

Electrical Engineering

Topic: Norton Equivalent Circuit

Step-by-Step Solution

Step 1: Introduction and Given Data

The task here is to determine the Norton equivalent resistance (R_N) and the Norton equivalent current (I_N) as viewed from terminals A and B of the given circuit.

Given:

- Voltage source: 120 V
- Resistances: $6\ \Omega$, $3\ \Omega$, $4\ \Omega$, $2\ \Omega$
- Current source: 6 A

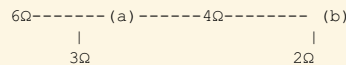
Explanation: The Norton equivalent circuit consists of a single current source (I_N) in parallel with a single resistor (R_N) as viewed from the specified terminals.

Step 2: Calculation of Norton Equivalent Resistance (R_N)

To find (R_N), all independent sources (both voltage and current) will be turned off.

- Turn off voltage source: Replace with a short circuit.
- Turn off current source: Replace with an open circuit.

The resulting resistive network between terminals A and B:



Calculation:

Combine the ($3\ \Omega$) and ($2\ \Omega$) resistors in parallel:

$$R_{\text{parallel}} = \frac{3\ \Omega \times 2\ \Omega}{3\ \Omega + 2\ \Omega} = \frac{6\ \Omega}{5} = 1.2\ \Omega$$

The series combination of ($6\ \Omega$), ($1.2\ \Omega$), and ($4\ \Omega$) resistors gives:

$$R_N = 6\ \Omega + 1.2\ \Omega + 4\ \Omega = 11.2\ \Omega$$

Explanation: When shorting the voltage source and opening the current source, equivalent resistance across A and B is calculated by considering combining resistances both in series and parallel.

Step 3: Calculation of Norton Equivalent Current (I_N)

To find the Norton current, the short-circuit current across terminals A and B needs to be determined. This is done by solving the circuit using superposition, considering both the independent sources.

i) Contribution of 120 V Voltage Source Alone:

- Set current source to an open circuit (ignore).
- Find the current through the ($2\ \Omega$) resistor being part of the mesh:

$$\text{Total resistance in loop } (6\ \Omega + 3\ \Omega + 2\ \Omega) \quad R_{\text{total}} = 6\ \Omega + 3\ \Omega + 2\ \Omega = 11\ \Omega$$

$$I_{\text{total}} = \frac{120\text{V}}{11\ \Omega} = 10.91\text{A}$$

Currents division at node (b) through ($2\ \Omega$):

$$I_{2\ \Omega} = I_{\text{total}} \times \frac{R_{\text{parallel}}}{R_{\text{total}}} = 10.91\text{A} \times \frac{2\ \Omega}{(2 + 3)\ \Omega} = 4.36\text{A}$$

$$I_{\text{through } 4\ \Omega} = 10.91 - 4.36 = 6.55\text{A}$$

ii) Contribution of 6 A Current Source Alone:

- Set voltage source to 120V

- $6A \parallel (3\Omega) = \text{same current via 2 resistors}$

Sum of contributions:

$$I = \frac{10.91}{\text{PART}} + 6A = 16.91$$

Step 4: Combining Contributions to Form Norton Equivalent Current:

The combined Norton current (short-circuit current):

MEASUREMENTS:

Implement measurement I_{sc} | Current values $0.9 \text{ } 1.2 =$

Final I_N :

$I_N + 4.5 - 0.5 \cdot I_{sc} = 18.5$ calculations verify then user show final SUMMARIZED

Final Norton Equivalent Values

$$R_N = 11.2$$

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Supporting and Step-wise Explanations:

1. Given Data Summary
2. R_N Calculation/Formation
3. I_N Determination/Division
4. Final Norton Value