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. <u>Select a node as the reference (i.e., ground) node</u>. Assign the node voltages to the remaining **(n-1)** nodes. Voltages are relative to the reference node.

  2. <u>Apply KCL to the **(n-1)** nodes</u>, expressing branch current in terms of the node voltages (using the *I-V* relationships of branch elements).

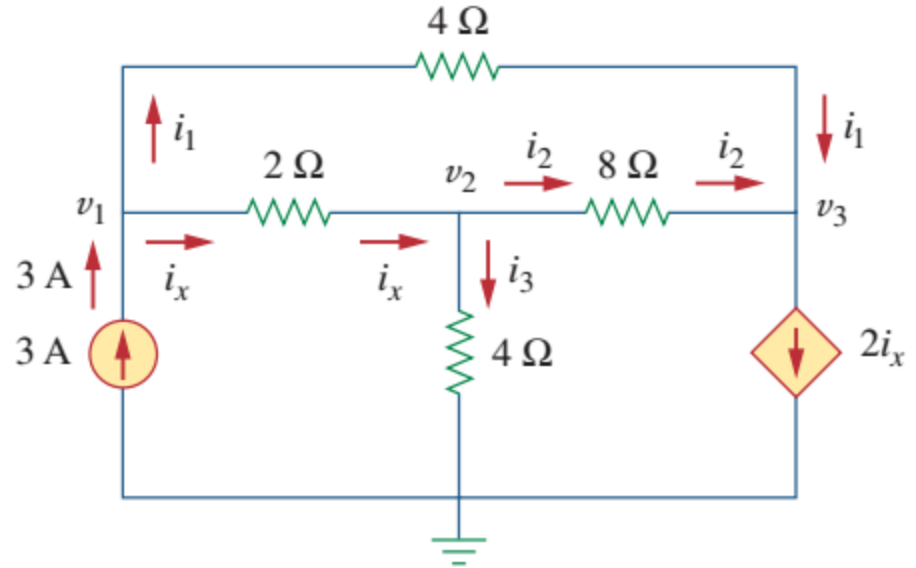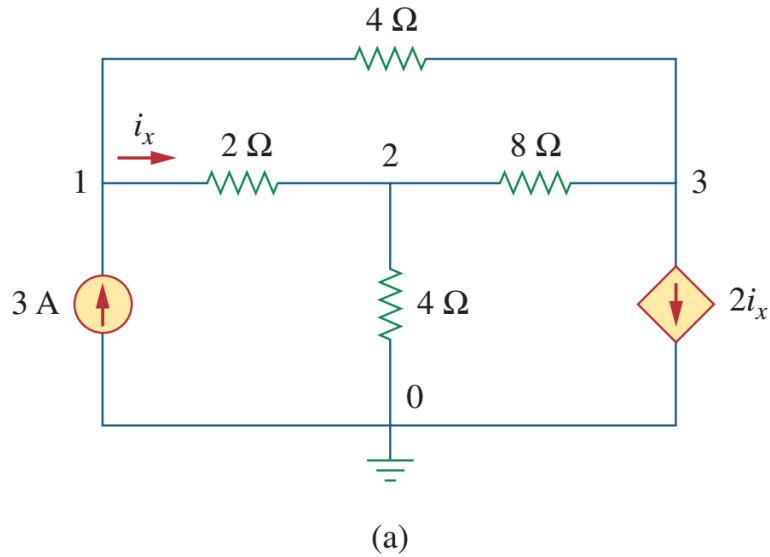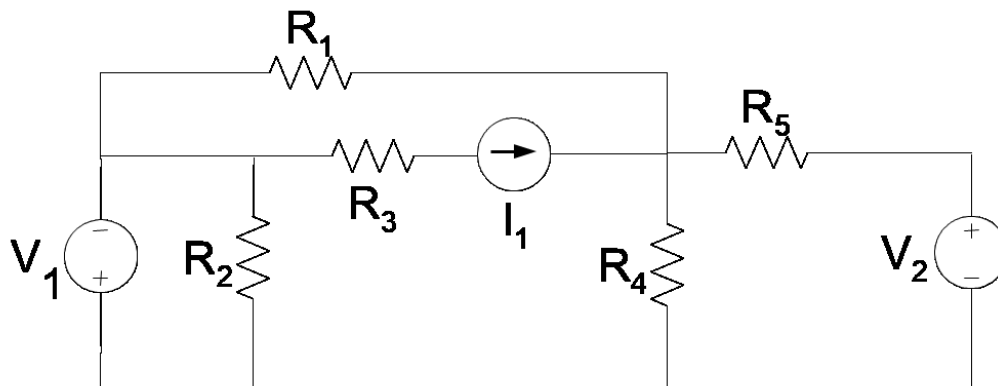 3. <u>Solve the resulting simultaneous equations </u>to obtain the unknown node voltages.

[Source: Berkeley]

Nodal Analysis: Example #1

(a)

Nodal Analysis: Example #1
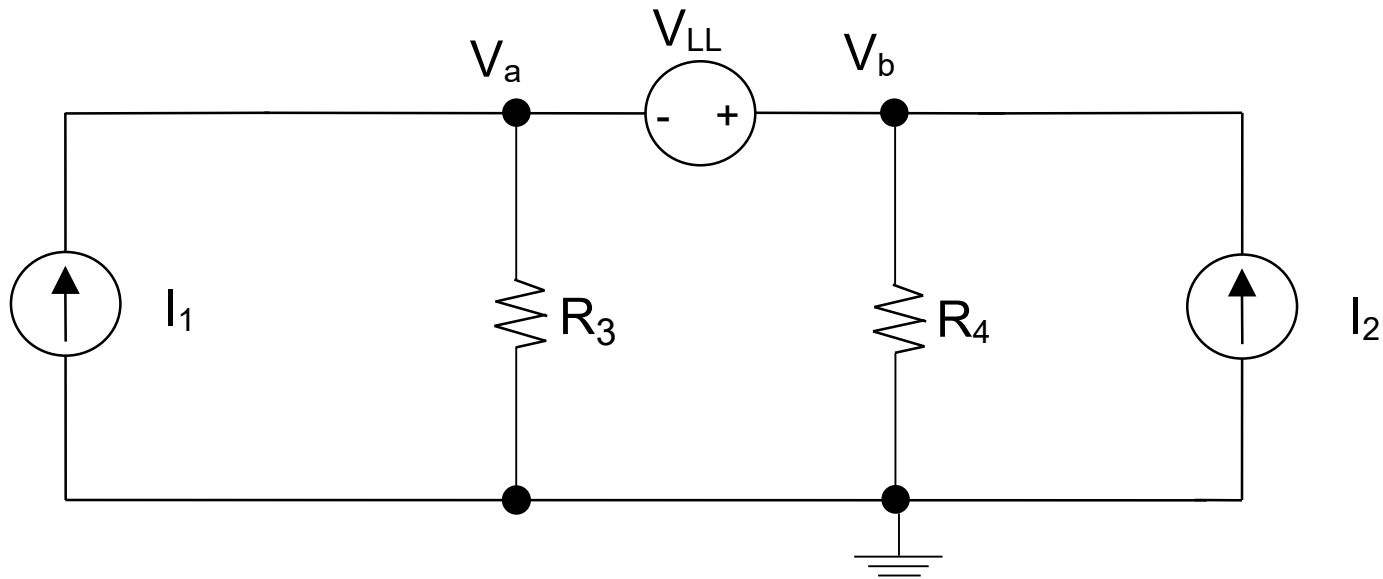

(a)
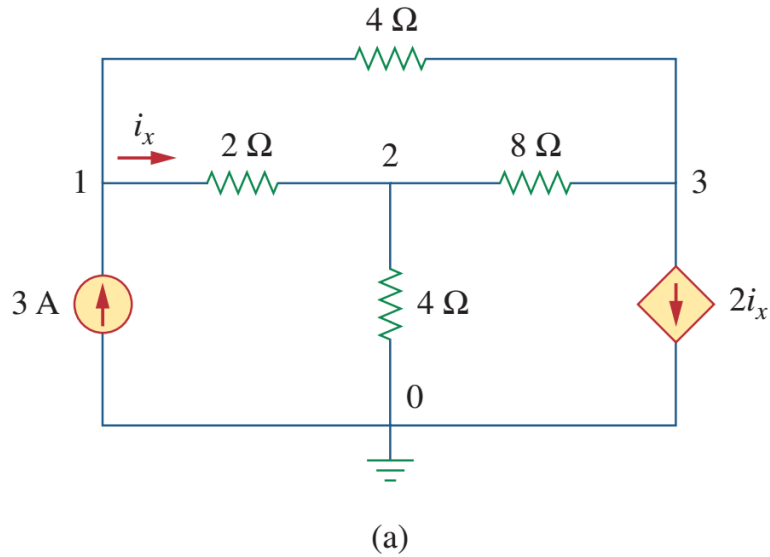
Nodal Analysis with Voltage Sources

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:
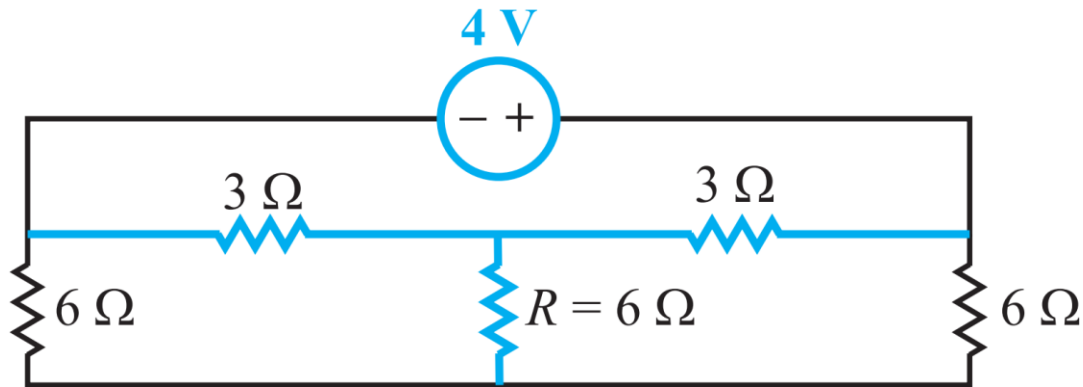

A supernode is formed by enclosing a (dependent or independent) voltage source connected between two nonreference nodes and any elements connected in parallel with it.
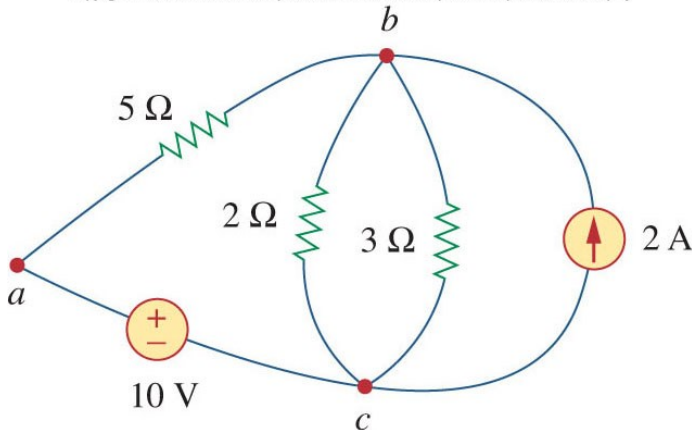
Exercise

- Find the power supplied by the voltage source.

Mesh Analysis--Loop, Independent Loop, Mesh

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

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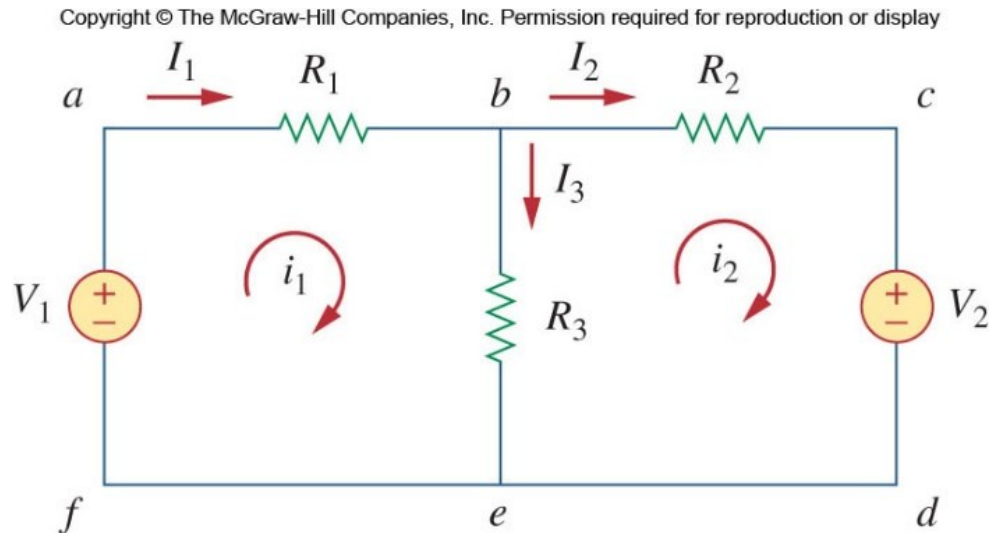- l_{ind} – number of ind. loops

Mesh = Independent loop?

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

Mesh Analysis

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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display

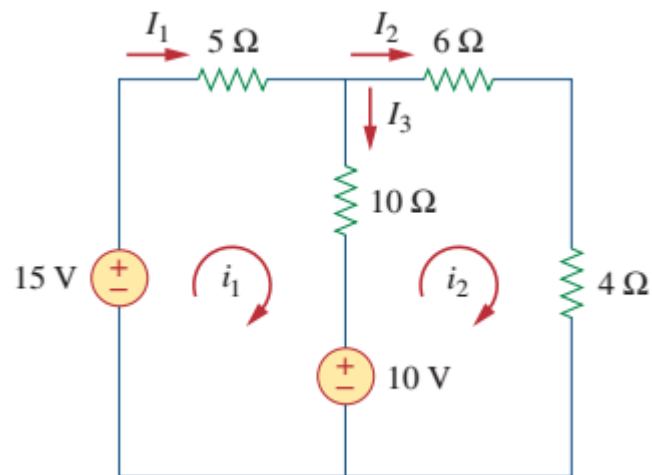- Mesh analysis uses KVL to find unknown currents.

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.
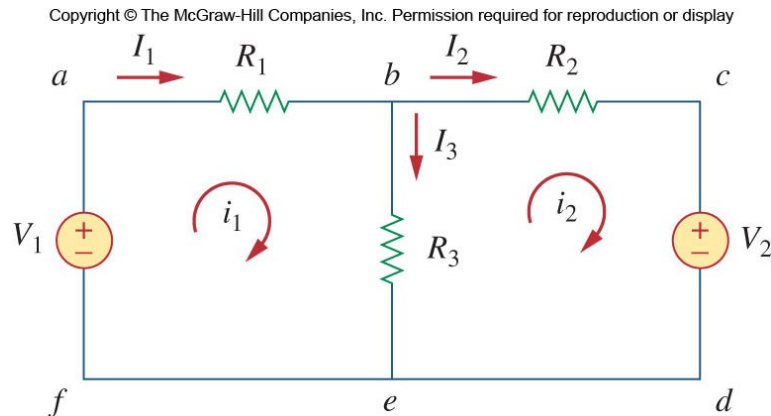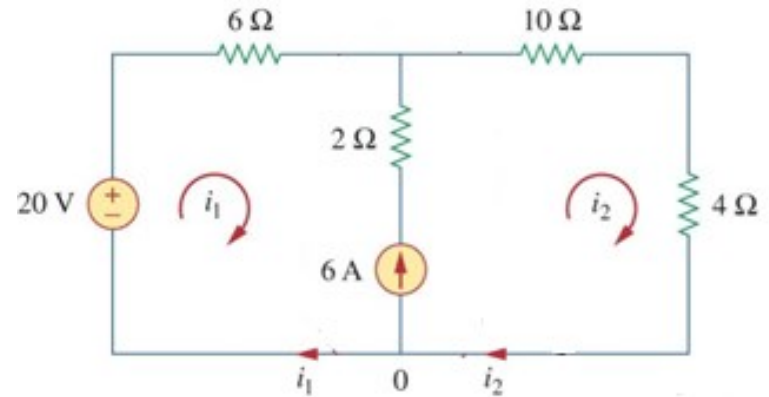
Example

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:
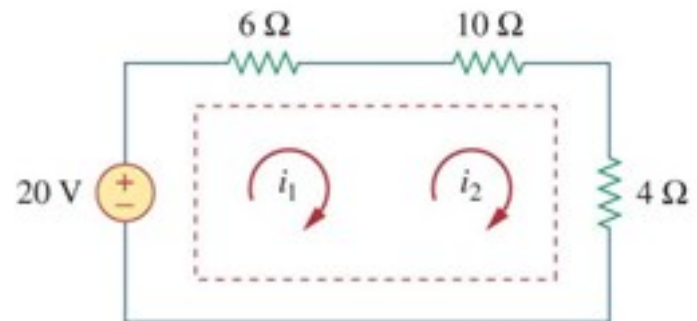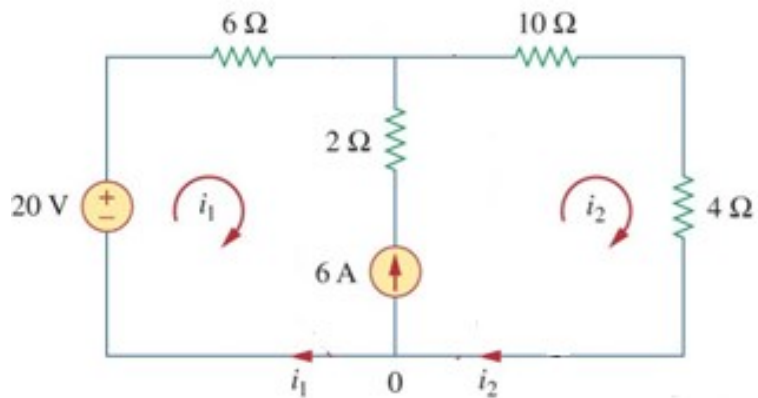

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display
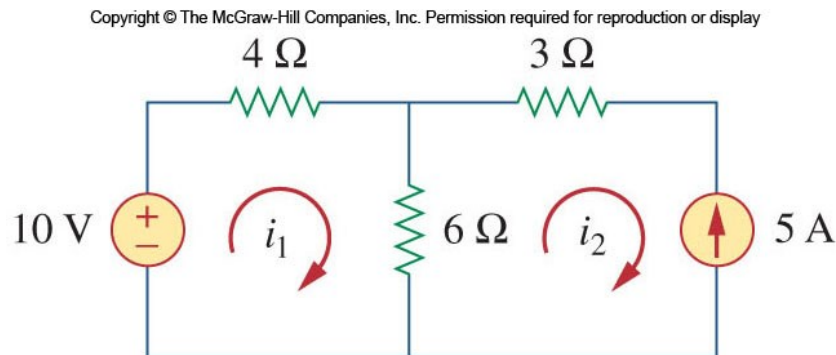
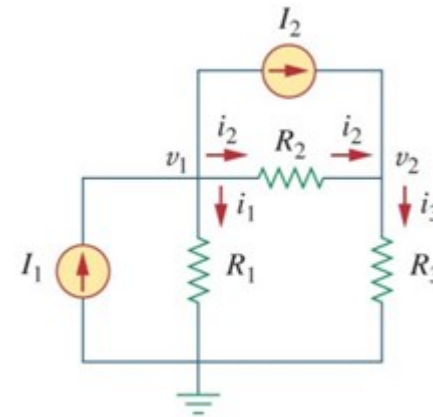# If the current source is located…

Supermesh

Summary

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

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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display