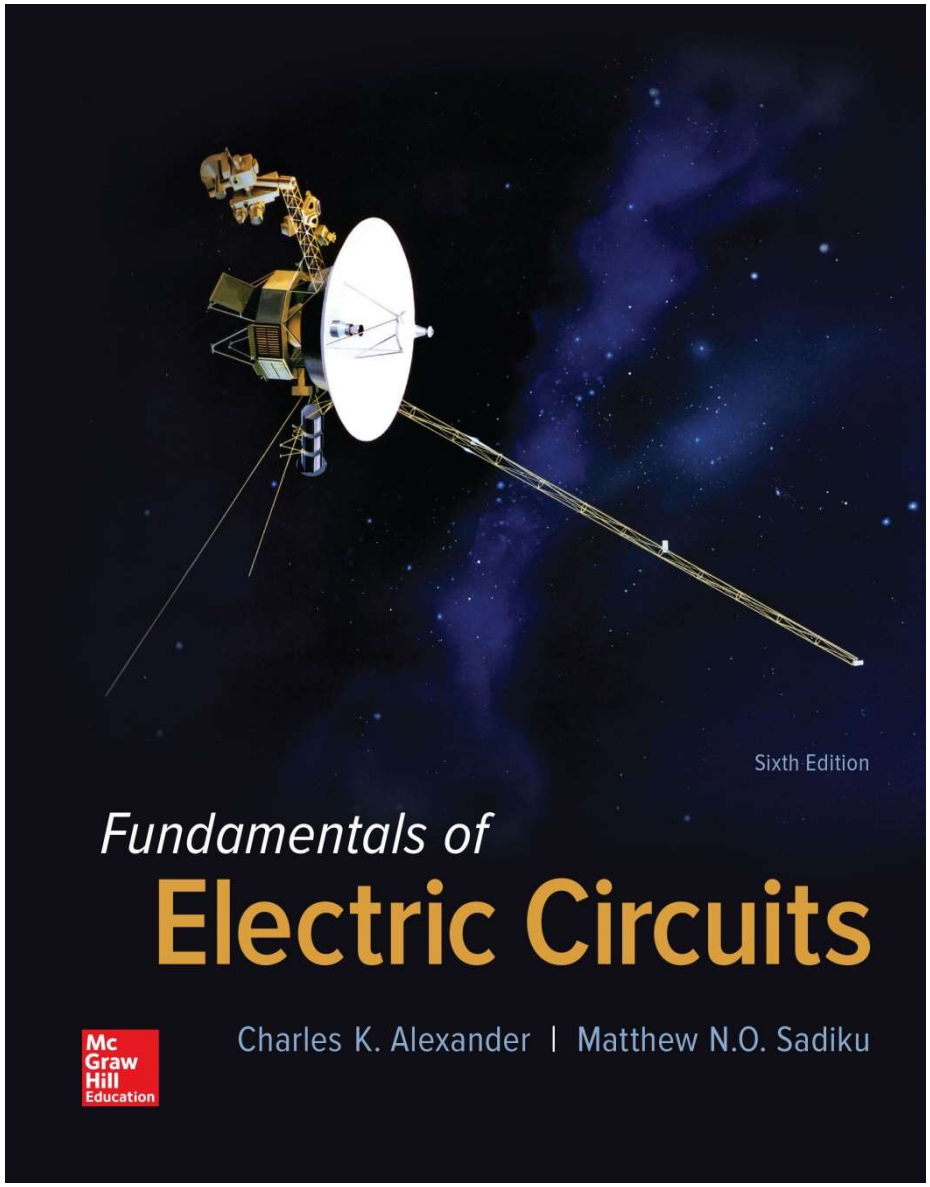
Fundamentals of Electric Circuits
Chapter 4



Overview

- In this chapter, the concept of superposition will be introduced.
- Source transformation will also be covered.
- Thevenin and Norton's theorems will be covered.
- Examples of applications for these concepts will be presented.

Linearity

- **Linearity in a circuit means that as current is changed, the voltage changes proportionally.**
- **It also requires that the response of a circuit to a sum of sources will be the sum of the individual responses from each source separately.**
- **A resistor satisfies both of these criteria.**

Superposition

- If there are two or more independent sources there are two ways to solve for the circuit parameters:
  - Nodal or mesh analysis
  - Use superposition
- The superposition principle states that the voltage across (or current through) an element in a linear circuit is the algebraic sum of the voltages across (or currents through) that element due to each independent source acting alone.

Applying superposition

- Using superposition means applying one independent source at a time
- Dependent sources are left alone
- The steps are:

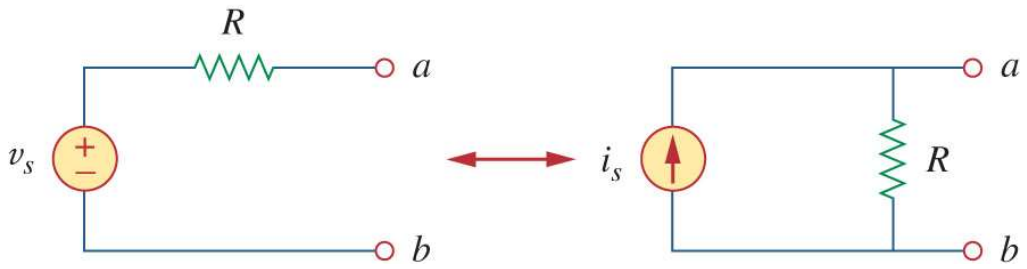
1. Turn off all independent sources except one source. Find the output (voltage or current) due to that active source using the techniques covered in Chapters 2 and 3.
2. Repeat step 1 for each of the other independent sources.
3. Find the total contribution by adding algebraically all the contributions due to the independent sources.

Source transformation

- It is possible to transform a source from one form to another.
- This can be useful for simplifying circuits.
- The principle behind all of these transformations is equivalence.

Source transformation II

- A source transformation 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.



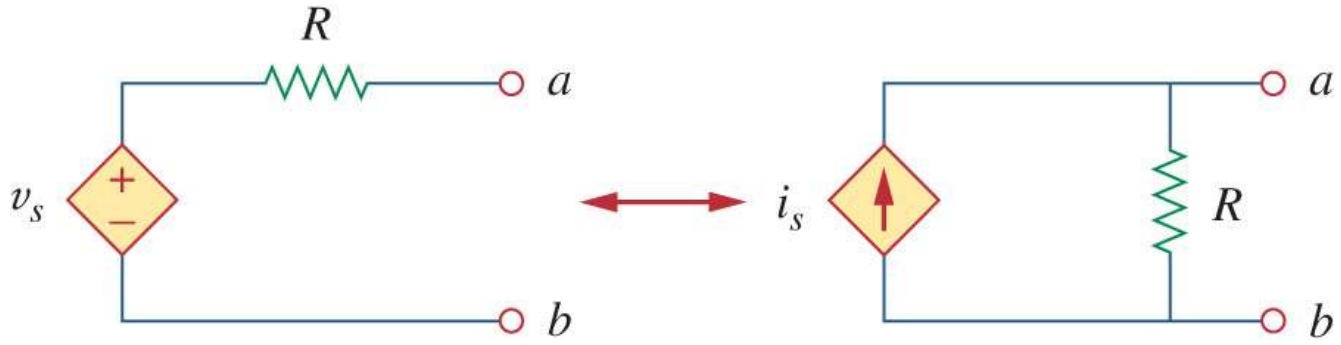
Terminal equivalency

- These transformations work because the two sources have equivalent behavior at their terminals.
- If the sources are turned off, the resistance at the terminals are both R.
- If the terminals are short circuited, the currents need to be the same.
- From this we get the following requirement:

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

Dependent sources

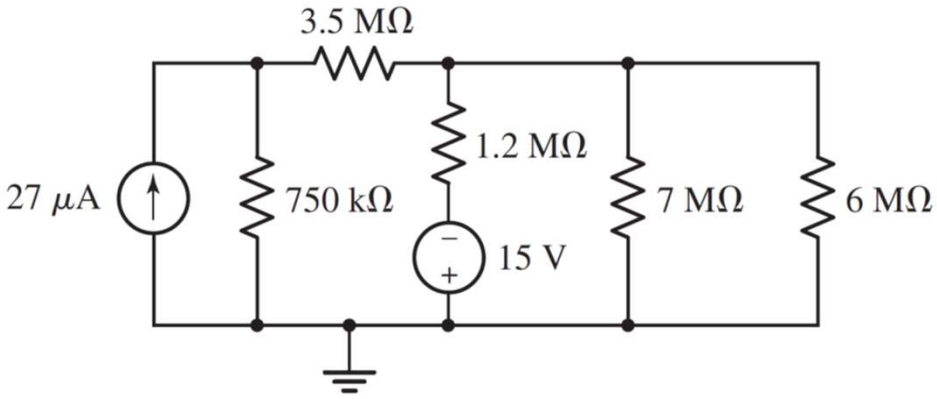
- Source transformation also applies to dependent sources.
- But, the dependent variable must be handled carefully.
- The same relationship between the voltage and current holds here:

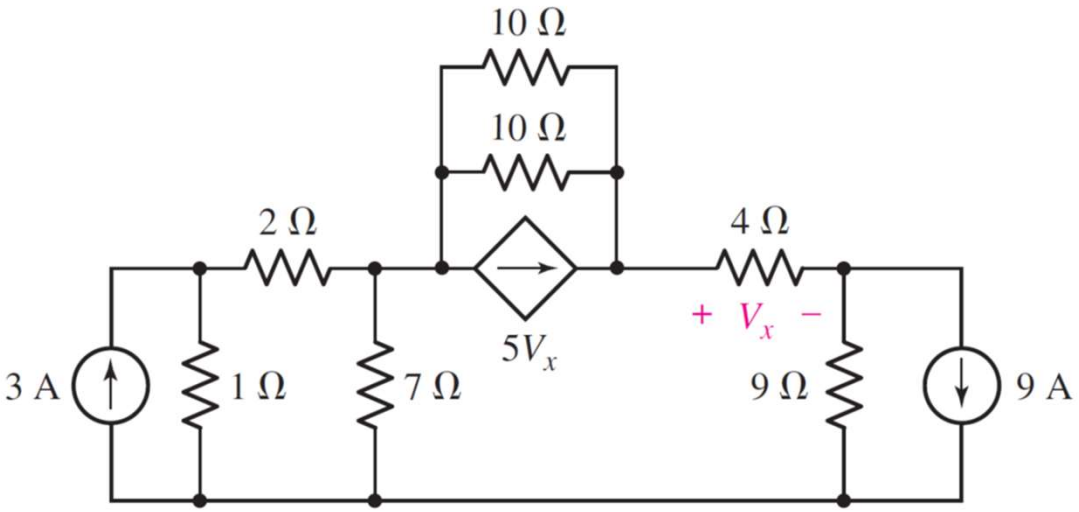


Source transformation rules

- Note that the arrow of the current source is directed towards the positive terminal of the voltage source.
- Source transformation is not possible when R=0 for an ideal voltage source.
- For a realistic source, $R \neq 0$.
- For an ideal current source, $R = \infty$ also prevents the use of source transformation.

(*a*) Using repeated source transformations, reduce the circuit of Fig. 5.62 to a voltage source in series with a resistor, both of which are in series with the 6 MΩ resistor. (*b*) Calculate the power dissipated by the 6 MΩ resistor using your simplified circuit.




10 Ω
10 Ω
2 Ω
4 Ω
+ V_x −
$5V_x$
3 A
1 Ω
7 Ω
9 Ω
9 A