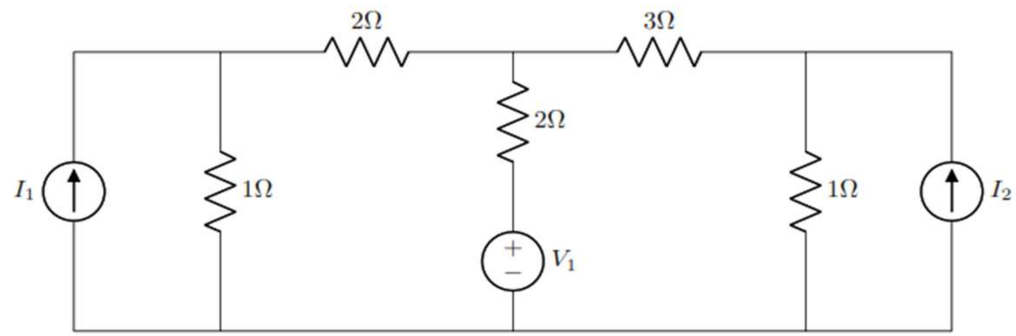
NORTON'S THEOREM

❖ Simplify the following circuit to find out the current flowing through 2 Ohm resistance.



❖ The mesh currents are as below

$$i_1 = \frac{3}{13}I_1 - \frac{1}{13}I_2 - \frac{2}{13}V_1$$

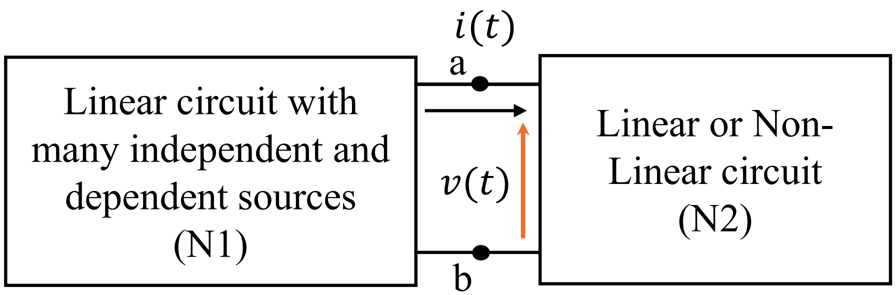
$$i_2 = \frac{1}{13}I_1 - \frac{5}{26}I_2 + \frac{3}{26}V_1$$

$$\boldsymbol{I_{2\Omega} = i_1 - i_2 = \frac{2}{13}I_1 + \frac{3}{26}I_2 - \frac{7}{26}V_1}$$

NORTON'S THEOREM

In this circuit the current can be represented as

$$i(t) = \sum_{i=1}^{n} a_i V_i(t) + \sum_{j=1}^{m} b_j I_j(t) - a_0 v(t)$$



Any linear bilateral network (N1) can be represented by a current source (I_N) in parallel with a resistance (R_N), where

- ❖ The value of the current source is equal to the current that would flow through a-b terminal when a and b terminals are shorted.

- ❖ The parallel resistance of the network N1 is measured between a-b terminal with N2 removed and the source emfs replaced by their internal resistances.

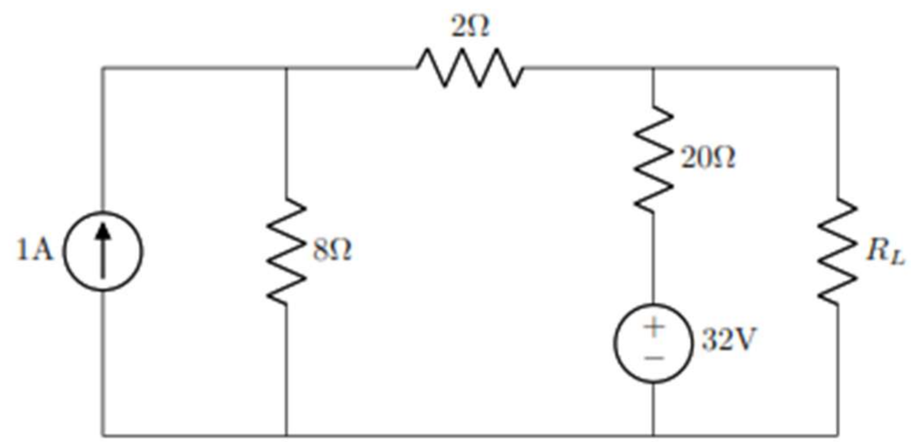
NB:

Ideal voltage sources are replaced by short circuit and the ideal current sources are replaced with open circuit.

NORTON'S THEOREM (INDEPENDENT SOURCES)

Problem-16:

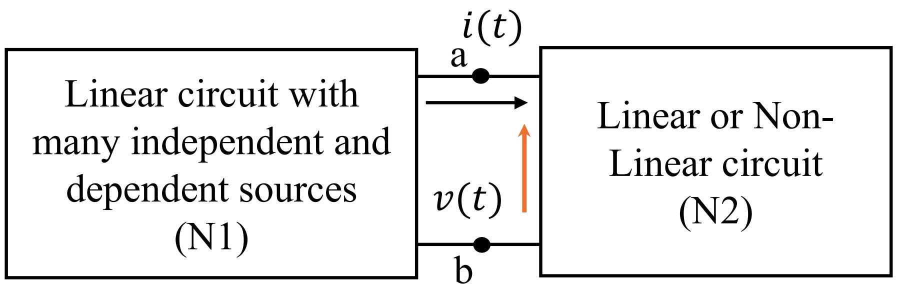
Determine the Norton equivalent circuit of the given network across the load resistance R_L.



Ans:

$$I_N = 2.4\ A$$
$$R_N = 6.6667\ \Omega$$

THEVENIN'S THEOREM



Any linear bilateral network (N1) can be represented by a voltage source (V_{TH}) in series with a resistance (R_{TH}), where

- ❖ The value of the voltage source is equal to the voltage that would appear across a-b terminal when a and b terminals are opened.
- ❖ The series resistance of the network N1 is measured between a-b terminal with N2 removed and the source emfs replaced by their internal resistances.

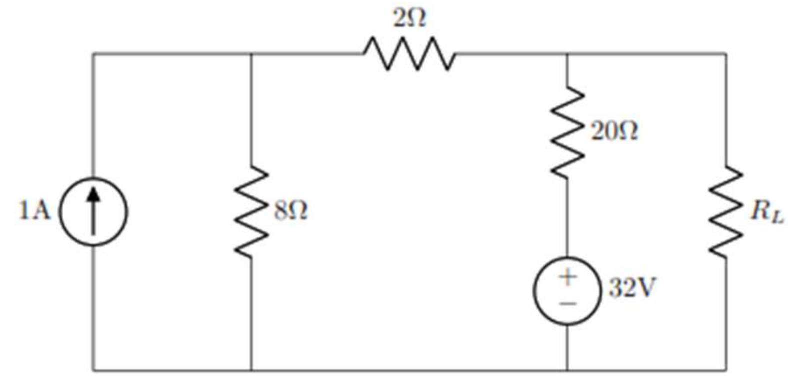
NB:

Ideal voltage sources are replaced by short circuit and the ideal current sources are replaced with open circuit.

THEVENIN'S THEOREM (INDEPENDENT SOURCES)

Problem-17:

Determine the Thevenin equivalent circuit of the given network across the load resistance R_L.



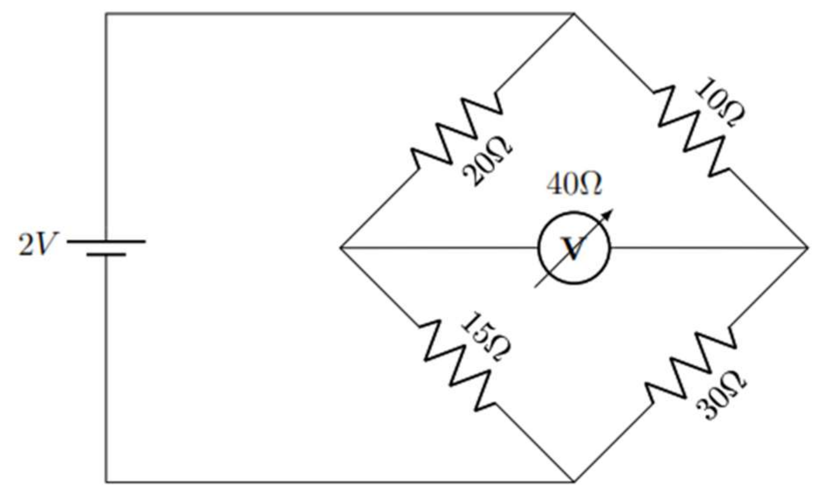
Ans:

$$V_{TH} = 16\ V$$
$$R_N = 6.6667\ \Omega$$

EXTRA PROBLEM

Problem:

Determine the galvanometer current in the wheastone bridge using the Thevenin's and Norton's Theorem.

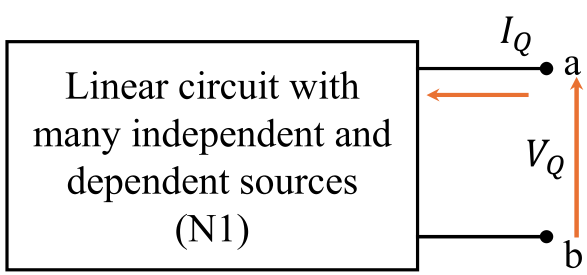


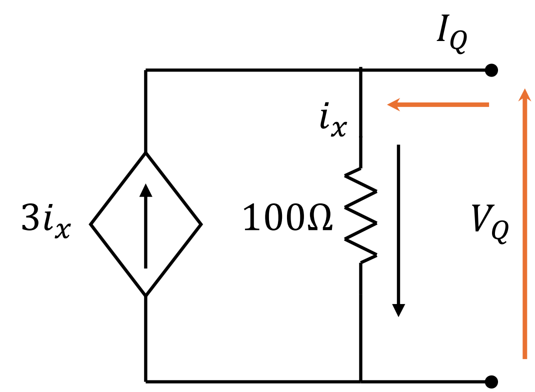
Ans:

$$R_N = 16.0714\,\Omega$$
$$I_N = 0.04\,A$$
$$V_{TH} = 0.6428\,V$$
$$I_{gal} = 11.4649\,mA$$

EQUIVALENT RESISTANCE

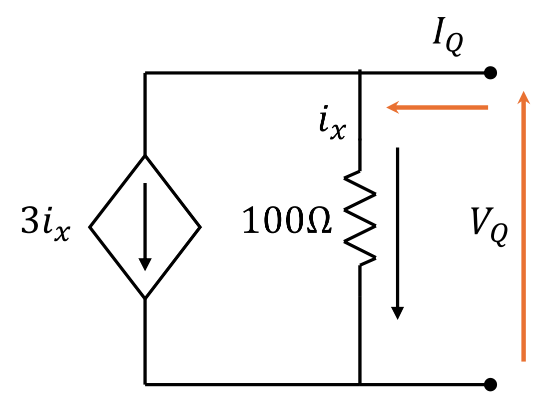
(DEPENDENT SOURCES)





- Determine the equivalent impedances for both circuits.

- With the change in the direction in the current sources, the ratio of $\frac{V_Q}{I_Q}$ is also changed which is the equivalent resistance observed by the V_Q source.



EQUIVALENT RESISTANCE

(DEPENDENT SOURCES)

- Set all independent sources equal to zero.
- Find the equivalent resistance.
  - a) When there are no dependent sources, find this equivalent resistance using the equivalent resistance rules (series combinations, parallel combinations, star-delta transformation) .
  - b) When there are dependent sources present, **apply a known test source to the two terminals of interest**. It can be either a voltage source or a current source.
    1) In case of **voltage source, measure the current** coming out of the voltage source.
    2) In case of **current source, measure the voltage** appeared across that current source.
    3) Find the ratio of the voltage to the current, which will be the equivalent resistance.
- Find out the Open circuit voltage (V_{oc}) and the short circuit current (I_{sc}) and find out the ratio which is supposed to be the equivalent resistance of the given circuit.

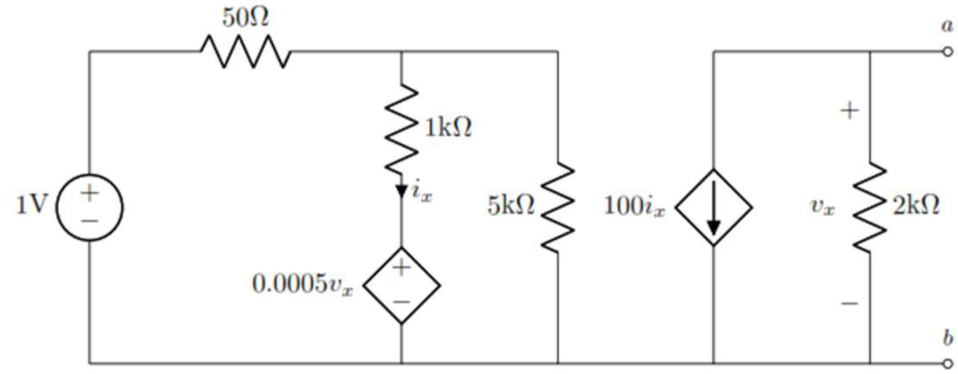
$$\boxed{R_{eq} = \frac{V_{oc}}{I_{sc}} = R_{TH} = R_N}$$

NORTON'S THEOREM EXAMPLE

(DEPENDENT SOURCES)

Problem-18:

For the given circuit determine the Norton's current and the Norton's equivalent resistance.



Ans:

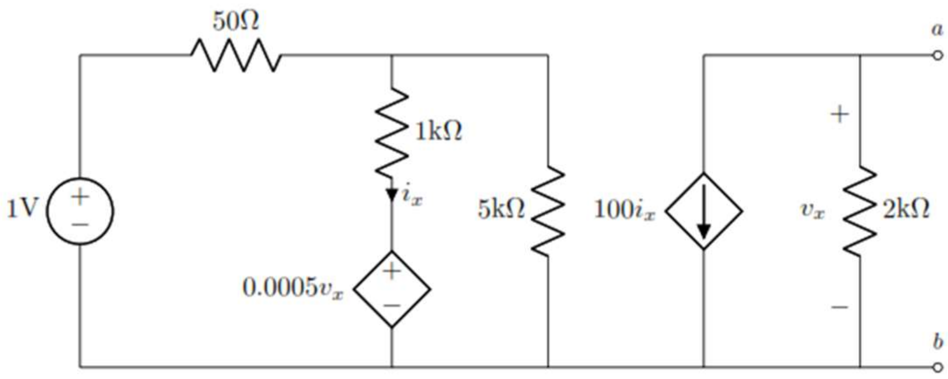
$$I_N = -0.09434\ A$$
$$R_N = 2.21\ k\Omega$$

THEVENIN'S THEOREM EXAMPLE

(DEPENDENT SOURCES)

Problem-19:

For the given circuit determine the Thevenin's voltage and the Thevenin's equivalent resistance.



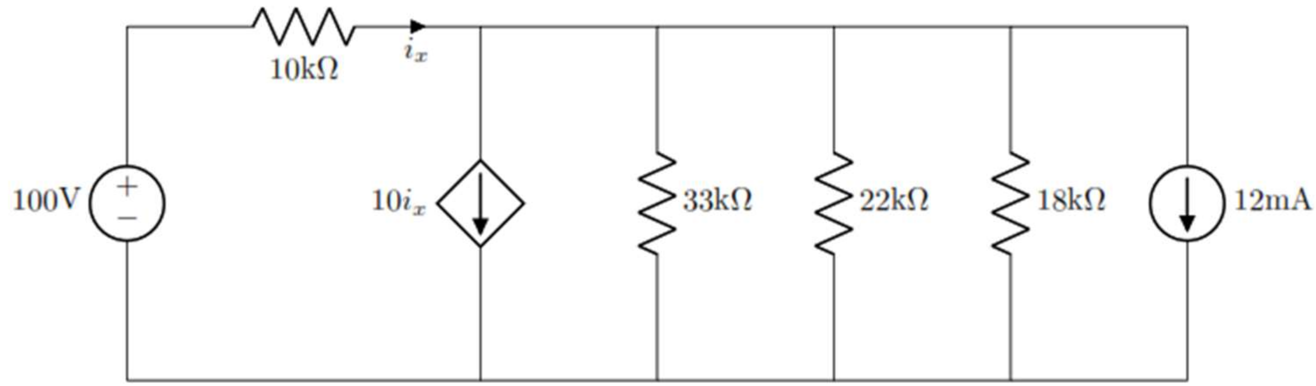
Ans:

$$V_{TH} = -208.5\ V$$
$$R_N = 2.21\ k\Omega$$

NETWORK THEOREM EXAMPLE

Problem-20:

For the given circuit determine the Thevenin's voltage, Norton's current and the equivalent resistance across the $22\ k\Omega$ resistance terminal.



Ans:

$$\boldsymbol{I_N = -102\ mA}$$
$$\boldsymbol{V_{th} = 125.256\ V}$$
$$\boldsymbol{R_{eq} = -1.228\ k\Omega}$$