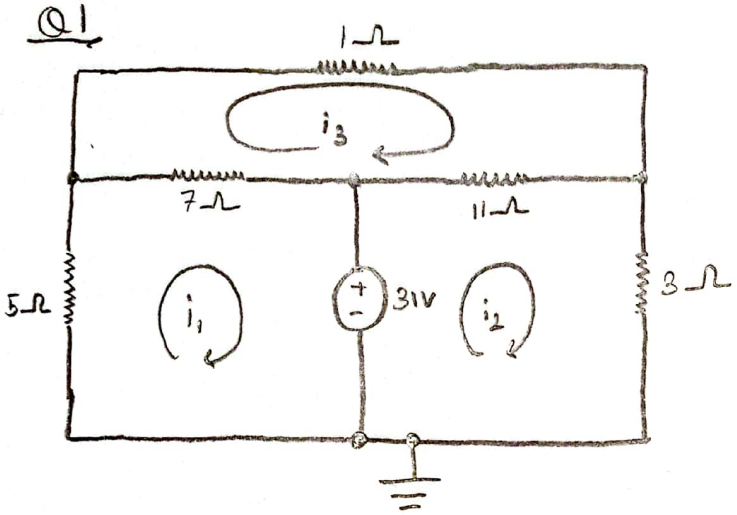
152120211104 – Doğukan Kışıklık

Q1



Power delivered by the voltage

Mesh 1

$5i_1 + 7i_1 - 7i_3 + 31 = 0$

$12i_1 - 7i_3 = -31$

Mesh 2

$-31 + 11i_2 - 11i_3 + 3i_2 = 0$

$14i_2 - 11i_3 = 31$

Mesh 3

$7i_3 - 7i_1 + i_3 + 11i_3 - 11i_2 = 0$

$-7i_1 - 11i_2 + 19i_3 = 0$

$$\begin{bmatrix} 12 & 0 & -7 \\ 0 & 14 & -11 \\ -7 & -11 & 19 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} -31 \\ 31 \\ 0 \end{bmatrix} \Rightarrow \left[\begin{array}{ccc|c} 12 & 0 & -7 & -31 \\ 0 & 14 & -11 & 31 \\ -7 & -11 & 19 & 0 \end{array}\right]$$

$7/12 \cdot S_1 + S_3 \rightarrow S_3$

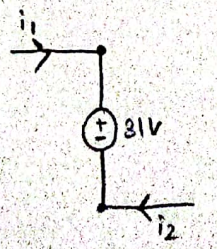
$$\Rightarrow \left[\begin{array}{ccc|c} 12 & 0 & -7 & -31 \\ 0 & 14 & -11 & 31 \\ 0 & -11 & 14.91 & -18,08 \end{array}\right]$$

$11/14\, S_2 + S_3 \rightarrow S_3 \Rightarrow \left[\begin{array}{ccc|c} 12 & 0 & -7 & -31 \\ 0 & 14 & -11 & 31 \\ 0 & 0 & 6,26 & 6,27 \end{array}\right]$

$6.26 i_3 = 6.27 \rightarrow i_3 = 1$

$-11 + 14 i_2 = 31 \rightarrow i_2 = 3$

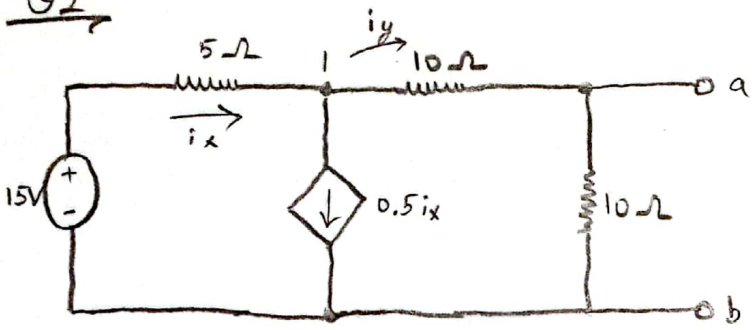
$-7 + 12 i_1 = -31 \rightarrow i_1 = -2$



$\Rightarrow$ $P = V.i \rightarrow 31.i_1 + (-31).i_2 \rightarrow -155$

Answer $\Rightarrow$ 155 J given by voltage source

Q2



Thévenin and Norton equivalent

At Node 1

$i_x = 0.5i_x + i_y$

$0.5i_x = i_y$

KVL at outer loop

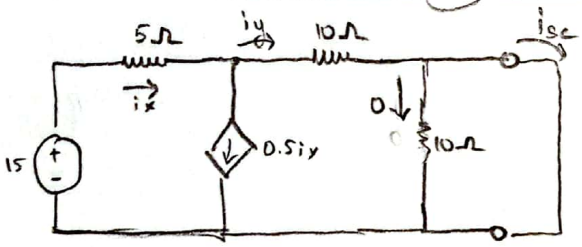
$-15 + 5i_x + 10.i_y + 10.i_y = 0$

$15i_x = 15$

$\hookrightarrow i_x = 1$

$V_{oc} = (10\Omega) \times (i_y)$

$= (10) \times (0.5) = 5V$



$i_{sc} = i_y = 0.5i_x$

KVL at outer loop

$-15 + 5i_x + 10i_y = 0$

$10i_x = 15$

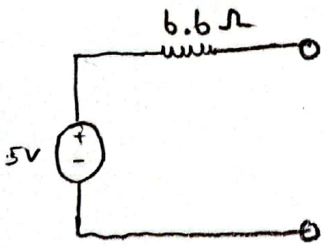
$\hookrightarrow i_x = 1.5A$

$i_{sc} = (0.5) \times (1.5) = 0.75A$

$R_t = \frac{V_{oc}}{i_{sc}} \Rightarrow \frac{5}{0.75} = 6.6\Omega$

Answer

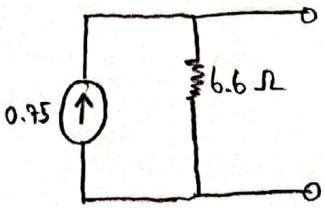
Thevenin



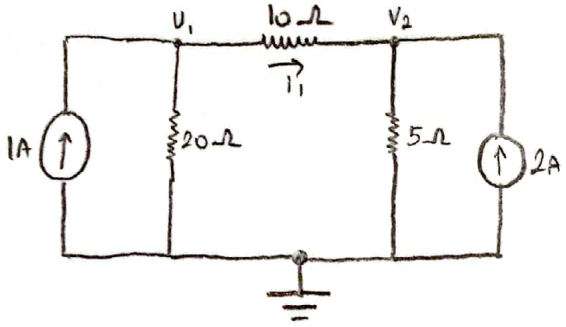
Answer

Norton

$I_n = i_{sc} = 0.75A$



Q3



value of i_1

$i_1 \Rightarrow \frac{V_1 - V_2}{10}$

KCL at node 1

$1 - i_1 - \frac{V_1}{20} = 0$

$1 + \frac{V_2 - V_1}{10} - \frac{V_1}{20} = 0$

$20 + 2V_2 - 2V_1 - V_1 = 0$

$-3V_1 + 2V_2 = -20$

KCL at node 2

$i_1 + 2 - \frac{V_2}{5} = 0$

$\frac{V_1 - V_2}{10} + 2 - \frac{V_2}{5} = 0$

$V_1 - V_2 + 20 - 2V_2 = 0$

$V_1 - 3V_2 = -20$

$-3V_1 + 2V_2 = V_1 - 3V_2$

$4V_1 = 5V_2 \longrightarrow V_1 = 5k,\ V_2 = 4k$

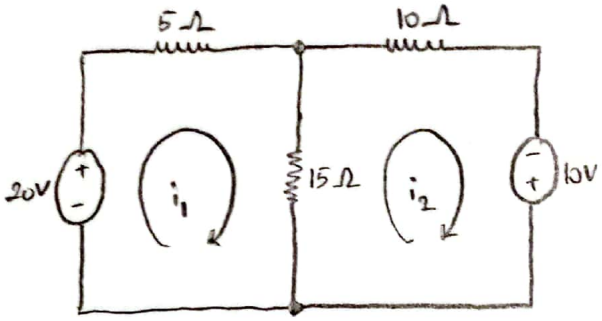
$-3.5k + 2.4k = -20$

$-7k = -20 \longrightarrow k = 2.85$

Answer

$i_1 \Rightarrow \frac{5k - 4k}{10} \Rightarrow \frac{2.85}{10} = 0.285\ A$

Q4



Power delivered to the 15Ω

Mesh 1

$-20 + 5i_1 + 15i_1 - 15i_2 = 0$

$20i_1 - 15i_2 = 20$

$4i_1 - 3i_2 = 4$

Mesh 2

$15i_2 - 15i_1 + 10i_2 - 10 = 0$

$-15i_1 + 25i_2 = 10$

$-3i_1 + 5i_2 = 2$

$4i_1 - 3i_2 = 2(-3i_1 + 5i_2) = 4i_1 - 3i_2 = -6i_1 + 10i_2$

$\Rightarrow 10i_1 = 13i_2 \longrightarrow$ $i_1 = 13k$, $i_2 = 10k$

$4.(13k) - 3.(10k) = 4$

$k = 0.18$

$i_1 = 2.34\ A$

$i_2 = 1.8\ A$

Current that flows through 15Ω is;

$i_1 - i_2 \Rightarrow 0.54\ A$

Answer

power $\Rightarrow R.i^2 \longrightarrow 15.(0,54)^2 = 4.37\ J$