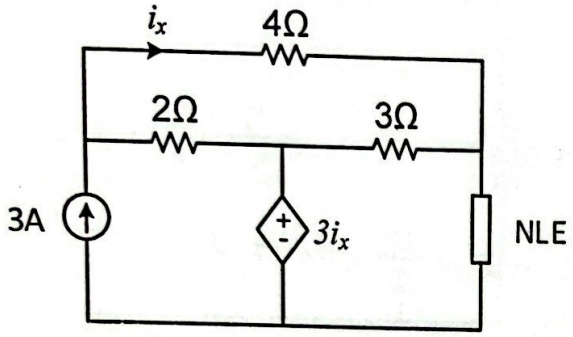
**Question 2 (25 pts)**

Consider the following circuit with a nonlinear element denoted as NLE.

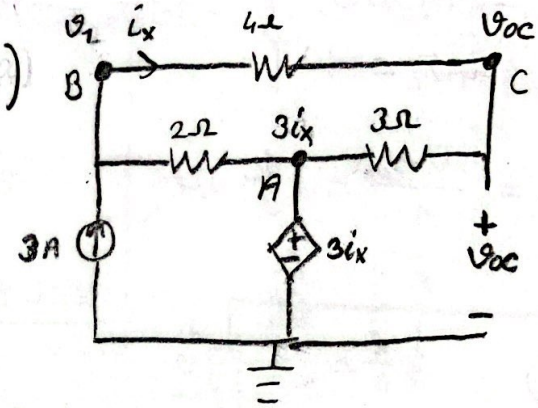
a) Find the Thevenin equivalent circuit seen from the terminals of the NLE by calculating open circuit voltage and short circuit current. Be careful about the polarity of the voltage and the direction of the current

b) Recalculate the Thevenin resistance seen from the terminals of the NLE by connecting a test source with 1A current.

c) Assume that the current voltage relation of the NLE is $i = (v-4)^2$ where the direction of current $i$ and the polarity of voltage $v$ obey the passive sign convention. Calculate the power dissipated by the NLE.




a)

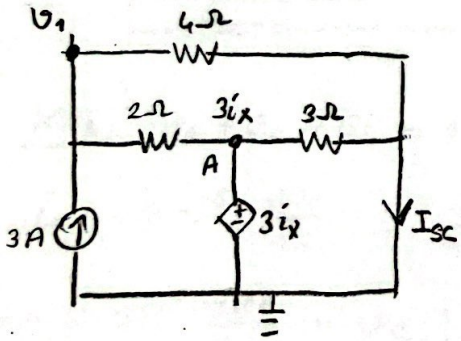



KCL A: $\frac{3i_x - v_1}{2} + \frac{3i_x - v_{oc}}{3} = 0 \Rightarrow 3v_1 - 15i_x + 2v_{oc} = 0.$

KCL B: $-3 + \frac{v_1 - 3i_x}{2} + \frac{v_1 - v_{oc}}{4} = 0 \Rightarrow 3v_1 - 6i_x - v_{oc} = 12$

const: $i_x = \frac{v_1 - v_{oc}}{4} \Rightarrow v_1 = 4i_x + v_{oc}$

$$\Rightarrow \begin{matrix} -3i_x + 5v_{oc} = 0 \\ 6i_x + 2v_{oc} = 12 \end{matrix} \Big\} \quad v_{oc} = 1V.$$




KCL A: $\frac{3i_x - v_1}{2} + \frac{3i_x}{3} = 0 \Rightarrow v_1 = 5i_x$

KCL $v_1$: $-3 + \frac{v_1 - 3i_x}{2} + \frac{v_1}{4} = 0 \Rightarrow 3v_1 - 6i_x = 12$

$v_1 - 2i_x = 4$

$\Rightarrow i_x = \frac{4}{3} A, \quad v_1 = \frac{20}{3} V.$

$I_{sc} = \frac{v_1}{4} + \frac{3i_x}{3} = \frac{5}{3} + \frac{4}{3} = 3A. \Rightarrow R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{1}{3}\Omega.$

Thevenin equiv circuit: