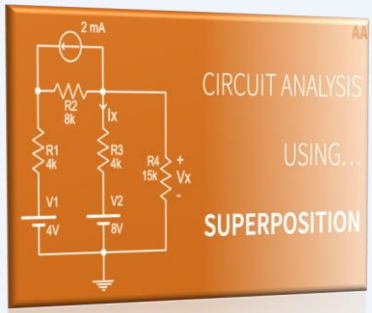
Physics Academy
www.physicsacademy.org

Electric Circuits



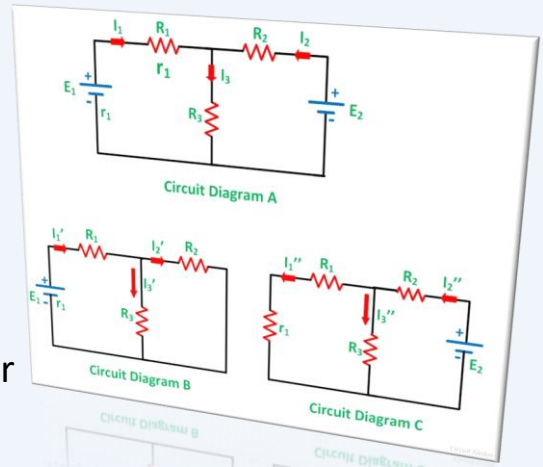
Unit: 4 | Lecture: 18

Circuit Theorems: Superposition

Dr. Hazem Falah Sakeek
Al-Azhar University of Gaza

1

Circuit Theorems



2

4.3 Superposition (1)

- The idea of superposition depends on the linearity property.
- The principle of superposition helps us to analyze a linear circuit with more than one independent source by calculating the contribution of each independent source separately.

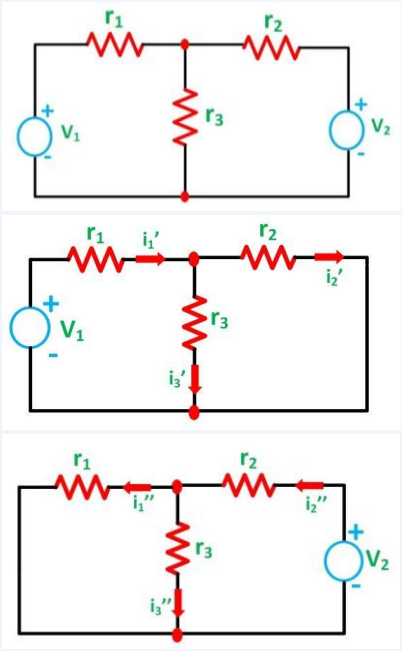
The superposition principle states that the voltage across (or current through) an element in a linear circuit is the algebraic sum of the voltages across (or currents through) that element due to each independent source acting alone.

3

4.3 Superposition (2)

Steps to Apply Superposition Principle:

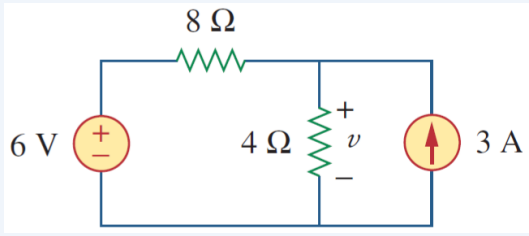
1. Turn off all independent sources except one source.
2. Find the output (voltage or current) due to that active source using the techniques covered in Chapters 2 and 3.
3. Repeat step 1 for each of the other independent sources.
4. Find the total contribution by adding algebraically all the contributions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



4

Example 4.3 (1)

Use the superposition theorem to find v



Solution:

We have two sources, so

$$v = v_1 + v_2$$

v_1 is the contribution due to the 6 V source

v_2 is the contribution due to the 3 A source.

To find v_1 we set the current source to 0

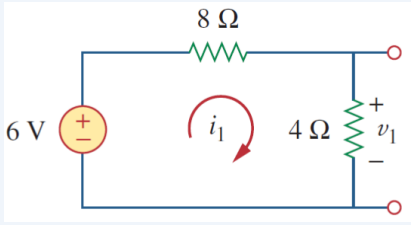
Applying KVL to the loop

$$12i_1 - 6 = 0$$

$$\therefore i_1 = 0.5A$$

Therefore,

$$v_1 = 4i_1 = 2\ V$$



Example 4.3 (2)

To find v_2 we set the voltage source to 0

Using current division

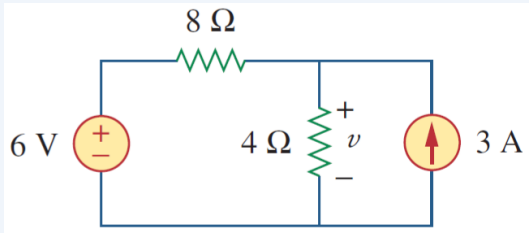
$$i_3 = \frac{8}{4+8}(3) = 2\ A$$

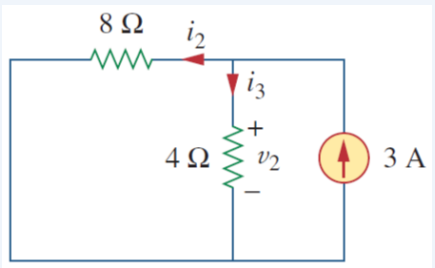
Therefore,

$$v_2 = 4i_3 = 8\ V$$

$$v = v_1 + v_2$$

$$\boldsymbol{v = 2 + 8 = 10\ V}$$





Example 4.4 (1) Use the superposition theorem to find i_0

Solution:

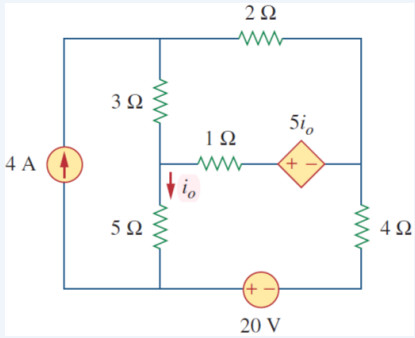
We have current source and voltage source, also we have dependent voltage source.

Let

$$i_o = i_{01} + i_{02} \quad (1)$$

i_{01} is the current due to the 4 A source.

i_{02} is the current due to the 20 V source.



Example 4.4 (2)

To obtain i_{01}, we apply mesh analysis

Loop 1

$$i_1 = 4\ A \quad (2)$$

Loop 2

$$-3i_1 + 6i_2 - 5i_{01} - 1i_3 = 0 \quad (3)$$

Loop 3

$$-5i_1 - 1i_2 + 5i_{01} + 10i_3 = 0 \quad (4)$$

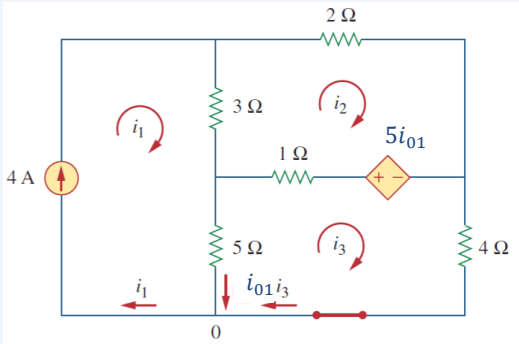
At node 0

$$i_3 + i_{01} = i_1$$

therefore,

$$i_3 = 4 - i_{01} \quad (5)$$

Substituting Eqs. (2) &(5) into Eqs. (3) &(4)



$$3i_2 - 2i_{01} = 8 \quad (6)$$

$$i_2 + 5i_{01} = 20 \quad (7)$$

$$\therefore i_{01} = \frac{52}{17}\ A \quad (8)$$

Example 4.4 (3)

To obtain i_{02}, we apply mesh analysis

Loop 4

$$6i_4 - i_5 - 5i_{02} = 0 \quad (9)$$

Loop 5

$$-i_4 + 10i_5 + 5i_{02} - 20 = 0 \quad (10)$$

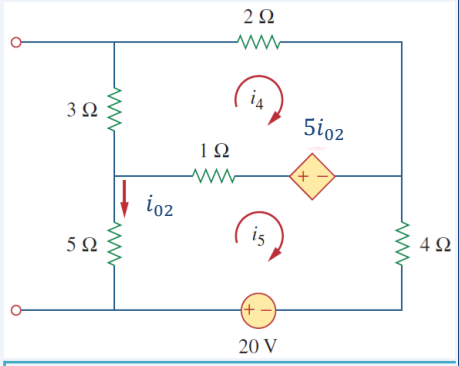
Note that $i_5 = -i_{02}$

Therefore eqs. (9) & (10) become

$$6i_4 - 4i_{02} = 0 \quad (11)$$

$$i_4 + 5i_{02} = -20 \quad (12)$$

$$\therefore i_{02} = -\frac{120}{34} = -\frac{60}{17}\ A \quad (13)$$



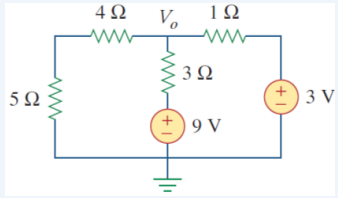
$$i_o = i_{01} + i_{02} \quad (1)$$

$$i_o = \frac{52}{17} - \frac{60}{17} = -\frac{8}{17}$$

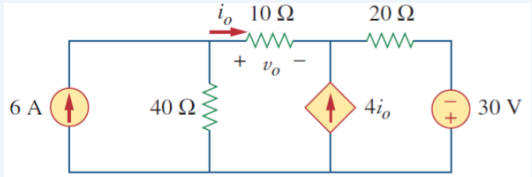
$$i_o = -0.47\ A$$

Problems to Solve by yourself

(1) Using superposition, find V_o in the circuit



(2) Use the superposition principle to find i_o and v_o in the circuit



(4) Use superposition to find v_o.