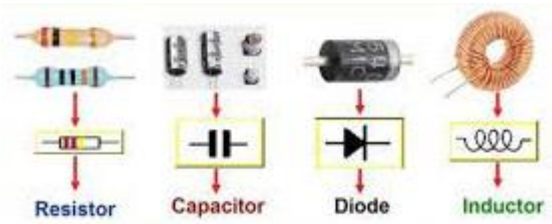
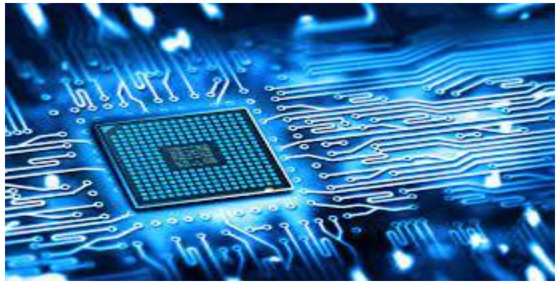


Electronics 1

BSC 113

Summer 2021-2022

Lecture 4



Nodal Analysis Method

Instructor

Dr / Ayman Soliman

➢ Contents

❑ 1. Nodal analysis

- Nodal analysis provides a general procedure for analyzing circuits using node voltages as the circuit variables.
- Choosing node voltages instead of element voltages as circuit variables is convenient and reduces the number of equations one must solve simultaneously. To simplify matters, we shall assume in this section that circuits do not contain voltage sources.
- Circuits that contain voltage sources will be analyzed in the next section. In nodal analysis, we are interested in finding the node voltages.

❑ 1. Nodal analysis

➢ Given a circuit with n nodes without voltage sources, the nodal analysis of the circuit involves taking the following three steps.

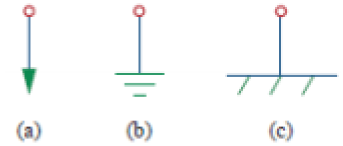


Fig. 6: Symbols of references node.

➢ Select a node as the reference node as shown in figure 6. Assign voltages $v1$, $v2$, … , vn to the remaining (n-1) nodes. The voltages are referenced with respect to the reference node.

➢ Apply KCL to each of the (n-1) non-reference nodes. Use Ohm's law to express the branch currents in terms of node voltages.

➢ Solve the resulting simultaneous equations to obtain the unknown node voltages.

❑ 1. Nodal analysis

- As shown in figure 7, Current flows from a higher potential to a lower potential in a resistor.

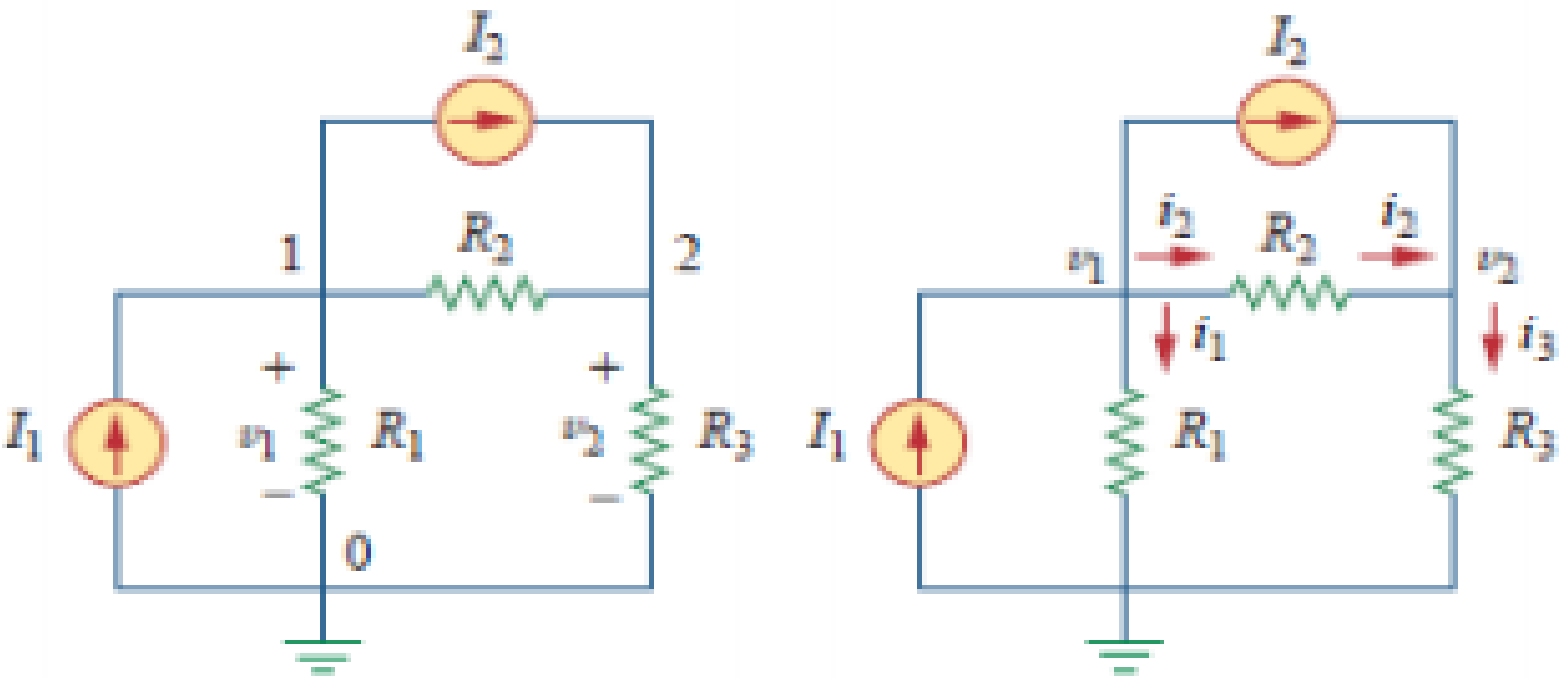


Fig. 7: Typical circuit for nodal analysis.

❑ 1. Nodal analysis

- As shown in figure 7, Current flows from a higher potential to a lower potential in a resistor.

$$i = \frac{v_{higher} - v_{lower}}{R}$$

$$i_1 = \frac{v_1 - 0}{R_1} = G_1 v_1$$

$$i_2 = \frac{v_1 - v_2}{R_2} = G_2(v_1 - v_2)$$

$$i_3 = \frac{v_2 - 0}{R_3} = G_3 v_2$$

node 1:

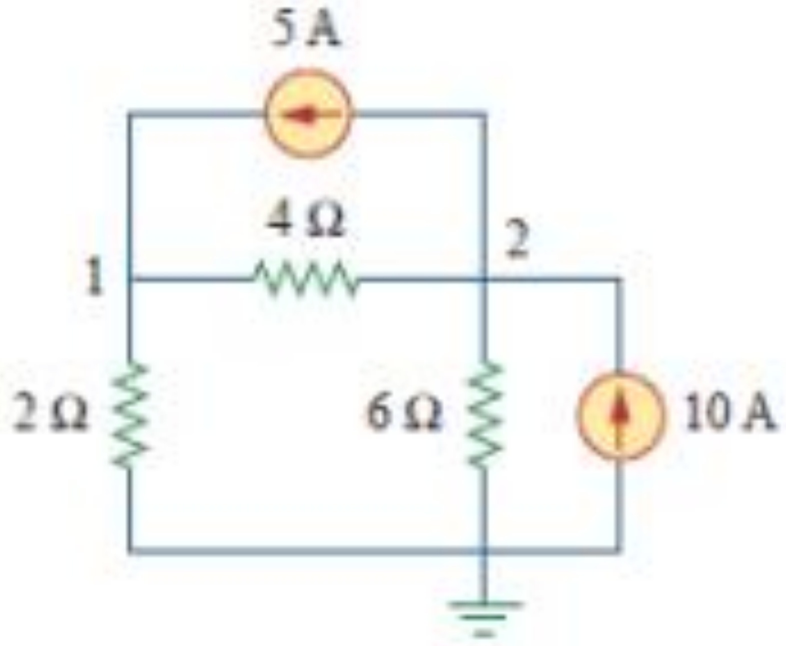
$$I_1 = I_2 + \frac{v_1}{R_1} + \frac{v_1 - v_2}{R_2}$$

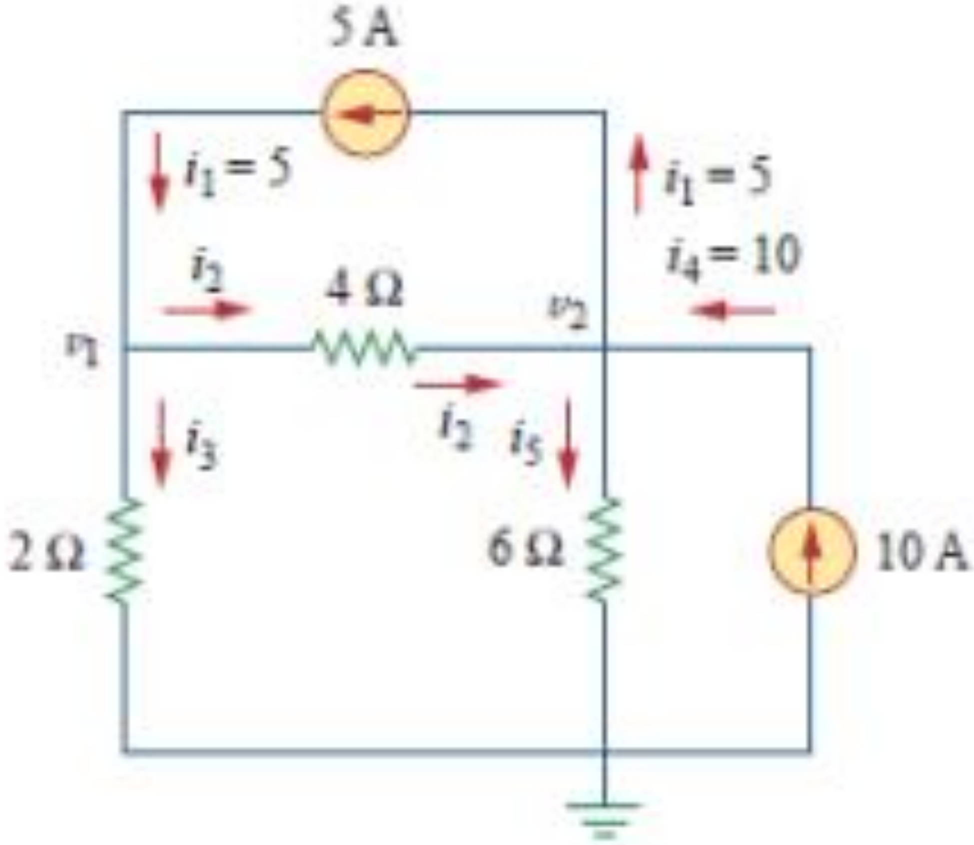
node 2:

$$\frac{v_2}{R_3} = I_2 + \frac{v_1 - v_2}{R_2}$$

❑ Example 1:

- Find $v1$and $v2$ using nodal analysis





❑ Example 1:

Answer: At node 1, applying KCL and Ohm's law gives

node 1:

$$i_1 = i_2 + i_3$$

$$5 = \frac{v_1 - v_2}{4} + \frac{v_1 - 0}{2} \quad (1)$$

node 2:

$$i_2 + i_4 = i_1 + i_5$$

$$\frac{v_1 - v_2}{4} + 10 = 5 + \frac{v_2 - 0}{6} \quad (2)$$

from (1) and (2) $v_1 = 13.33V$ *and* $v_2 = 20V$.

❑ super-node

- ➢ Nodal analysis with voltage source is called super-node (A super-node is formed by enclosing a (dependent or independent) voltage source connected between two non-reference nodes and any elements connected in parallel with it.) and considers as special case.

❑ CASE 1

- If a voltage source is connected between the reference node and a non-reference node, we simply set the voltage at the non-reference node equal to the voltage of the voltage source. In figure 8., for example,

$$v1 = 10V$$

- Thus, our analysis is somewhat simplified by this knowledge of the voltage at this node.

❑ CASE 2

- If the voltage source (dependent or independent) is connected between two non-reference nodes, the two nonreference nodes form a generalized node or super-node; we apply both KCL and KVL to determine the node voltages.

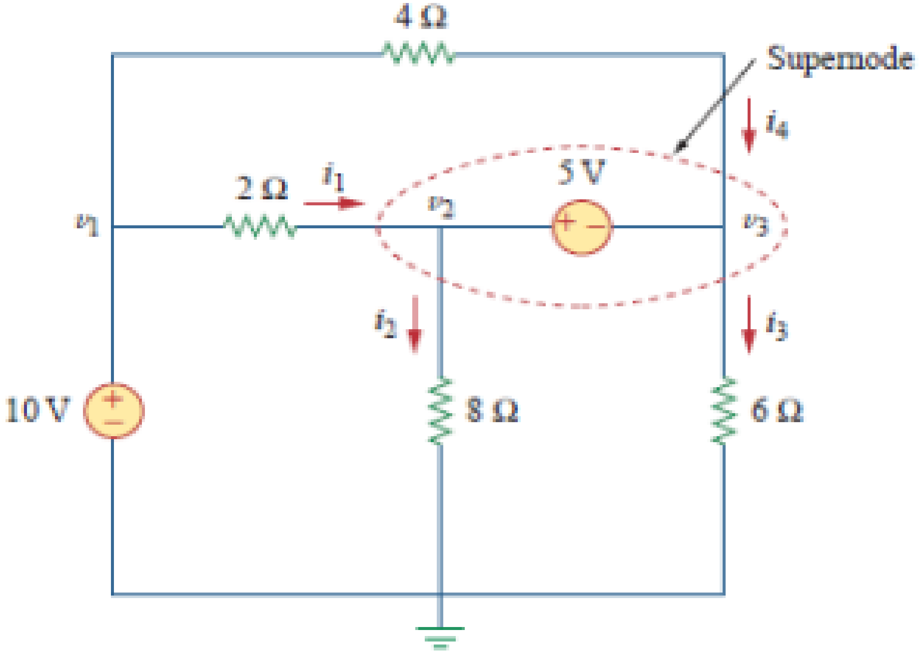


Fig. 8: Nodal analysis with voltage source

❑ CASE 2

- We can solve the following three equation to find all three voltages.

$$i_1 + i_4 = i_2 + i_3$$

$$\frac{v_1 - v_2}{2} + \frac{v_1 - v_3}{4} = \frac{v_2 - 0}{8} + \frac{v_3 - 0}{6} \quad (1)$$

$$v_2 - v_3 = 5 \ (2) \qquad v_1 = 10 \ (3)$$


Thank you