Fundamentals of Electric Circuits

CHAPTER 4

CIRCUIT THEOREMS

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Circuit Theorems - Chapter 4

4.4 Source Transformation

Note:- read these parts form Ref (*Fundamentals of Electric Circuits* ‘Charles K. Alexander & Matthew N. O. Sadiku ’)

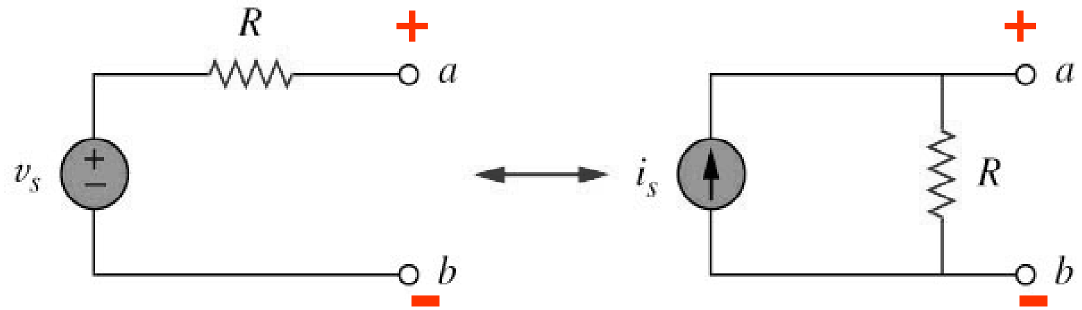
Source Transformation

4.4 Source Transformation

- An equivalent circuit is one whose *v-i* characteristics are identical with the original circuit.
- It is the process of replacing a voltage source v_S in series with a resistor R by a current source i_S in parallel with a resistor R, or vice versa.

4.4 Source Transformation

- The arrow of the current source is directed toward the positive terminal of the voltage source.

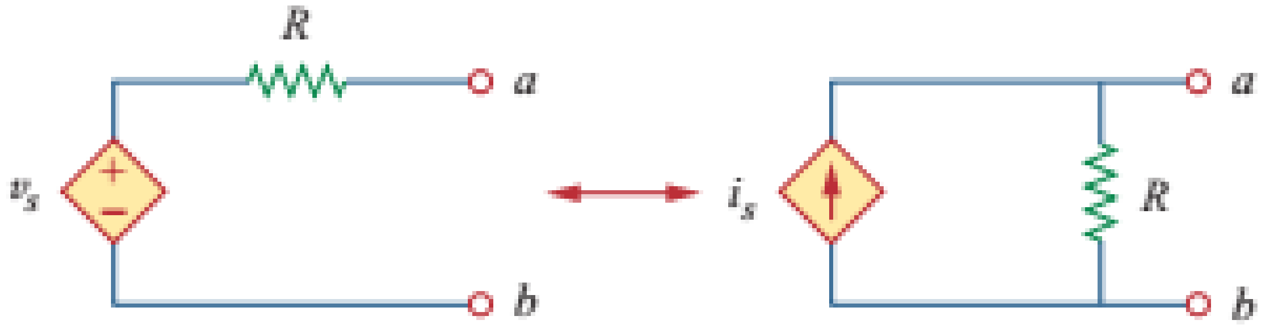


Independent source transform

$$v_s = i_s R \qquad \text{or} \qquad i_s = \frac{v_s}{R}$$

4.4 Source Transformation

Source transformation also applies to dependent sources, provided we carefully handle the dependent variable. As shown in Fig. dependent voltage source in series with a resistor can be transformed to a dependent current source in parallel with the resistor or vice versa.



Examples for source transformation

Use source transformation to find v_o in the circuit of Fig. 4.17.

Example 4.6

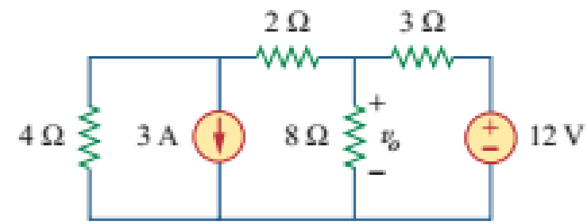


Figure 4.17
For Example 4.6.

Solution:

We first transform the current and voltage sources to obtain the circuit in Fig. 4.18(a). Combining the 4-Ω and 2-Ω resistors in series and transforming the 12-V voltage source gives us Fig. 4.18(b). We now combine the 3-Ω and 6-Ω resistors in parallel to get 2-Ω. We also combine the 2-A and 4-A current sources to get a 2-A source. Thus, by repeatedly applying source transformations, we obtain the circuit in Fig. 4.18(c).

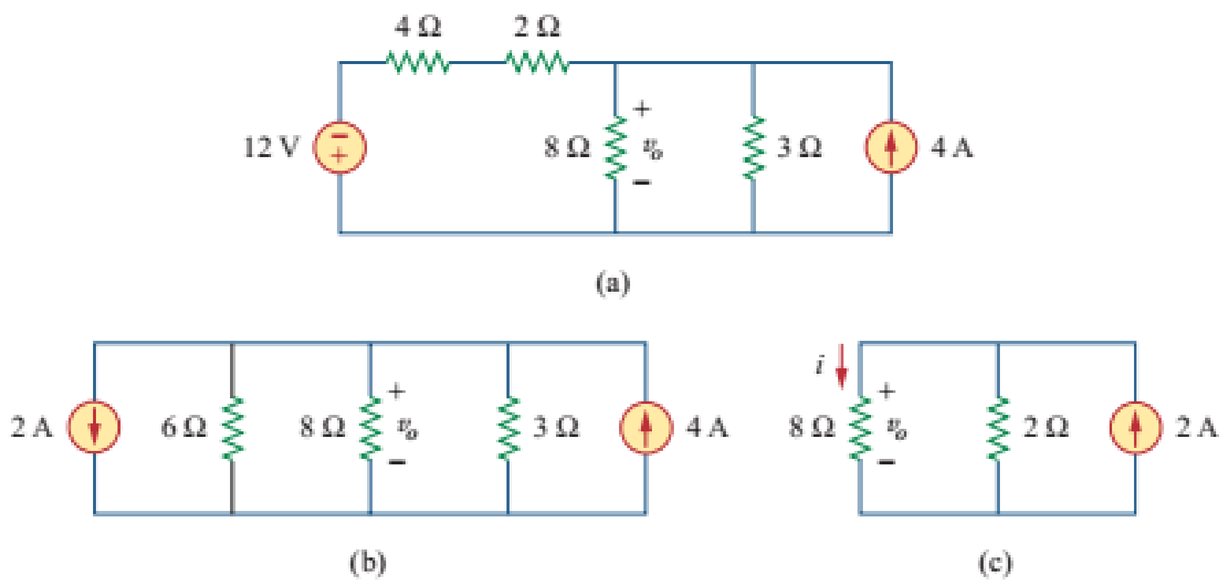


Figure 4.18
For Example 4.6.

We use current division in Fig. 4.18(c) to get

$$i = \frac{2}{2+8}(2) = 0.4 \text{ A}$$

and

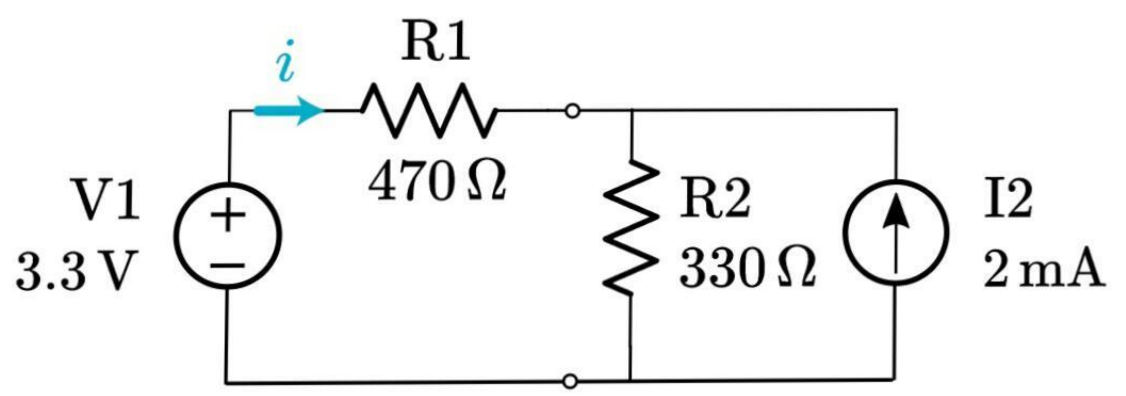
$$v_o = 8i = 8(0.4) = 3.2 \text{ V}$$

Alternatively, since the 8-Ω and 2-Ω resistors in Fig. 4.18(c) are in parallel, they have the same voltage v_o across them. Hence,

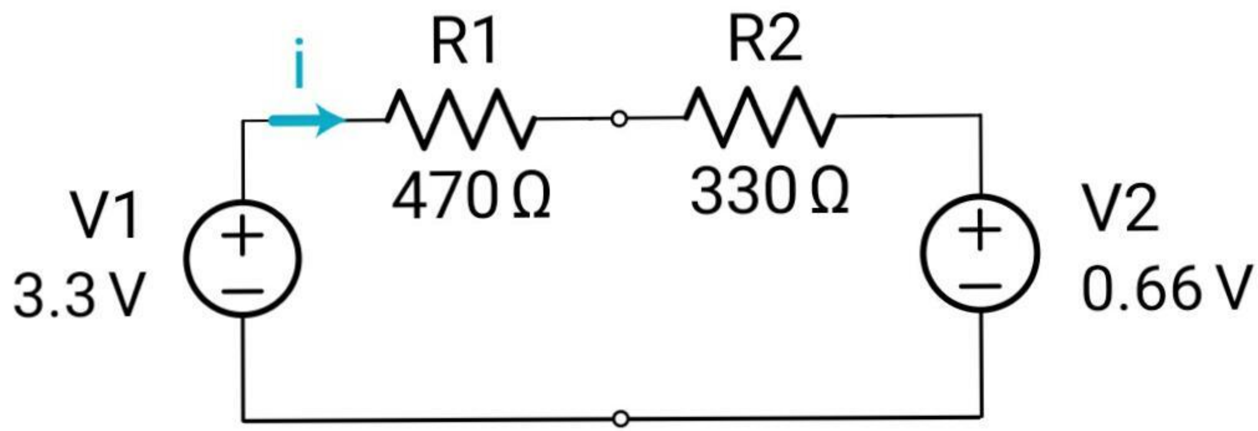
$$v_o = (8 \parallel 2)(2 \text{ A}) = \frac{8 \times 2}{10}(2) = 3.2 \text{ V}$$

Example

- Find *i* (with source transformation)



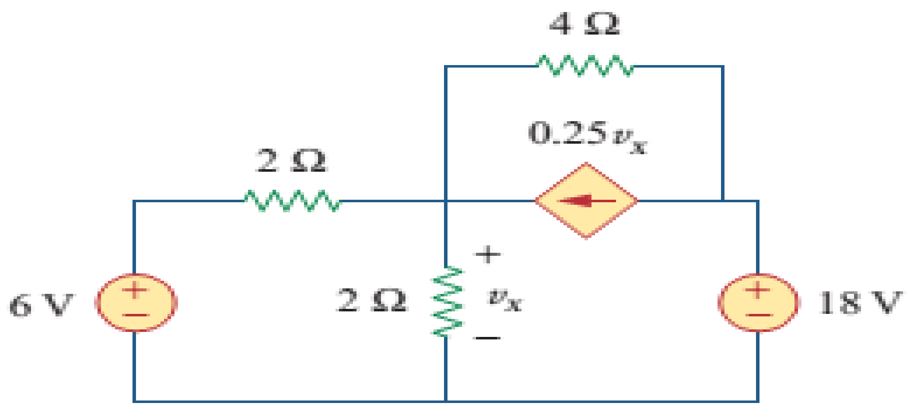
- Transform the circuit form to the equivalent form
- **R2** is the same for both .
- **R2 = 330Ω**
- The voltage sources is
- **V2=i2·   R2=2mA·   330Ω=0.66V**

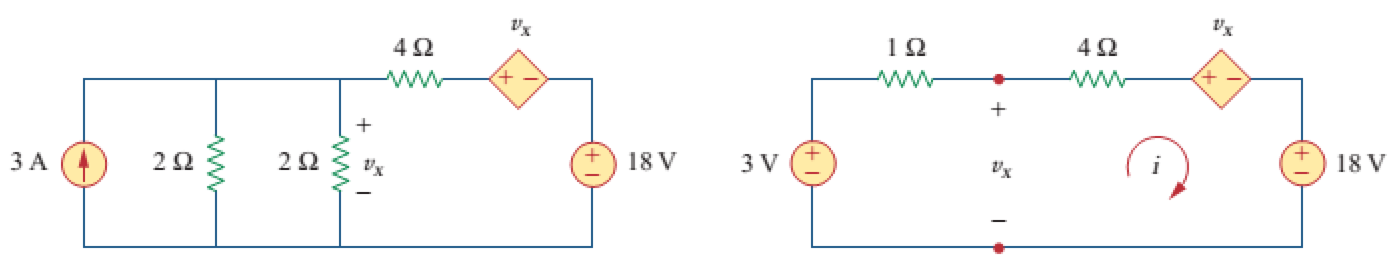


- Source transformation gave us two resistors in series. The voltage across the series resistors is **V1−V2 .**
- Ohm’s Law gives us,
- **i=(V1−V2)÷(R1+R2)**
- ***i*=(3.3−0.66)÷(470+330)**
- **<u>i =3.3mA</u>**

Example

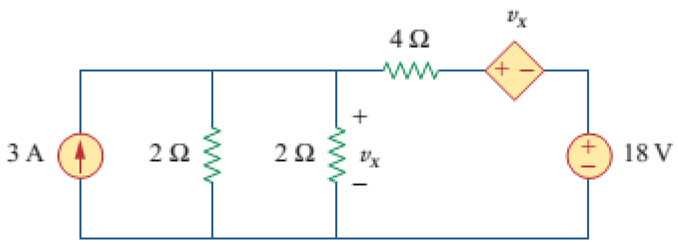
Find v_x in Figure using source transformation



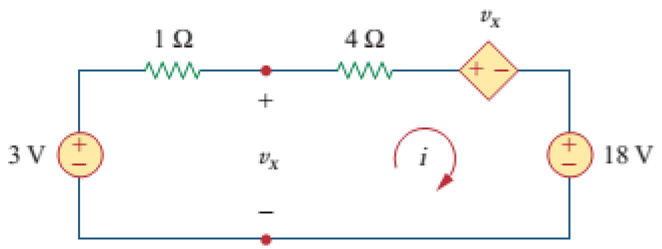


(a) (b)

Solution



(a)



(b)

Applying KVL around the loop in Fig. (b) gives

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

Applying KVL to the loop containing only the 3-V voltage source, the 1-Ω resistor, and v_x yields

$$-3 + 1i + v_x = 0 \quad \Rightarrow \quad v_x = 3 - i$$

$$15 + 5i + 3 - i = 0 \quad \Rightarrow \quad i = -4.5 \text{ A}$$

Thus, $v_x = 3 - i = 7.5$ V.