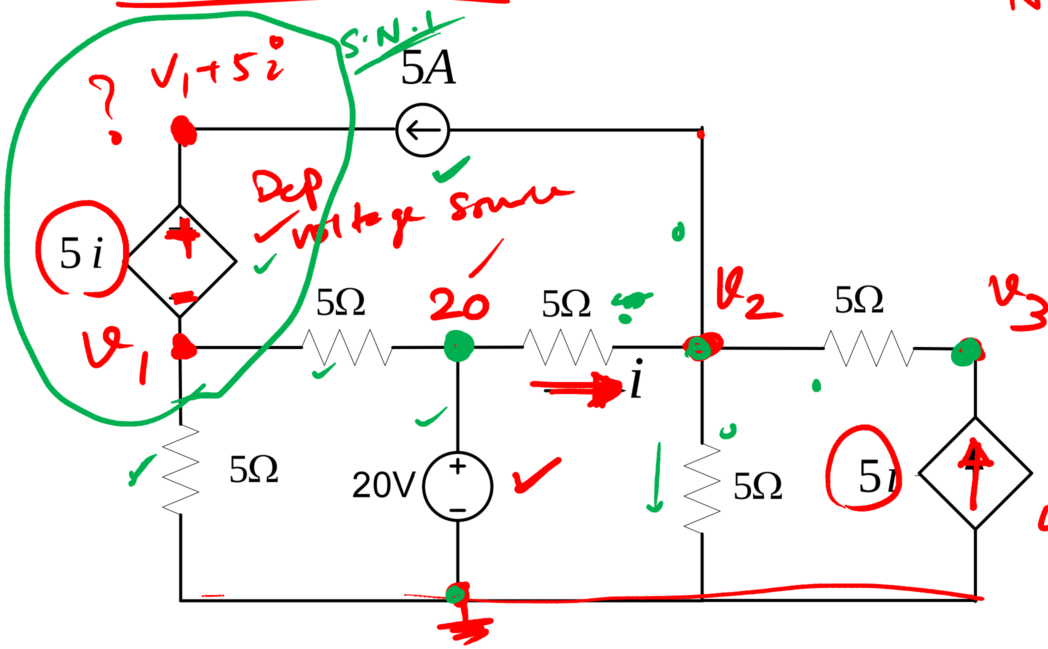
EE1002
Introduction to Circuits and Systems

Midterm Test 1 Discussion

You are asked to use **Node Voltage Analysis method** to solve the circuit below**. Identify the node voltage variables** and **write as many independent equations** as the number of unknowns.

DO NOT SOLVE the equations!



Dep. curr source

$$i = \frac{20 - V_2}{5} \quad \text{— (1)}$$

No. of unknowns: i, V_1, V_2, V_3

KCL at S.N.1.

$$\frac{V_1 - 0}{5} + \frac{V_1 - 20}{5} - 5 = 0 \quad \text{— (2)}$$

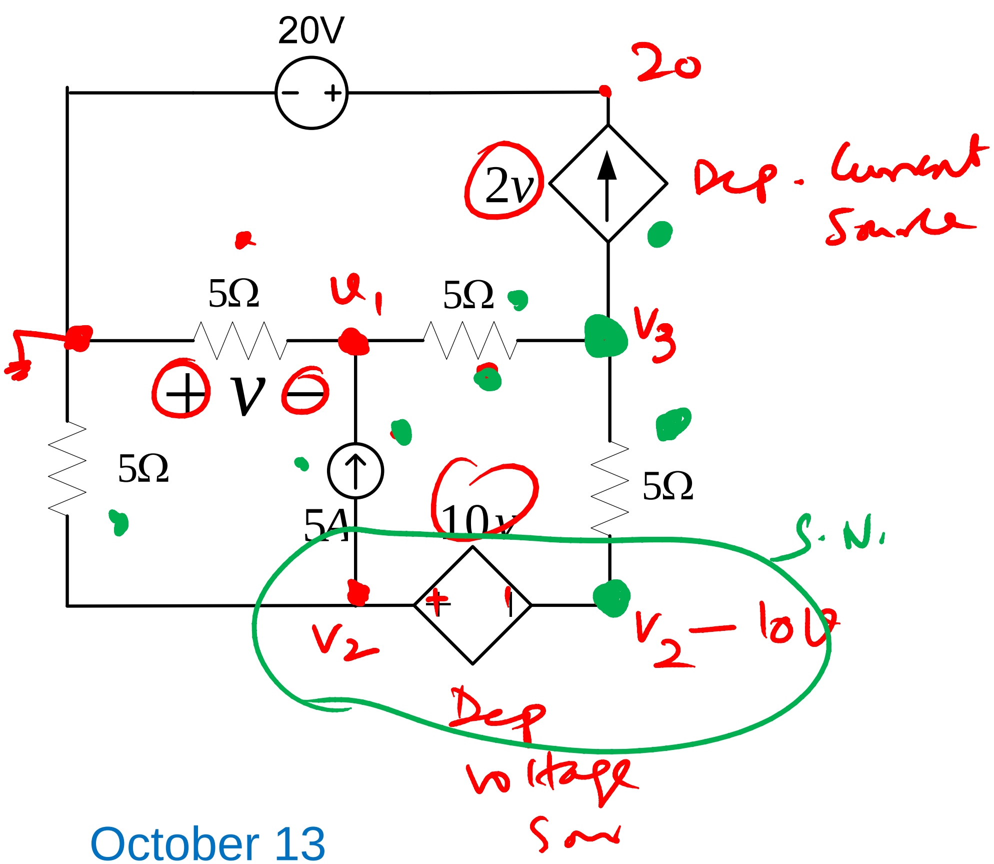
KCL at node V_2.

$$5 + \frac{V_2 - 20}{5} + \frac{V_2 - 0}{5} + \frac{V_2 - V_3}{5} = 0 \quad \text{— (3)}$$

$$\frac{V_3 - V_2}{5} - 5i = 0 \quad \text{— (4)}$$

You are asked to use **Node Voltage Analysis method** to solve the circuit below**. Identify the node voltage variables** and **write as many independent equations** as the number of unknowns.

DO NOT SOLVE the equations!



$$v = 0 - v_1 = -v_1 \quad \text{— (1)}$$

KCL at v_1

$$\frac{v_1 - 0}{5} - 5 + \frac{v_1 - v_3}{5} = 0 \quad \text{— (2)}$$

KCL at S.N.

$$\frac{v_2 - 0}{5} + 5 + \frac{v_2 - 10v - v_3}{5} = 0 \quad \text{— (3)}$$

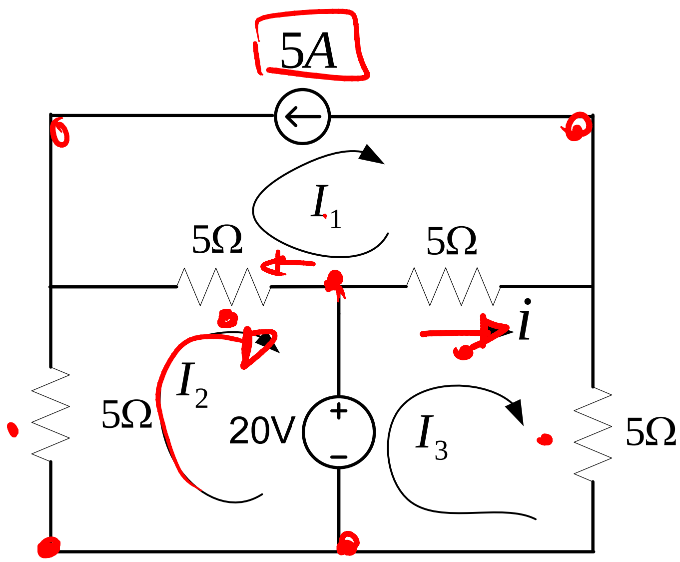
KCL at v_3

$$2v + \frac{v_3 - v_1}{5} + \frac{v_3 - (v_2 - 10v)}{5} = 0 \quad \text{— (4)}$$

You are asked to solve the circuit below using **Mesh Current Analysis Method**. The three mesh currents are shown as $\mathbf{I_1}$, $\mathbf{I_2}$ and $\mathbf{I_3}$. **Write 3 independent equations** involving the 3 mesh currents.

Express the current *i* in terms of the mesh currents.

DO NOT SOLVE the equations!



KVL. for mesh I_1

$\cancel{5\times(I_1 - I_2) = 5}$

$I_1 = -5$ — ①

Mesh I_2:

$5\times I_2 + 5\cdot(I_2 - I_1) + 20 = 0$ — ②

Mesh I_3,

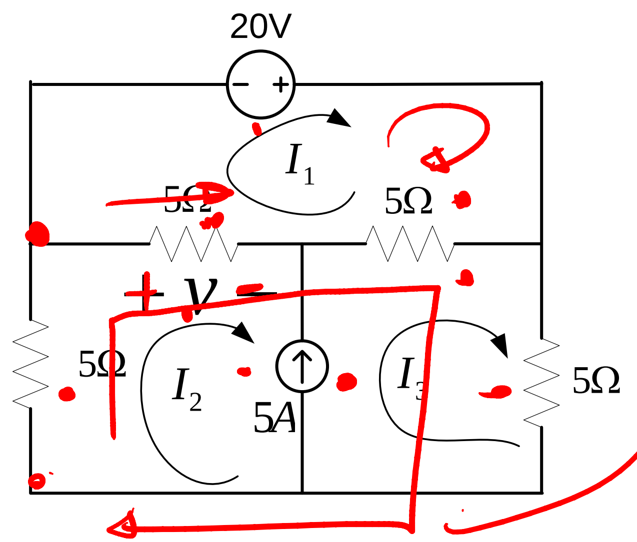
$-20 + 5\times(I_3 - I_1) + 5\cdot I_3 = 0$ — ③

$i = I_3 - I_1$

You are asked to solve the circuit below using **Mesh Current Analysis Method**. The three mesh currents are shown as **I_1, I_2** and **I_3**. **Write three independent equations** involving the 3 mesh currents.

Express the ~~current~~ voltage *v* in terms of the mesh currents.

DO NOT SOLVE the equations!



Mesh I_1:

$-20 + 5(I_1 - I_3) + 5(I_1 - I_2) = 0$ — ①

Mesh I_2: ×

Mesh I_3: ×

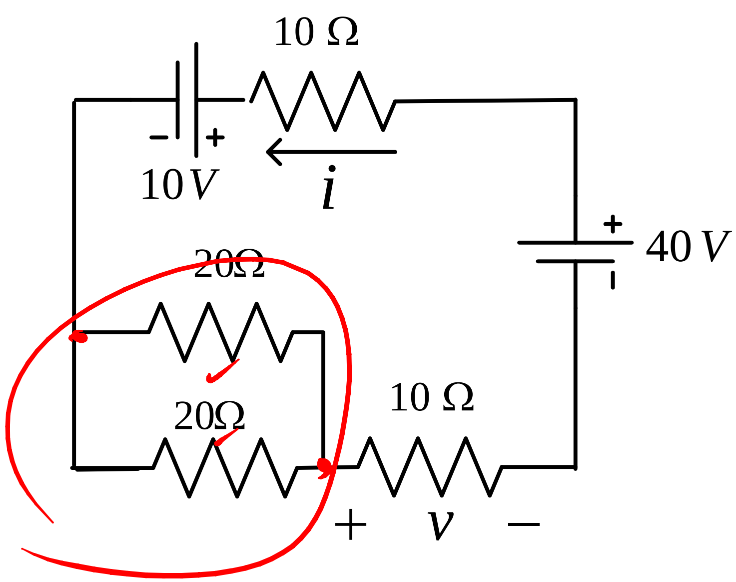
KVL:

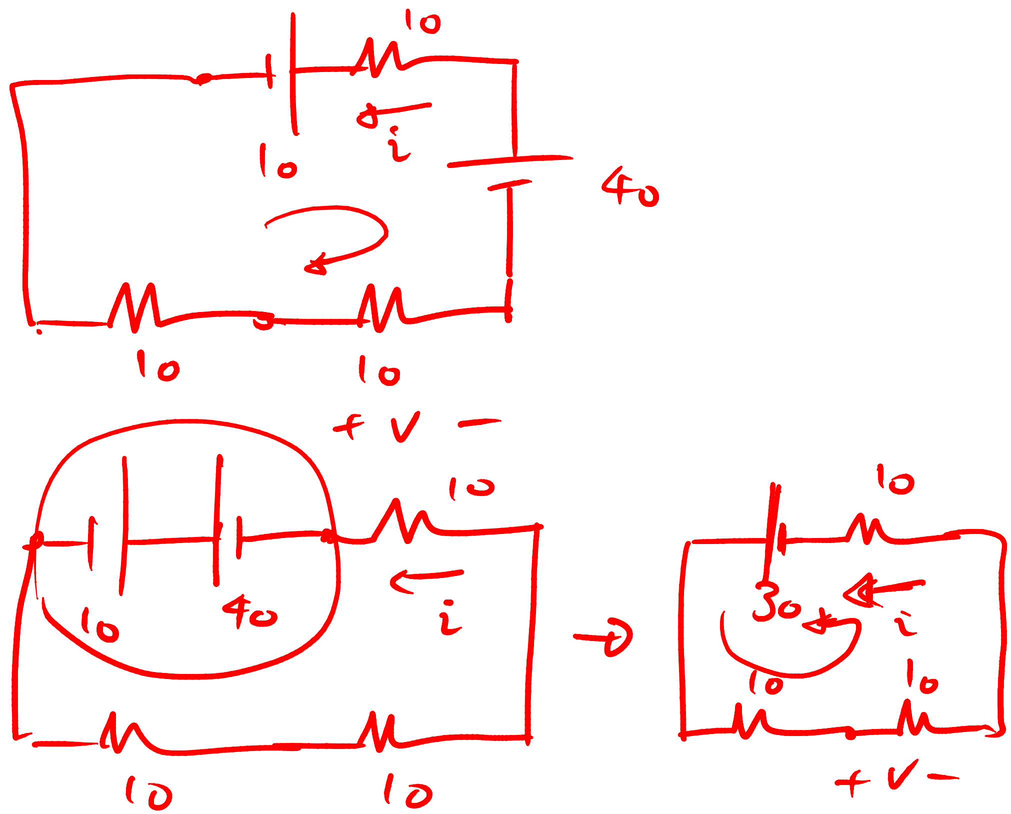
$5I_2 + 5(I_2 - I_1) + 5(I_3 - I_1) + 5I_3 = 0$ — ②

$I_3 - I_2 = 5$ — ③

$5 \times (I_2 - I_1) = v$

For the circuit below, find the **voltage and current .**



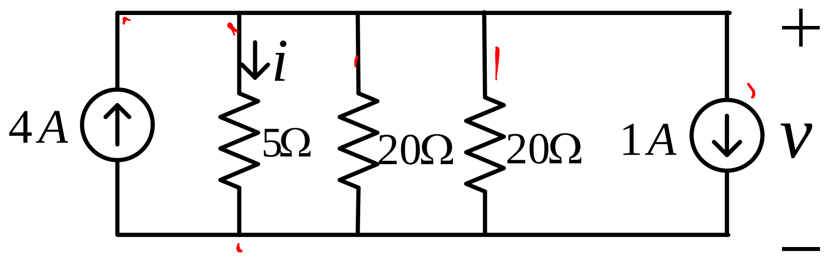


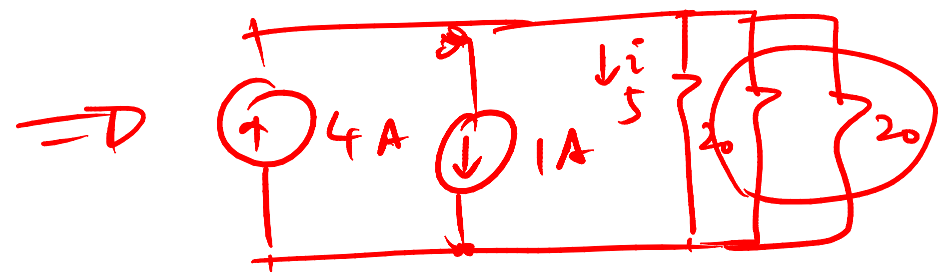
voltage divider rule = $v = \frac{10}{10+10+10} \times 30 = 10\,V$

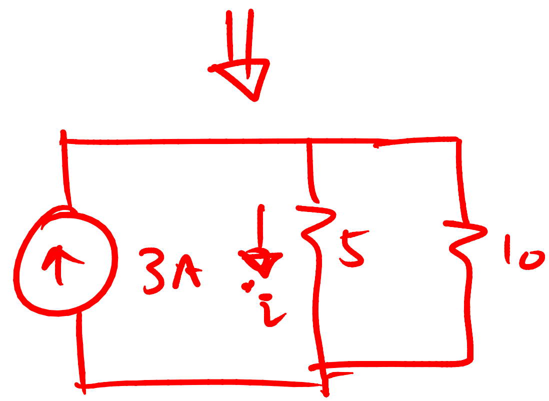
$i = \frac{30}{10+10+10} = 1\,A$.

$V = 10 \times 1 = 10\,V$.

For the circuit below, find the **current *i* and voltage *v***.





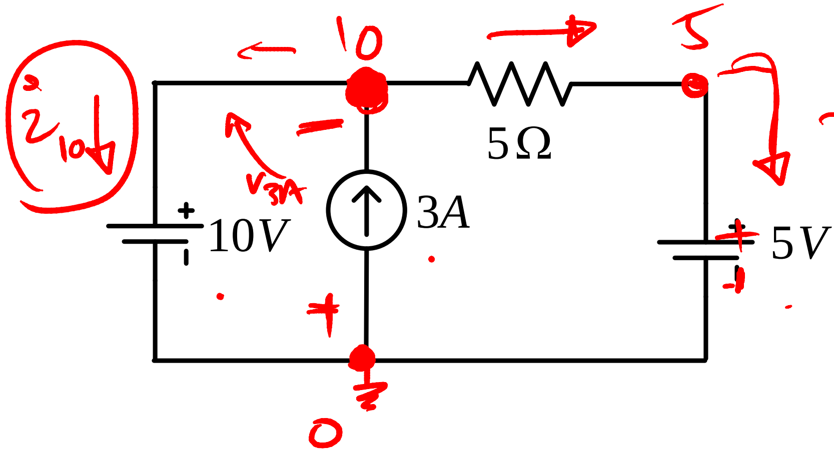


Current divider rule.

$$i = 3 \times \frac{10}{10+5} = 2\,A.$$

$$V = i \times R = 2 \times 5 = 10\,V.$$

Find the **power associated with all the 3 sources** in the circuit below. Mention if they are **absorbing or delivering power**.



$i_{5V} = \frac{10-5}{5} = \cancel{2A}$ 1 A

KCL at node 10v:

$i_{10} - 3 + \cancel{i_{5V}}^{1} = 0$

$i_{10} = 3 - \cancel{i_{5V}}^{1} =$

$= 3 - \cancel{2}^{1} = 2A$

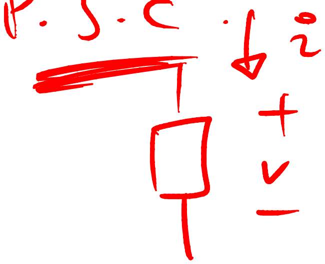
$i_{10v} = 1\,A$.

$P_{10V} = 10 \times i_{10V} = 10 \times 2 = \cancel{10}^{20}\ W$ (abs)

$P_{3A} = V_{3A} \times 3 = (0-10) \times 3 = -30\ W$ (del).

$P_{5V} = 5 \times i_{5V} = 5 \times 2 = 10\ W$ (abs).

P.S.C.

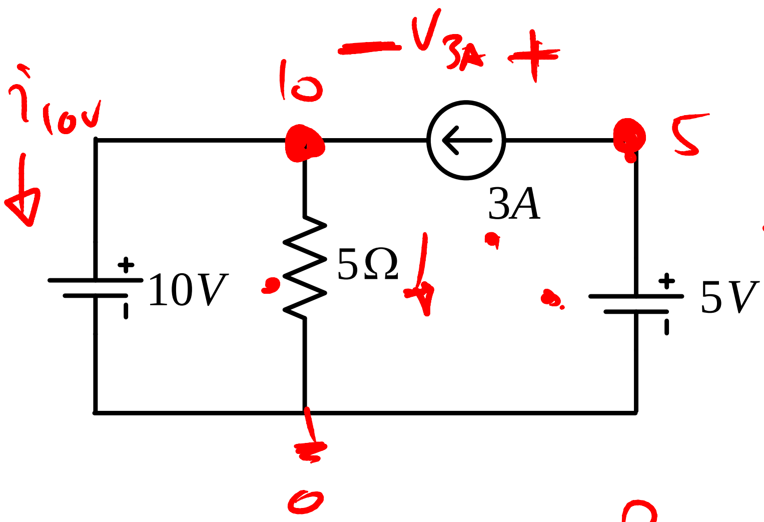


$P = v \cdot i$

+ve → abs.

−ve → del.

Find the **power associated with all the 3 sources** in the circuit below. Mention if they are **absorbing or delivering power**.



$i_{10V} + \frac{10}{5} - 3 = 0$

$i_{10V} = 1\,A$.

$i_{5V} = -3A$

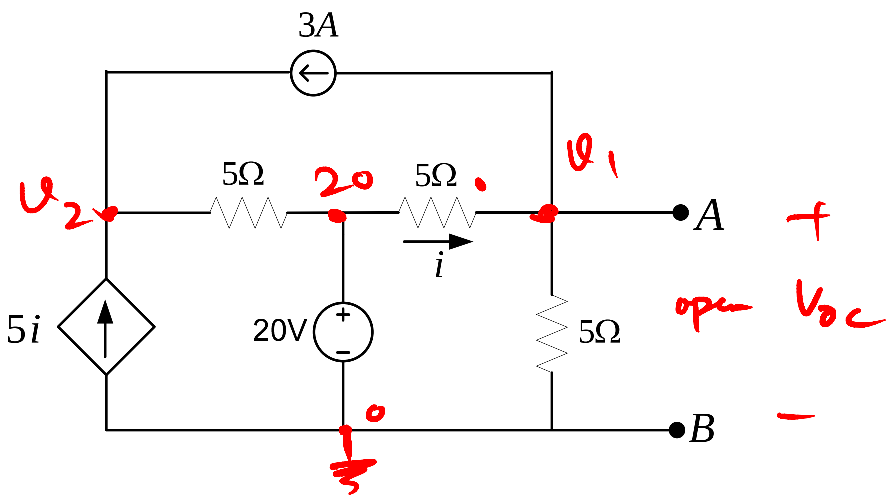
$V_{3A} = 5 - 10 = -5V$.

$P_{10V} = 10 \times i_{10V} = 10 \times 1 = 10W$ (abs)

$P_{3A} = V_{3A} \times 3 = -5 \times 3 = -15W$ (del)

$P_{5V} = 5 \times i_{5V} = 5 \times (-3) = -15W$ (del)

For the circuit below, find the **Norton's equivalent** between nodes A and B.



V_{oc}, I_{sc}.

$V_{oc} = V_1$.

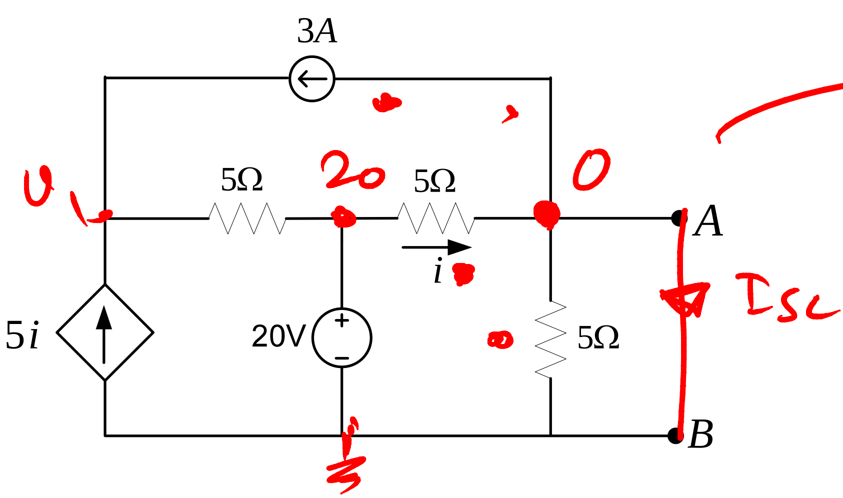
KCL at V_1:

$$\frac{V_1 - 20}{5} + 3 + \frac{V_1}{5} = 0 \quad \text{— ①}$$

$$V_1 - 20 + 15 + V_1 = 0$$

$$2V_1 = 5 \Rightarrow V_1 = 2.5V.$$

$$= V_{oc}$$



KCL:

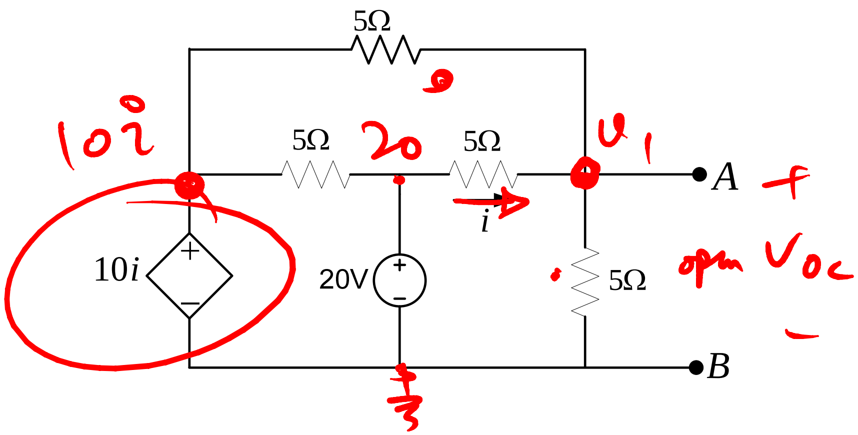
$$+3 + \frac{0-20}{5} + \frac{0}{5} + I_{sc} = 0$$

$$+3 - 4 + I_{sc} = 0$$

$$I_{sc} = 1\ A.$$

$R_{TH} =$

For the circuit given below, find the **Thevenin's equivalent** circuit between nodes A and B.



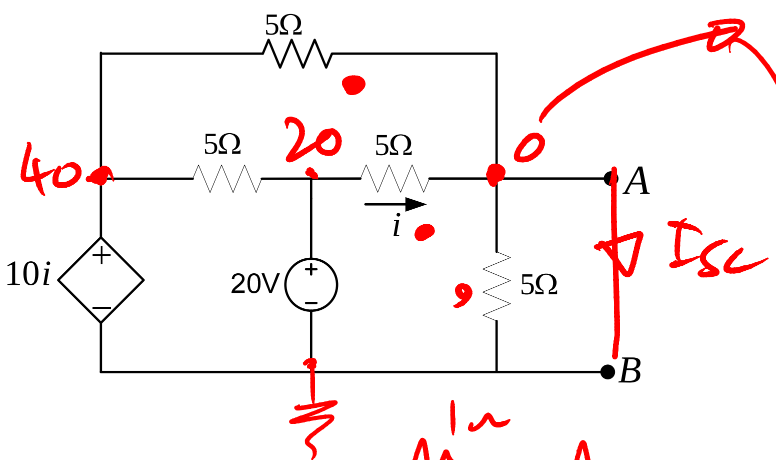
$$i = \frac{20 - V_1}{5} \Rightarrow 10i = 2(20 - V_1) = 40 - 2V_1$$

KCL at V_1:

$$\frac{V_1 - (40 - 2V_1)}{5} + \frac{V_1 - 20}{5} + \frac{V_1}{5} = 0$$

$$V_1 - 40 + 2V_1 + V_1 - 20 + V_1 = 0$$

$$5V_1 = 60 \Rightarrow V_1 = 12 = V_{oc}$$



$$i = \frac{20 - 0}{5} = 4\text{ A}.$$

$$10i = 40$$

KCL:

$$\frac{0 - 40}{5} + \frac{0 - 20}{5} + 0 + I_{sc} = 0$$

$$-8 - 4 + I_{sc} = 0 \Rightarrow I_{sc} = 12\text{A}$$

$$R_{TH} = \frac{V_{oc}}{I_{sc}} = 1\,\Omega$$