Thevinin's Theory

- Thevinin's theory states that in a circuit, all resistors can be replaced by one resistor that consumes the same amount of power and a voltage source series to it.
- In the "Thevinin" circuit, the positive pole of the source is connected to the resistor if E_{TH} is positive and vice versa.
- If a resistor is series with a current source, this resistor is not included in either nodal or mesh equations.

Cases

1. Independent source + Resistor
2. Independent source + Dependant source + Resistors
3. Dependant source + Resistors

Example

1. (Case 1) Find thevenin's equivalent at the terminals a-b

   Sol:
   1. Disconnect the element at which the quantity is required. (R_L)
   2. Deactivate all sources.
   3. Calculate R_{TH}

   $$R_{\text{eq}} = R_{\text{TH}} = \frac{4 \times 12}{4 + 12} + 1 = 4\Omega$$

   4. Calculate E_{TH}
      - Using Nodal analysis at V_1:

      $$2 = \frac{V_1 - 0}{12} + \frac{V_1 - 32}{4} \to V_1 = 30V$$

      $\because$ No current is between a-b.

      $\therefore E_{\text{TH}} = V_1 = 30V$

2. (Case 2) Find thevenin's equivalent at the terminals a-b

   Sol:
   1. Disconnect the element at which the quantity is required. (R_L)
   2. Calculate E_{TH}
      - Using Mesh analysis:

      $$I_1 = 5A$$

      Mesh equation for I_2:

      $$0 = I_2(4 + 6 + 2) - I_1(4) - I_3(2)$$

      Mesh equation for I_2:

      $$2V_x = I_3(2) - I_2(2)$$

      $\therefore E_{\text{TH}} = 6 \times I_2$

3. Create a short circuit between a-b and calculate I_{ab}
   - Using Mesh analysis:

$$I_1 = 5A$$

$$0 = I_2(4+6+2) - I_1(4) - I_3(2)$$

$$2V_x = I_3(2) - I_2(2) - I_4(6)$$

$$0 = I_4(2+6) - I_2(6)$$

$$V_x = 4(I_1 - I_2)$$

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

Norton’s theory

- Norton’s theory states that in a circuit, all resistors can be replaced by one resistor that consumes the same amount of power and a current source parallel to it.

Examples

1. Find Norton’s equivalent at the terminals a-b.

   Sol:
   1. Disconnect all sources.
   2. Calculate R_N.

$$R_N = 6\Omega$$

   3. Calculate $I_N = I_{\text{ab}}$.
      - Using nodal analysis:

$$0 = \frac{V_1 - 1}{6} + \frac{V_1 - 0}{3} + \frac{V_1 - 0}{10}$$

      - Using KCL:

$$\frac{18 - 0}{12} + \frac{V_1 - 0}{10} = I_{\text{ab}}$$

   4. Draw the “Norton” circuit.