Chapter 8

Methods of Analysis

Constant Current Sources

- Maintains same current in branch of circuit
  - Doesn't matter how components are connected external to the source
- Direction of current source indicates direction of current flow in branch

Constant Current Sources

- Voltage across current source
  - Depends on how other components are connected

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Constant Current Sources

- Series circuit
  - Current must be same everywhere in circuit
- Current source in a series circuit
  - Value of the current for that circuit
- For the circuit shown
  - I = 2 mA

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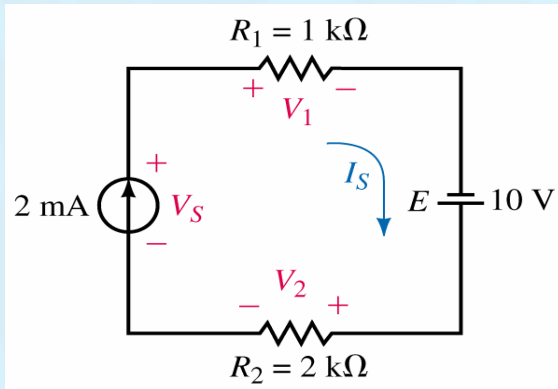
Constant Current Sources



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Source Conversions

- Circuit analysis
  - Sometimes convenient to convert between voltage sources and current sources
- To convert from a voltage source to a current source
  - Calculate current from E/R_S

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Source Conversions

- R_S does not change
- Place current source and resistor in parallel

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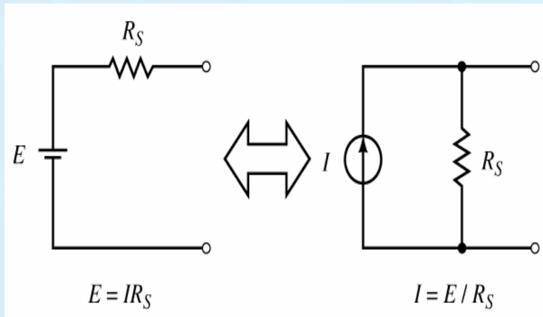
Source Conversions

- Can also convert from a current source to a voltage source
- $E = I \cdot R_S$
- Place voltage source in series with resistor

Source Conversions



Source Conversions

- A load connected to a voltage source or its equivalent current
  - Should have same voltage and current for either source

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Source Conversions

- Although sources are equivalent
  - Currents and voltages within sources may differ
- Sources are only equivalent external to terminals

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Current Sources in Parallel and Series

- Current sources in parallel
  - Simply add together algebraically
- Magnitude and direction of resultant source
  - Add currents in one direction
  - Subtract currents in opposite direction

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Current Sources in Parallel and Series

- Current sources with different values
  - Never place in series
  - This violates KCL

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Branch Current Analysis

- For circuits having more than one source
  - Use different methods of analysis
  - Begin by arbitrarily assigning current directions in each branch
  - Label polarities of the voltage drops across all resistors

Branch Current Analysis

- Write KVL around all loops
- Apply KCL at enough nodes so all branches have been included
- Solve resulting equations

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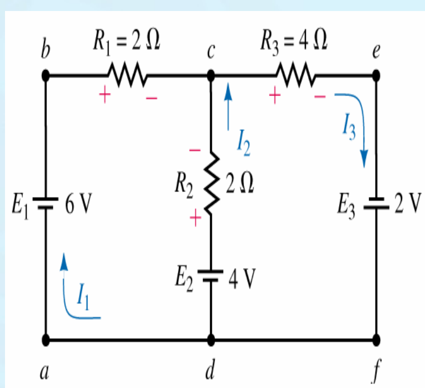
Branch Current Analysis

- From KVL:
  - $6 - 2I_1 + 2I_2 - 4 = 0$
  - $4 - 2I_2 - 4I_3 + 2 = 0$
- From KCL:
  - $I_3 = I_1 + I_2$
- Solve simultaneous equations



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Mesh Analysis

- Arbitrarily assign a clockwise current to each interior closed loop (Mesh)
- Indicate voltage polarities across all resistors
- Write KVL equations

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Mesh Analysis

- Solve resulting simultaneous equations
- Branch currents determined by:
  - Algebraically combining loop currents common to branch

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Mesh Analysis

- Assign loop currents and voltage polarities
- Using KVL: $6 - 2I_1 - 2I_1 + 2I_2 - 4 = 0$

  $4 - 2I_2 + 2I_1 - 4I_2 + 2 = 0$
- Simplify and solve equations

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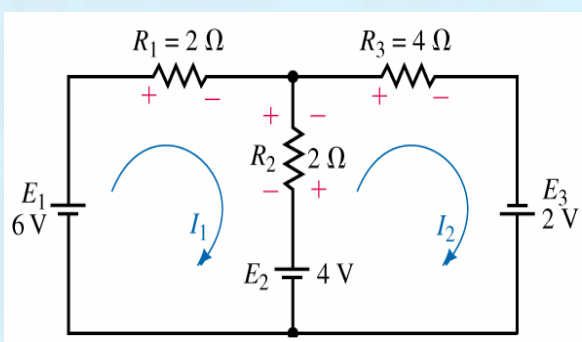
Mesh Analysis



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Format Approach

- Mutual resistors represent resistors shared between two loops
- R_{12} represents resistor in loop 1 that is shared by loop 1 and loop 2
- Coefficients along principal diagonal will be positive

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Format Approach

- All other coefficients will be negative
- Terms will be symmetrical about principal diagonal

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Format Approach

- Convert current sources into equivalent voltage sources
- Assign clockwise currents to each independent closed loop
- Write simultaneous linear equations
  - Use format outline or matrix method

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Format Approach

- Solve resulting simultaneous equations or matrix equations
- Use a calculator or software program to solve

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Nodal Analysis

- Assign a reference node within circuit and indicate node as ground
- Convert voltage sources to current sources

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Nodal Analysis

- Assign voltages V_1, V_2, etc. to remaining nodes
- Arbitrarily assign a current direction to each branch where there is no current source

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Nodal Analysis

- Apply KCL to all nodes except reference node
- Rewrite each current in terms of voltage
- Solve resulting equations for voltages

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Format Approach

- Mutual conductance
  - Common to two nodes
- Mutual conductance G_{23}
  - Conductance at Node 2
  - Common to Node 3
- Conductances at certain nodes are positive

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Format Approach

- Mutual conductances are negative
- Equations are written correctly
  - Terms will be symmetrical about principal diagonal

Format Approach

- Convert voltage sources into equivalent current sources
- Label reference node as ground
- Label remaining nodes as V_1, V_2, etc.

Format Approach

- Write linear equation for each node or in matrix form
- Solve resulting equations for voltages
- Method of solution is same as for mesh

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Delta-Wye Conversion

- Resistors connected to a point of Y
  - Obtained by finding product of resistors connected to same point in Delta
  - Divide by sum of all Delta resistors

Delta-Wye Conversion

- Given a Delta circuit with resistors of 30, 60, and 90 Ω
  - Resulting Y circuit will have resistors of 10, 15, and 30 Ω

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Wye-Delta Conversions

- A Delta resistor is found:
  - Taking sum of all two-product combinations of Y resistor values
  - Divide by resistance of Y directly opposite resistor being calculated

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Wye-Delta Conversions

- For a Y circuit having resistances of 2.4, 3.6, and 4.8 Ω
  - Resulting Delta resistors will be 7.8, 10.4, and 15.6 Ω