NODAL ANALYSIS

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Nodal Analysis

In electric circuits analysis, **nodal analysis**, **node-voltage analysis**, or the **branch current method** is a method of determining the voltage (potential difference) between "nodes" (points where elements or branches connect) in an electrical circuit in terms of the branch currents.

Nodal analysis is possible when all the circuit elements branch constitutive relations have an admittance representation.

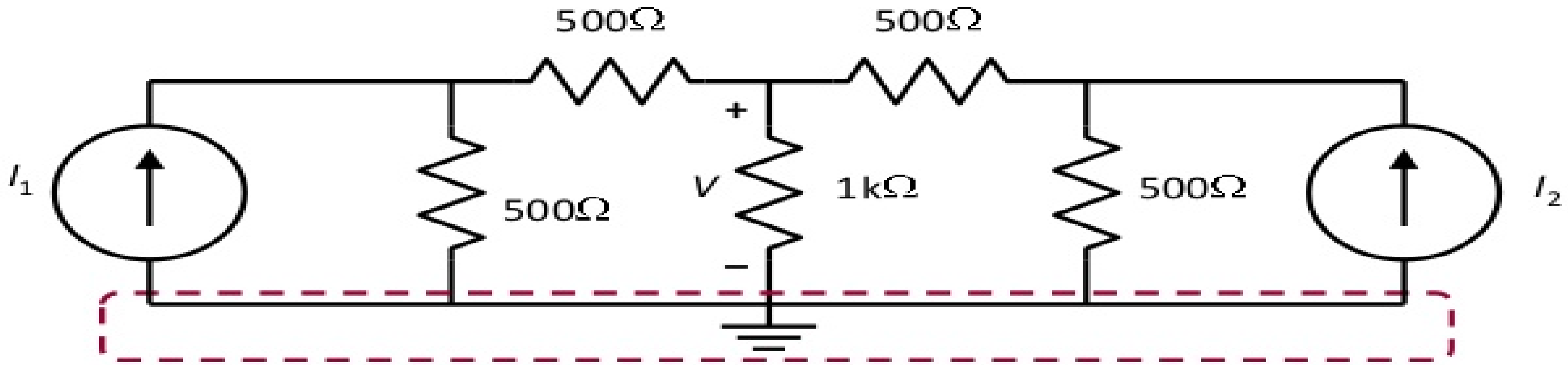
Kirchhoff's current law is used to develop the method referred to as **nodal analysis**

STEPS FOR NODAL ANALYSIS:-

- Note all connected wire segments in the circuit. These are the *nodes* of nodal analysis.
- Select one node as the ground reference. The choice does not affect the result and is just a matter of convention. Choosing the node with most connections can simplify the analysis.
- Assign a variable for each node whose voltage is unknown. If the voltage is already known, it is not necessary to assign a variable.
- For each unknown voltage, form an equation based on Kirchhoff's current law. Basically, add together all currents leaving from the node and mark the sum equal to zero.

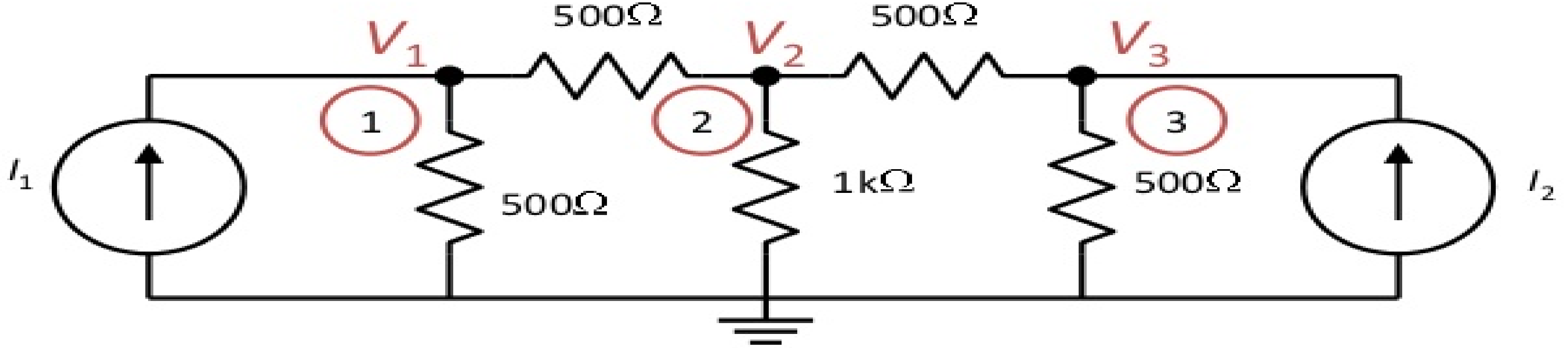
- If there are voltage sources between two unknown voltages, join the two nodes as a super node. The currents of the two nodes are combined in a single equation, and a new equation for the voltages is formed.
- Solve the system of simultaneous equations for each unknown voltage.

1. Reference Node



The reference node is called the *ground* node where $V = 0$

Example

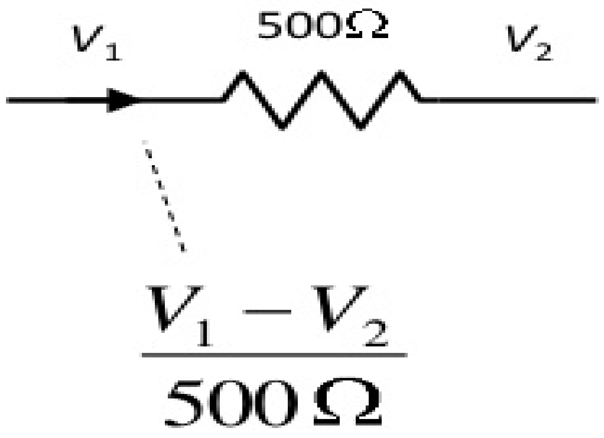


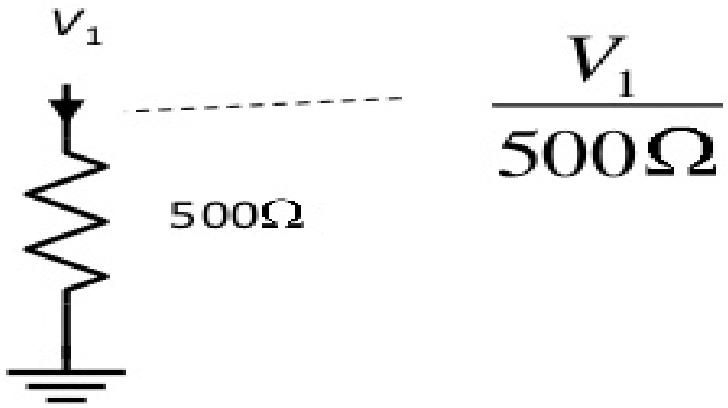
V_1, V_2, and V_3 are unknowns for which we solve using KCL

Steps of Nodal Analysis

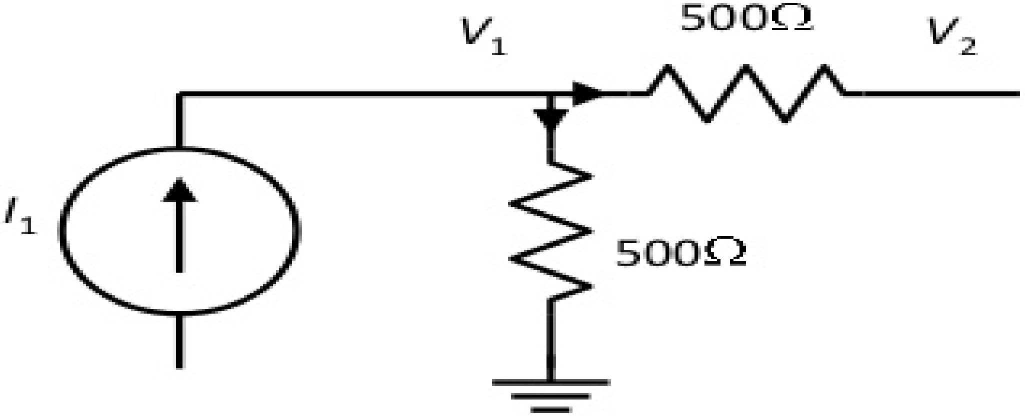
1. Choose a reference (ground) node.
2. Assign node voltages to the other nodes.
3. Apply KCL to each node other than the reference node; express currents in terms of node voltages.
4. Solve the resulting system of linear equations for the nodal voltages.

Currents and Node Voltages



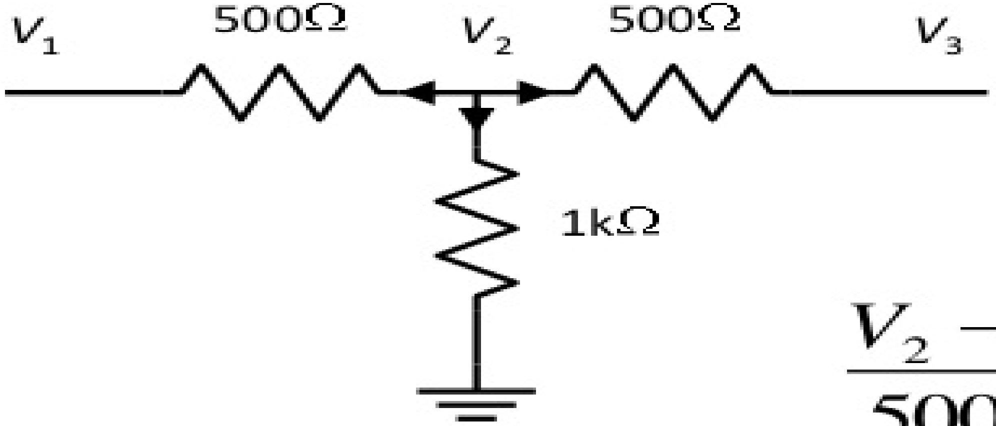


3. KCL at Node 1



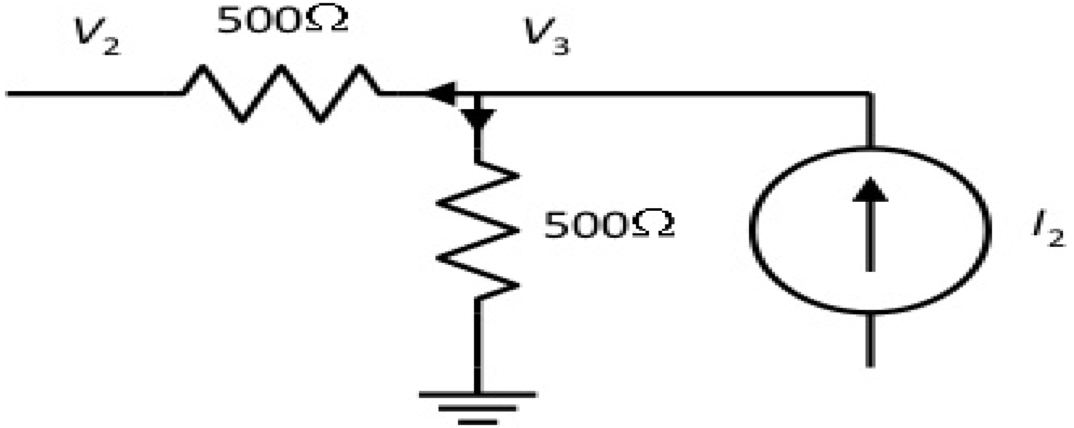
$$I_1 = \frac{V_1 - V_2}{500\Omega} + \frac{V_1}{500\Omega}$$

3. KCL at Node 2



$$\frac{V_2 - V_1}{500\,\Omega} + \frac{V_2}{1\mathrm{k}\Omega} + \frac{V_2 - V_3}{500\,\Omega} = 0$$

3. KCL at Node 3



$$\frac{V_3 - V_2}{500\Omega} + \frac{V_3}{500\Omega} = I_2$$