Outline

- Basic Laws
  - Ohm's Law
  - Kirchhoff's Laws -- KCL,KVL
- Circuit Analysis
  - Nodal Analysis
  - Mesh Analysis

Circuit Analysis

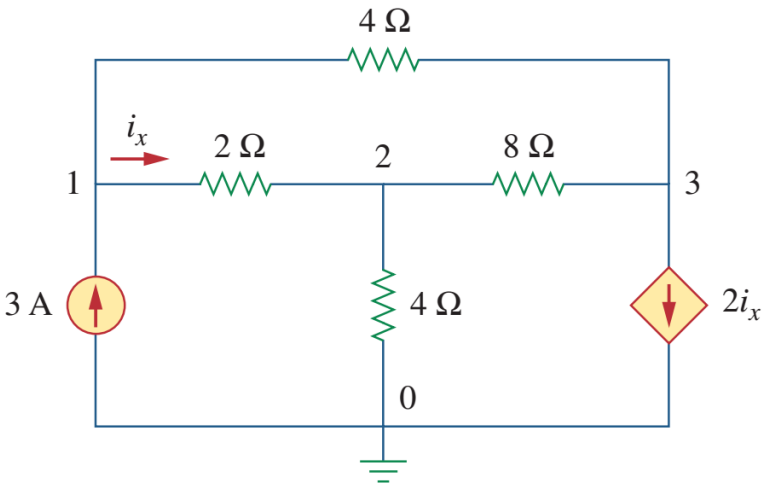
- Two techniques will be presented in this part:
  - Nodal analysis, which is based on **KCL**
  - Mesh analysis, which is based on **KVL**

Nodal Analysis – Three Steps

- Given a circuit with ***n*** nodes, the nodal analysis is accomplished via three steps:
  1. Select a node as the reference (i.e., ground) node. Assign the node voltages to the remaining ***(n-1)*** nodes. Voltages are relative to the reference node.
  2. Apply KCL to the ***(n-1)*** nodes, expressing branch current in terms of the node voltages (using the *I-V* relationships of branch elements).
  3. Solve the resulting simultaneous equations to obtain the unknown node voltages.

[Source: Berkeley]

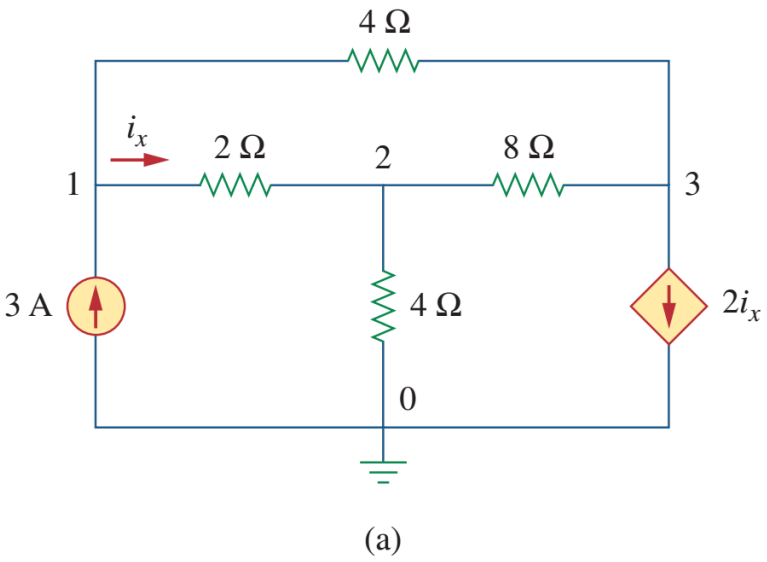
Nodal Analysis: Example #1



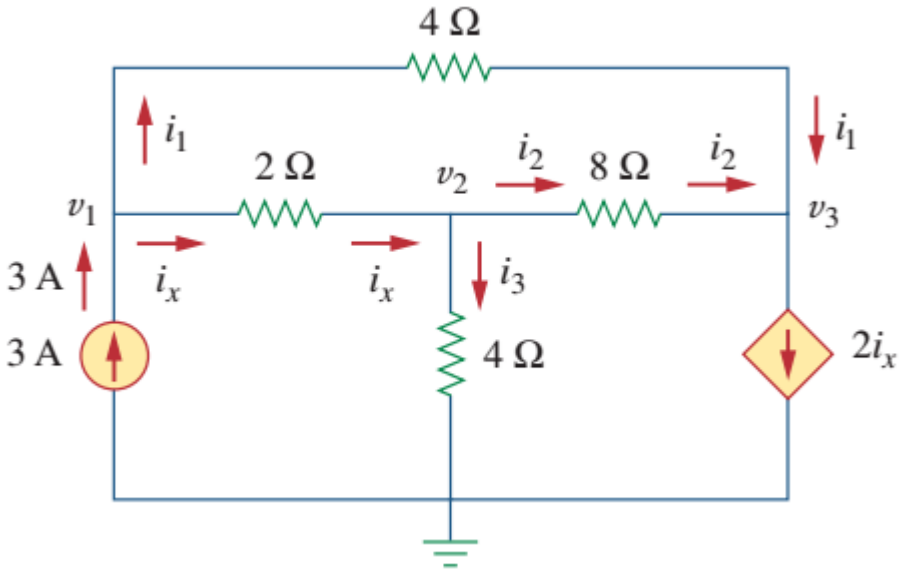
(a)

[Source: Berkeley]

Nodal Analysis: Example #1



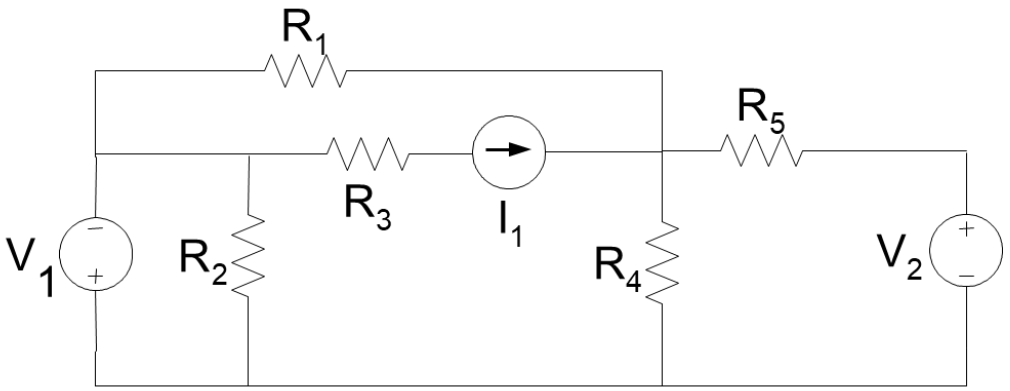
(a)



[Source: Berkeley]

Nodal Analysis with Voltage Sources

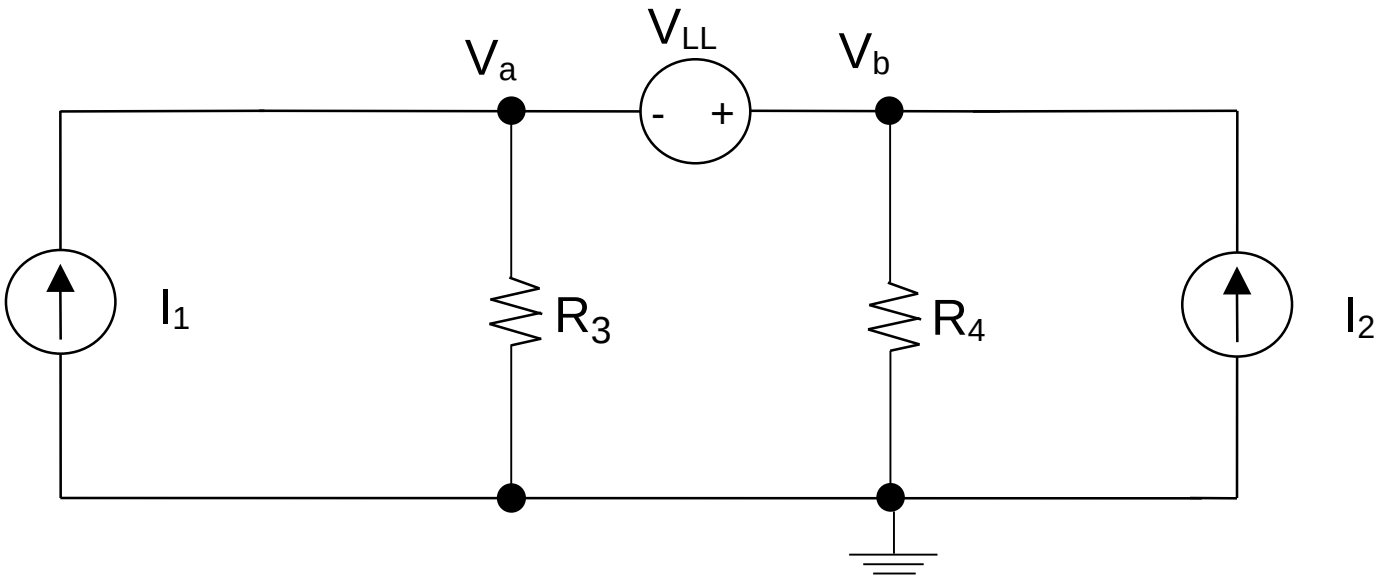
Case I:



Nodal Analysis: Supernode

Case II

A “floating” voltage source is one for which neither side is connected to the reference node, e.g. V_{LL} in the circuit below:

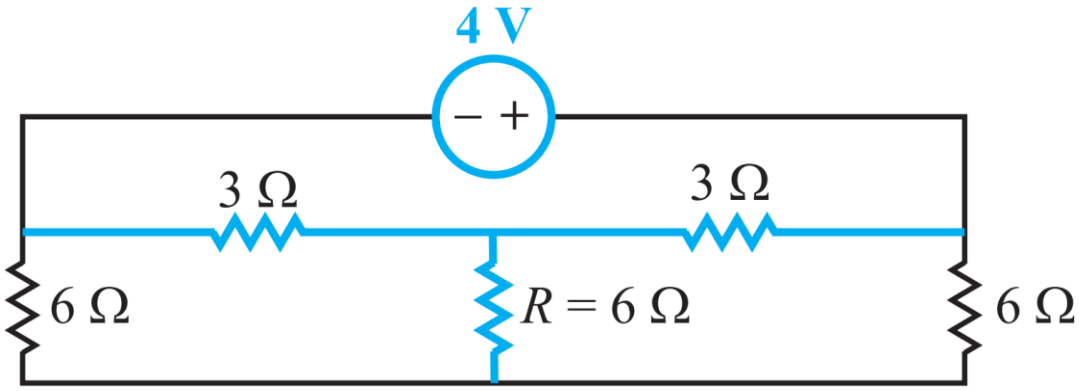


A supernode is formed by enclosing a (dependent or independent) voltage source connected between two nonreference nodes and any elements connected in parallel with it.

[Source: Berkeley]

Exercise

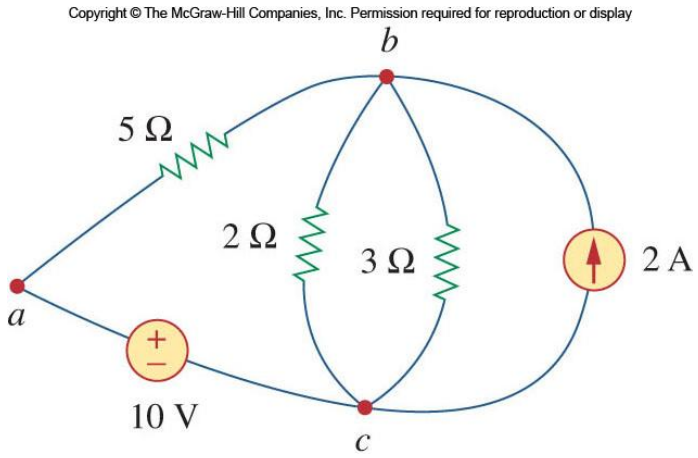
- Find the power supplied by the voltage source.



[Source: Berkeley]

Mesh Analysis--Loop, Independent Loop, Mesh

- A loop is a closed path.
- A loop is independent if it contains at least one branch which is not a part of any other independent loop.
- A mesh is a loop that does not contain any other loop within it.



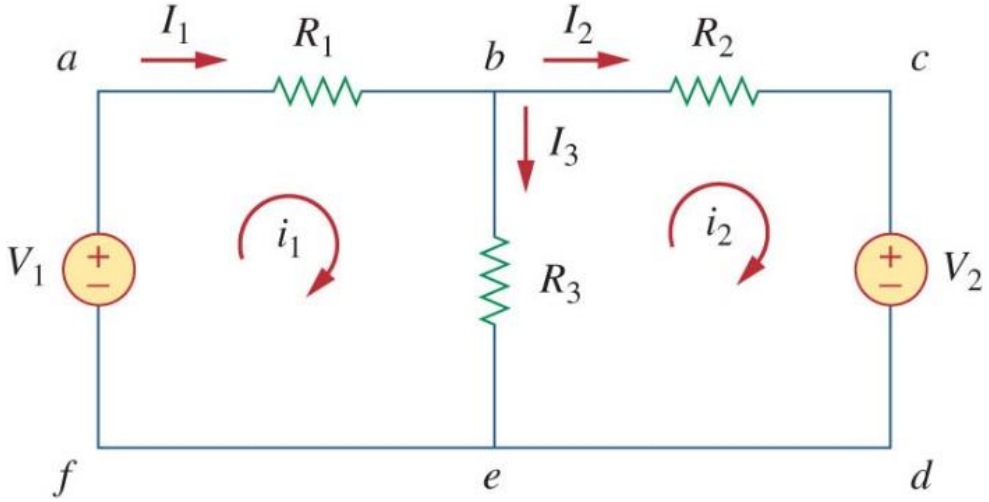
Mesh = Independent loop?

- b – number of branches
- n – number of nodes
- l_{ind} – number of ind. loops

$$l_{ind} = b - (n - 1)$$

Mesh Analysis

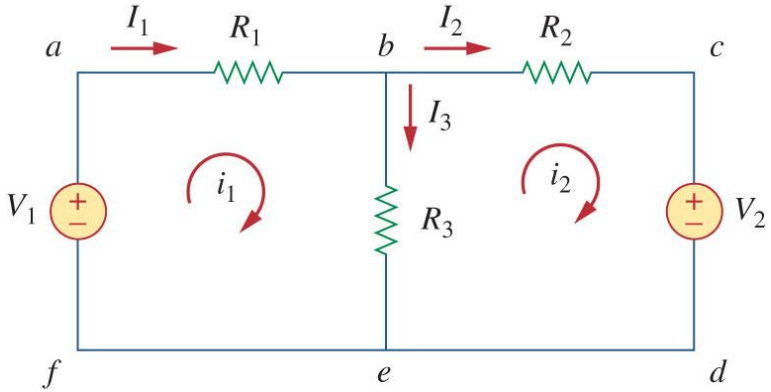
- Another general procedure for analyzing circuits is to use the mesh currents as the circuit variables.



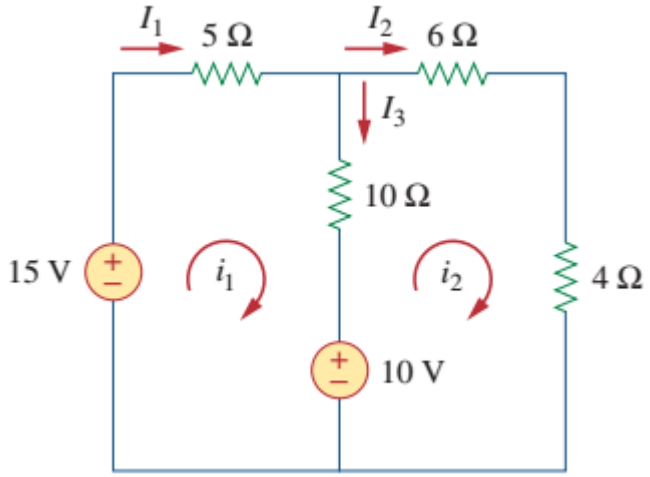
- Mesh analysis uses KVL to find unknown currents.

Mesh Analysis Steps

- Mesh analysis follows these steps:
  1. Assign mesh currents $i_1, i_2, \ldots i_x$ to the x meshes
  2. Apply KVL to each of the x mesh currents.
  3. Solve the resulting x simultaneous equations to get the mesh currents.

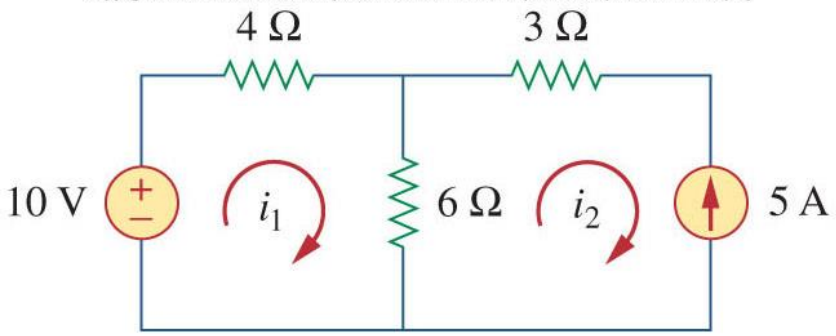


Example

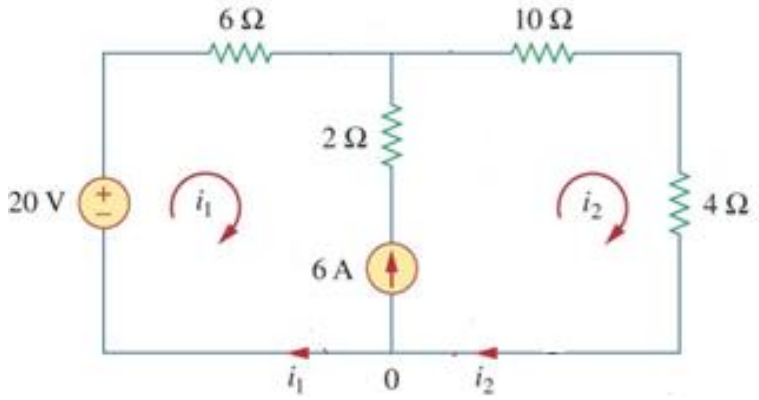


Mesh Analysis with Current Sources

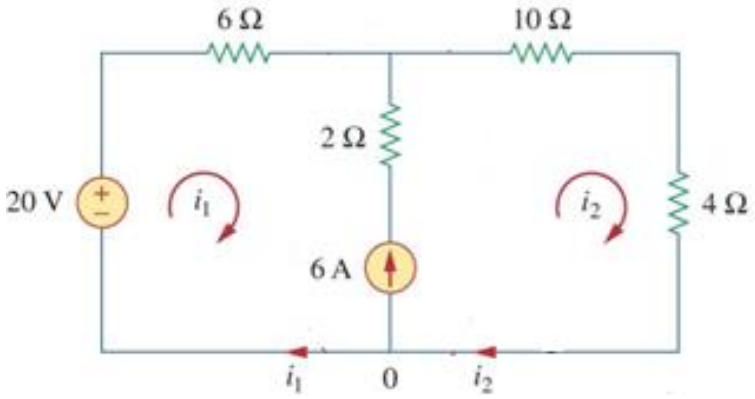
- The presence of a current source makes the mesh analysis simpler in that it reduces the number of equations.
  - If the current source is located on only one mesh, the current for that mesh is defined by the source. For example:

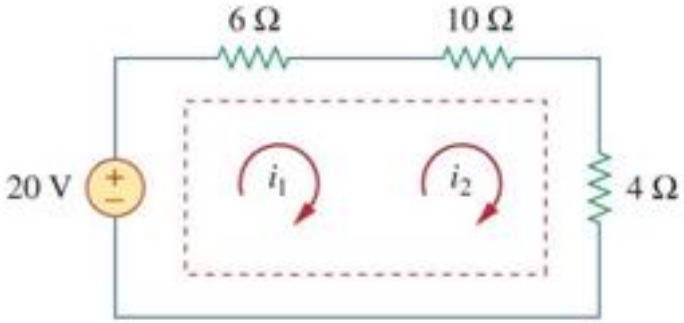


If the current source is located…



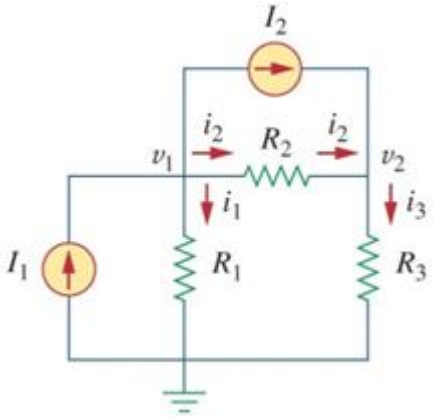
Supermesh





Summary

- Node Analysis
  - Node voltage is the unknown
  - Solve by KCL
  - Special case: Floating voltage source



- Mesh Analysis
  - Loop current is the unknown
  - Solve by KVL
  - Special case: Current source