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

Case 3 (Circuit with dependent source only)

Since the dependaent source depends on a independent source, $E_{\text{TH}} = 0$

Examples

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

$$E_{\text{TH}} = 0$$

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

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

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

2. Using mesh analysis:

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

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

$$i_3 = -1A \to 3$$

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

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

The theory of the maximum power transfer

If a circuit containing either an independant source and a dependanent source or an independant source soley, 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 thevinin 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 diffrentiated and made equal to 0.

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

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

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

To find the maximum power:

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

After diffrentiation:

$$R_L = R_{\text{TH}}$$

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

Examples

1. Find the maximum power.

By disconnecting all power sources:

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

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

Using nodal analysis at V_1 :

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

(3 Ω resistance is ignored since it is connected in series with a current source)

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

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

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

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