Chapter 4 — Circuit Theorems: Source Transformation & Thevenin's Theorem

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Overview

1 Source Transformation

2 Thevenin's Theorem

3 Conclusions

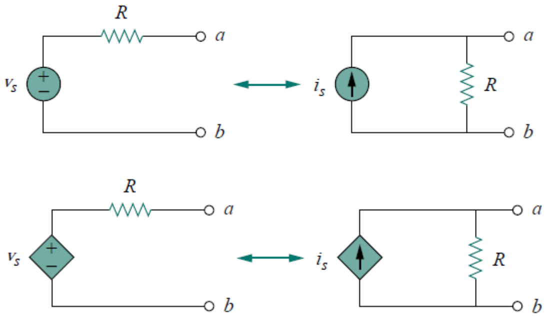
Reference:

[1] Alexander Sadiku, Fundamentals of Electric Circuits, 4th ed. McGraw-Hill, 2009.

Introduction

Source transformation is another tool for simplifying circuits.

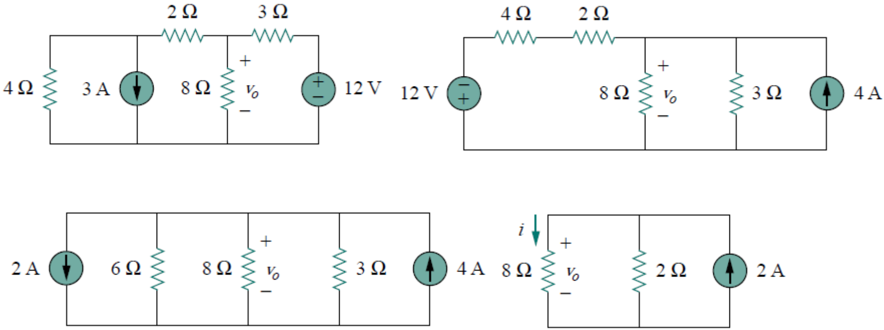
A *source transformation* is the process of replacing a voltage source v_s in series with a resistor R by a current source is in parallel with a resistor R, or vice versa



Example 1

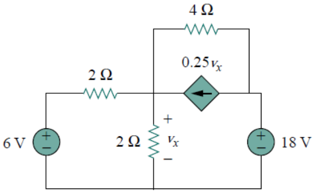
Use source transformation to find v_0 in the circuit shown

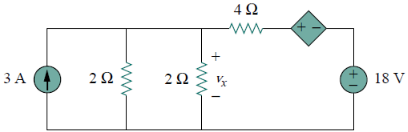
Answer: 3.2 V

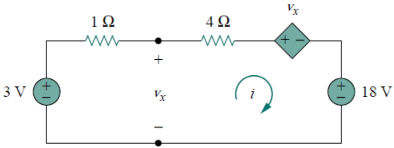


Example 2

Find v_x in figure shown using source transformation





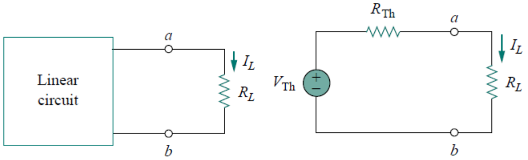


$$-3 + 5i + v_x + 18 = 0$$

$$-3 + 1i + v_x = 0 \Rightarrow v_x = 7.5\,\text{V}$$

Thevenin's Theorem

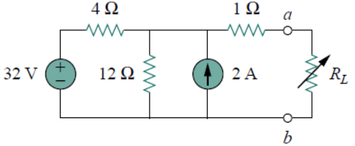
Thevenin's theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a voltage source V_{Th} in series with a resistor R_{Th}, where V_{Th} is the open-circuit voltage at the terminals and R_{Th} is the input or equivalent resistance at the terminals when the independent sources are turned off.



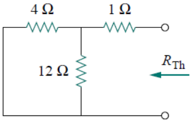
$$I_L = \frac{V_{Th}}{R_{Th}+R_L}, \qquad V_L = I_L R_L = \frac{V_{Th}R_L}{R_{Th}+R_L}$$

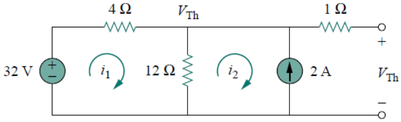
Examples

Find the Thevenin equivalent circuit of the circuit shown, to the left of the terminals a-b. Then find the current through $R_L = 6$, 16, and 36Ω

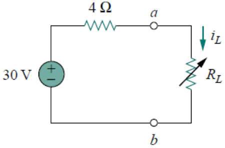


$R_{Th} = 4||12 + 1 = 4\Omega$
$-32 + 4i_1 + 12(i_1 - i_2) = 0$, $i_2 = -2$ A $\Rightarrow i_1 = 0.5$ A
Thus, $V_{Th} = 12(i_1 - i_2) = 30$ V





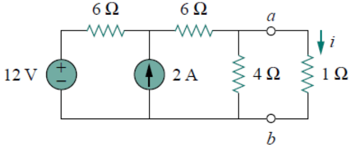
$I_L = \frac{V_{Th}}{R_{Th}+R_L} = \frac{30}{4+R_L} = 3, 1.5,$ and 0.75 A for $R_L = 6$, 16, and 36Ω respectively.



Examples (cont'd)

Using Thevenin's theorem, find the equivalent circuit to the left of the terminals in the circuit shown. Then find i.

Answer: $V_{Th} = 6$ V, $R_{Th} = 3\Omega$, $i = 1.5$ A



Conclusions

Concluding remarks

- Source transformation has been given with some examples
- Thevenin's Theorem has been studied highlighted by some examples