Summer 2022

CSE250 – Circuits and Electronics

Open circuit, Short circuit, Nodal analysis

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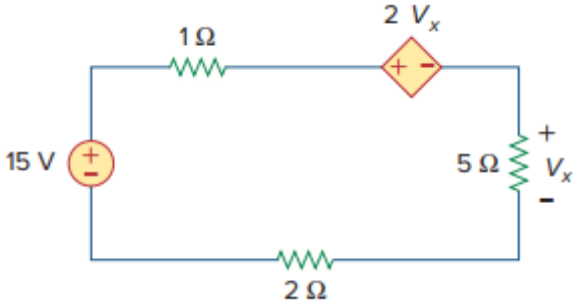
Ground

- Except for a few special cases, electrical and electronic systems are grounded for reference and safety purposes.

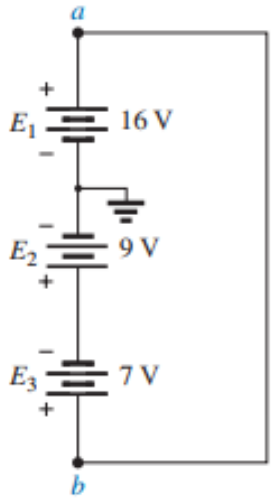
- *In general, the placement of the ground connection will not affect the magnitude or polarity of the voltage across an element but it may have a significant impact on the voltage from any point in the network to ground.*



Example 1

For the series network shown below, determine

i) The voltage V_a.
ii) The voltage V_b.
iii) The voltage V_{ab}

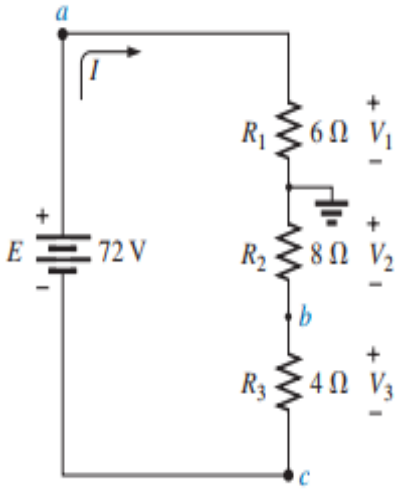


Ans: (i) $\mathbf{V_a = 16\ V}$
(ii) $\mathbf{V_b = 16\ V}$
(iii) $\mathbf{V_{ab} = 0\ V}$

Example 2

For the series network shown below, determine

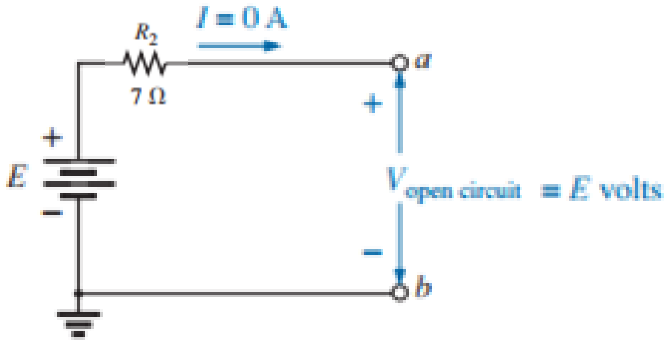
i) The voltage V_a.
ii) The voltages V_b *and* V_c.
iii) The voltage V_{ab}

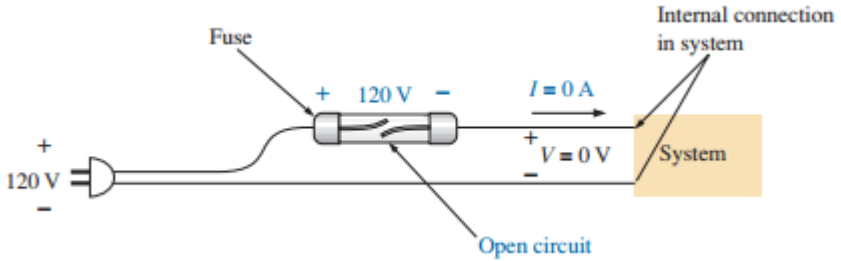


Ans: (i) $\mathbf{V_a = 24\ V}$
(ii) $\mathbf{V_b = -32\ V;\ V_c = -48\ V}$
(iii) $\mathbf{V_{ab} = 56\ V}$

Open circuit

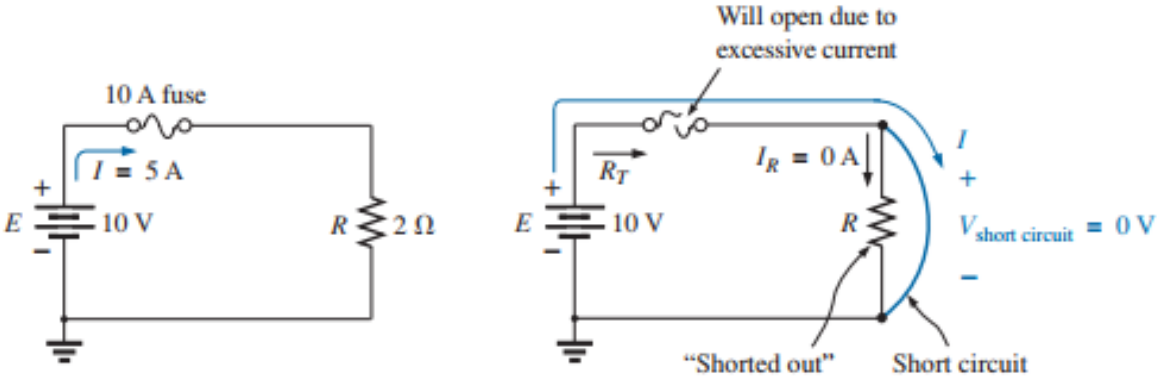
- An **open circuit** is two isolated terminals not connected by an element of any kind
- ***An open circuit can have a potential difference (voltage) across its terminals, but the current is always zero amperes***



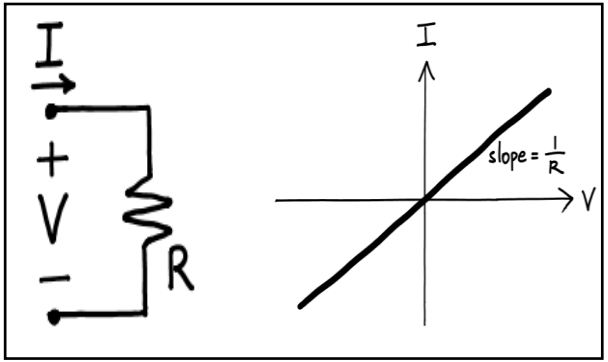


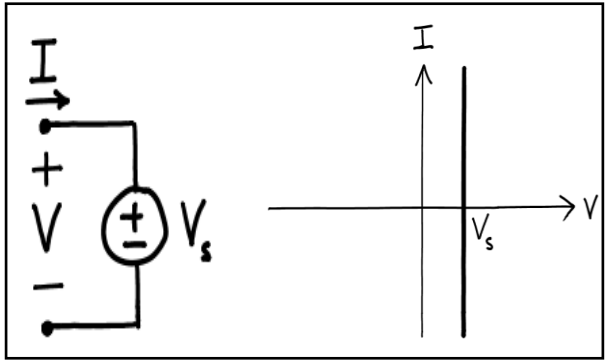
Short circuit

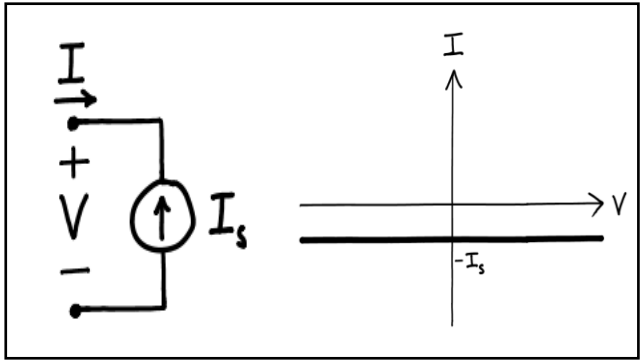
- A **short circuit** is a very low resistance, direct connection between two terminals of a network
- ***A short circuit can carry a current of a level determined by the external circuit, but the potential difference (voltage) across its terminals is always zero volts.***

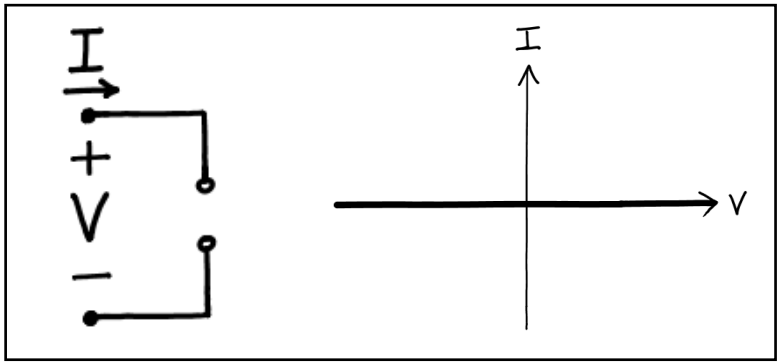


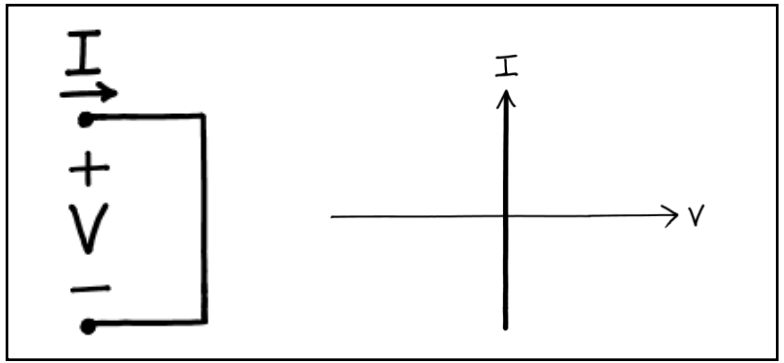
I–V characteristics











Circuit laws, method of analysis, & theorems

Laws

- Ohm's Law
- Kirchhoff's current law
- Kirchhoff's voltage law

Method of analysis

- Nodal analysis
- Mesh analysis

Theorems

- Superposition theorem
- Source transformation
- Thevenin's theorem
- Norton's theorem
- Maximum power transfer theorem

Nodal analysis

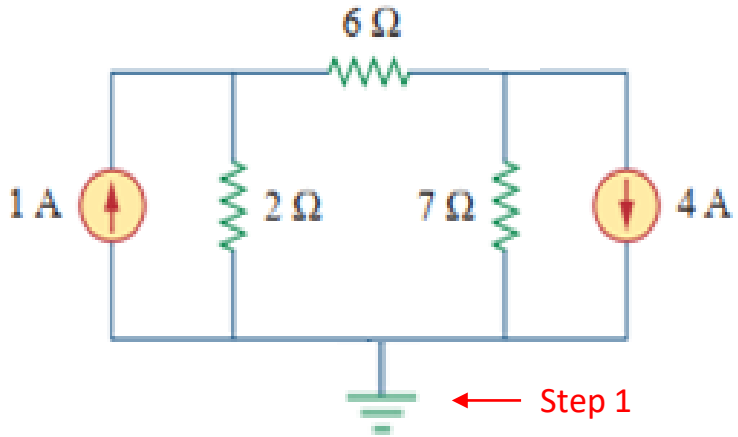
- Nodal analysis provides a general procedure for analyzing circuits using node voltages as the circuit variables

Steps to Determine Node Voltages:

1. Select a node as the reference node. Assign voltages v_1, $v_2, \ldots, v_{n-1}$ to the remaining $n - 1$ nodes. The voltages are referenced with respect to the reference node.
2. Apply KCL to each of the $n - 1$ nonreference nodes. Use Ohm's law to express the branch currents in terms of node voltages.
3. Solve the resulting simultaneous equations to obtain the unknown node voltages.

Example 3

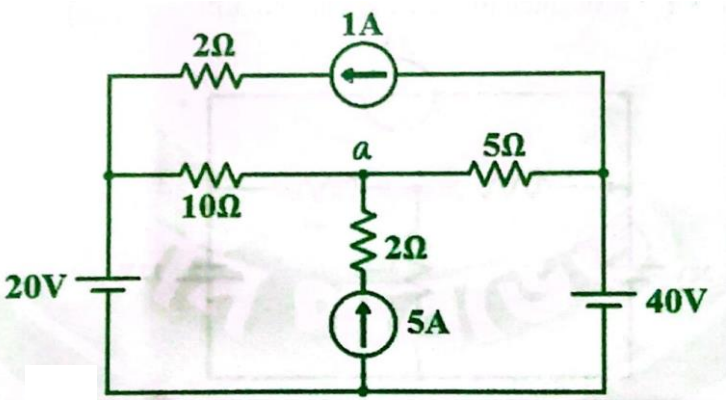
- Find all the node voltages



Ans: **- 2 V; - 14 V; 0 V**

Example 4

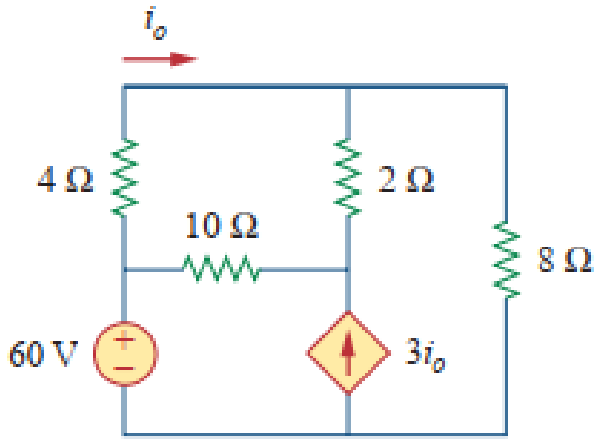
- Find V_a using nodal analysis



Ans: $V_a = 50$ V

Example 5

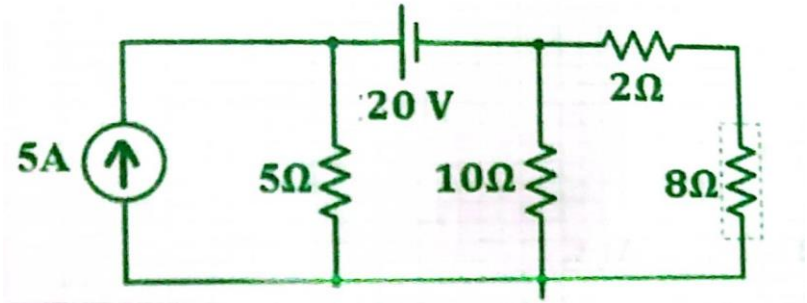
- Find $\mathbf{i_0}$ using nodal analysis



Ans: $\mathbf{i_0 = 1.73\ A}$

Example 6

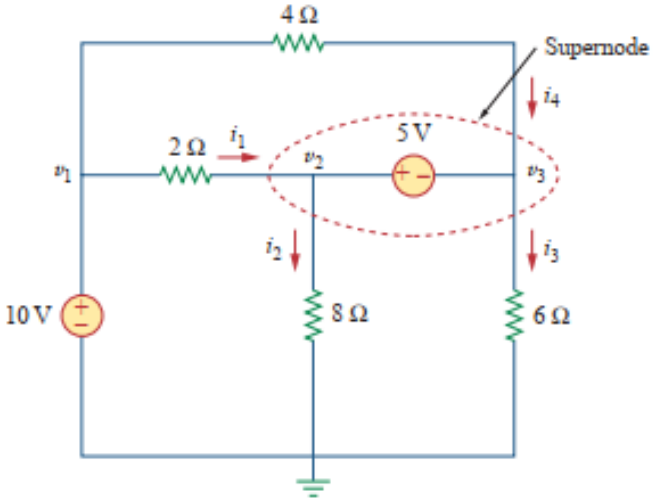
- Find voltages across the current source and across the 8 Ω resistor using nodal analysis



Ans: **22.5 V; 2 V**

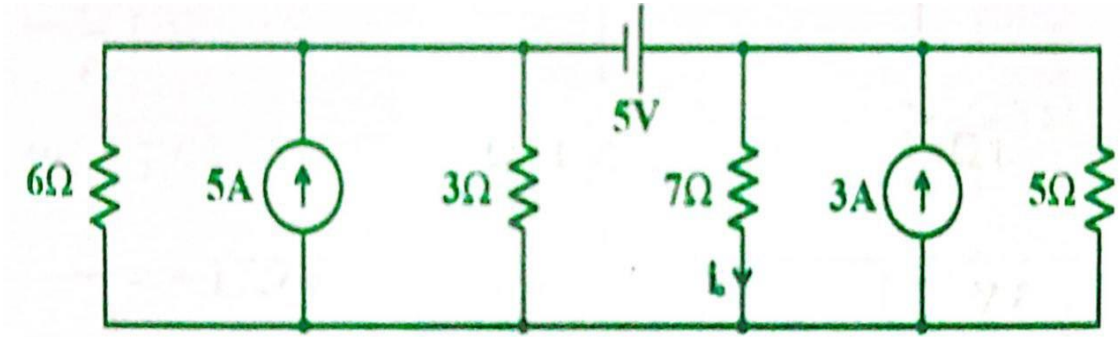
Supernode

- A supernode is formed by enclosing a (dependent or independent) voltage source connected between two nonreference nodes and any elements connected in parallel with it.



Example 7

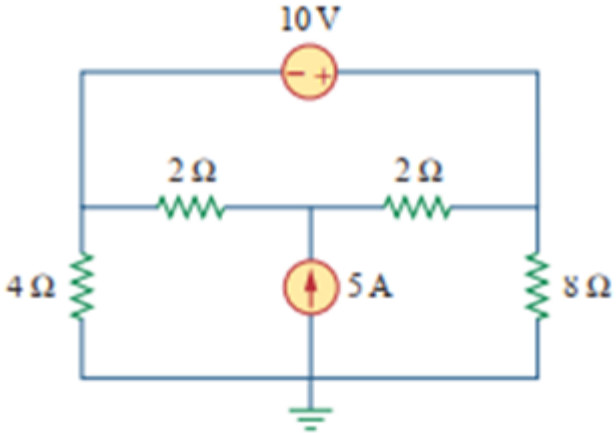
- Find $\mathbf{i_0}$ using nodal analysis



Ans: $\mathbf{i_0 = 1.78\ A}$

Example 8

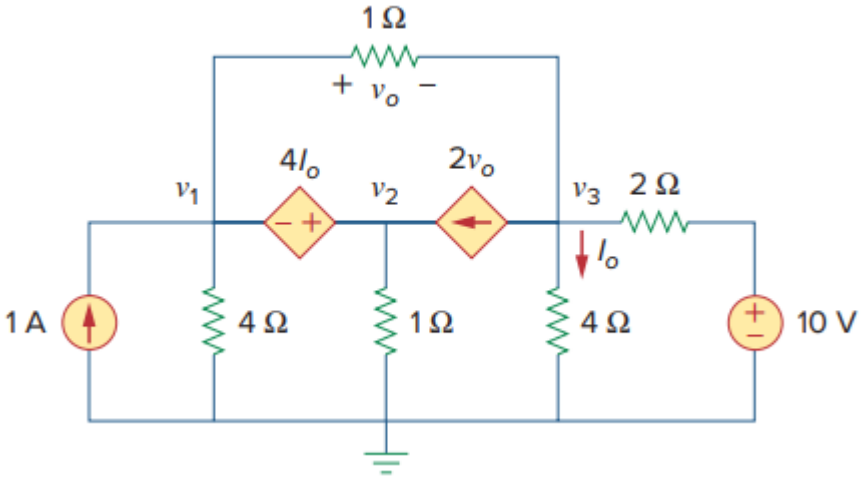
- Determine the node voltages using nodal analysis



Ans: **10 V; 20 V; 20 V; 0 V**

Example 9

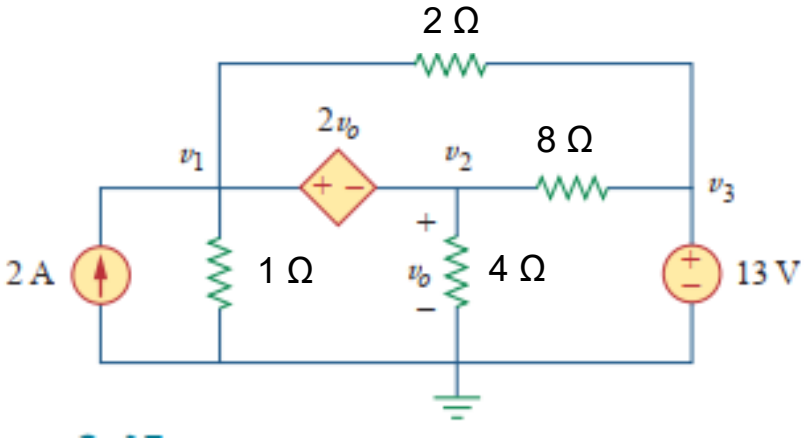
- Find v_1, v_2, v_3



Ans: **v_1 = 2.61 V; v_2 = 2.78 V; v_3 = 0.17 V**

Example 10

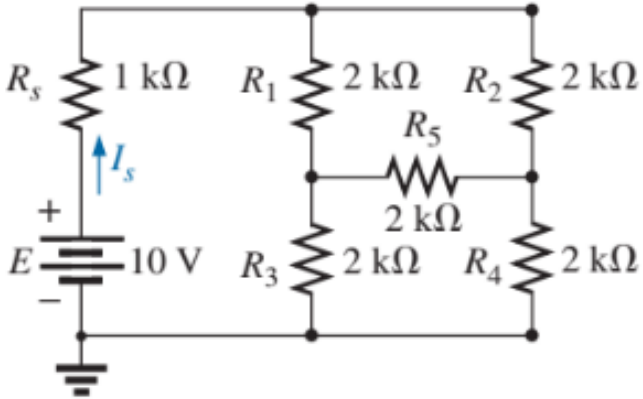
- Determine voltages through in the circuit using nodal analysis.



Ans: $\mathbf{v_1 = 6.23\ V;\ v_2 = 2.08\ V;\ v_3 = 13\ V}$

Example 11

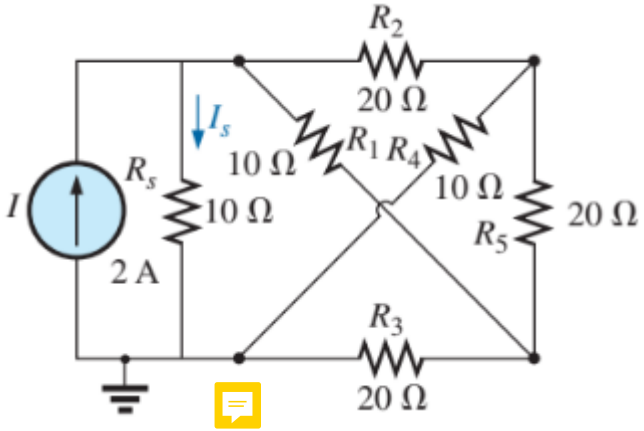
- Determine the current through the source resistor $\boldsymbol{R_s}$ using nodal analysis



Ans: $\mathbf{i_s = 3.33\ mA}$

Example 12

- Determine the current through the source resistor $\boldsymbol{R_s}$ using nodal analysis



Ans: $\mathbf{i_s = 1.18\ A}$

Thank you for your attention