

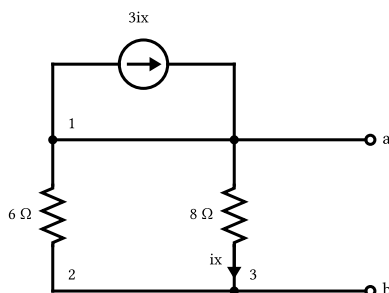
## Thevenin's/Norton's theory (cont.)

### Case 3 (Circuit with dependent source only)

Since the dependent source depends on an independent source,  $E_{TH} = 0$

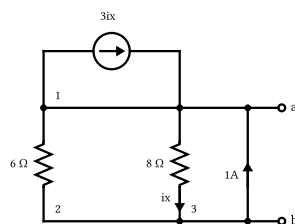
#### Examples

1. Find Thevenin's equivalent between the terminals a-b.



$$E_{TH} = 0$$

By connecting a current/voltage (1A/1V) supply between the two terminals a and b:



1. Calculate  $V_{ab}$  across the  $1\text{A}$  current source.

$$\therefore R_{ab} = \frac{V_{ab}}{1\text{A}} = R_{TH}$$

2. Using mesh analysis:

$$i_1 = -3i_x \rightarrow 1$$

$$0 = i_2(2 + 6 + 8) - i_2(2) - i_3(8) \rightarrow 2$$

$$i_3 = -1\text{A} \rightarrow 3$$

$$i_x = i_2 - i_3 \rightarrow 4$$

$$\therefore V_{ab} = 8i_x = R_{TH}$$

## The theory of the maximum power transfer

If a circuit containing either an independent source and a dependent source or an independent source only, is connected to a variable resistance between two terminals a-b, The value of the power ( $P_L$ ) starts from 0 and ends at 0. If the circuit is substituted by a thevenin circuit,  $P_L$  can be considered a function with the variable  $R_L$ . Therefore, to find the maximum power generated by the circuit, the function can be differentiated and made equal to 0.

$$I_L = \frac{E_{TH}}{R_{TH} + R_L}$$

$$P_L = (I_L)^2 \times R_L$$

$$P_L = \frac{(E_{TH})^2 \times R_L}{(R_{TH} + R_L)^2}$$

To find the maximum power:

$$\frac{dP_L}{dR_L} = 0$$

After differentiation:

$$R_L = R_{TH}$$

$$\therefore P_{\max} = \frac{(E_{TH})^2 \times R_{TH}}{4(R_{TH})^2} = \frac{(E_{TH})^2}{4R_{TH}} W$$

### Examples

1. Find the maximum power.

By disconnecting all power sources:

$$R_{TH} = 9\Omega$$

$$E_{TH} = V_{ab}$$

Using nodal analysis at  $V_1$  :

$$2 = \frac{V_1 - 0}{12} + \frac{V_1 - 12}{6}$$

(3  $\Omega$  resistance is ignored since it is connected in series with a current source)

By applying KVL on the first two loops from the right:

$$-V_1 - 6 - 0 + V_{ab} = 0$$

$$E_{TH} = V_{ab}$$

$$\therefore P_L = \frac{(E_{TH})^2}{4R_{TH}}$$