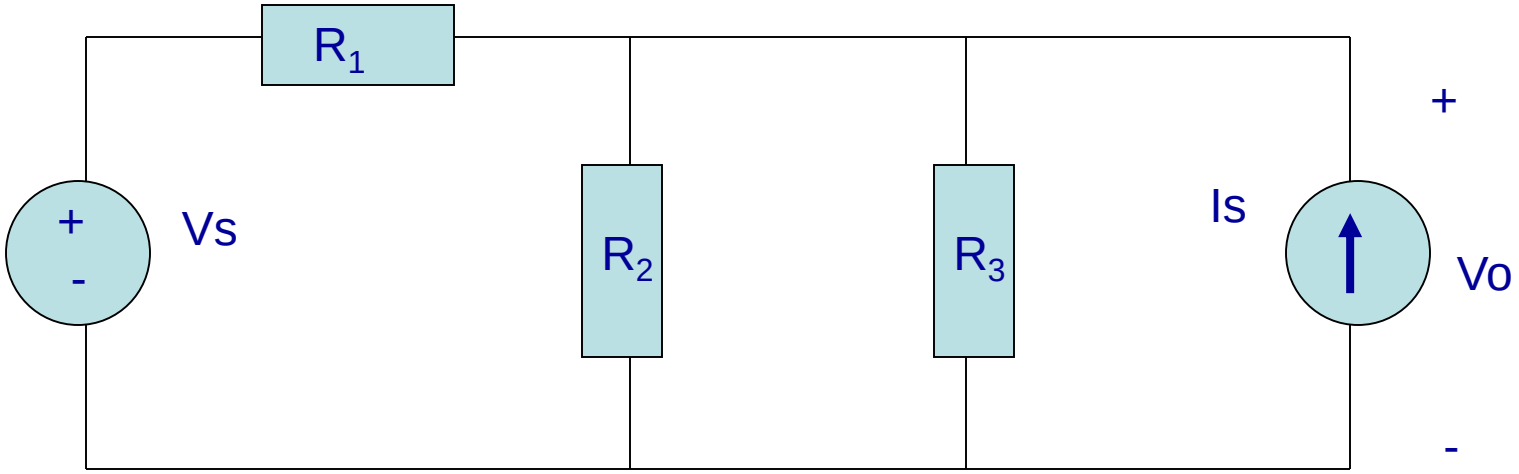
Lecture
Kirchoff's Laws

Circuit Definitions

- Node – any point where 2 or more circuit elements are connected together
  - Wires usually have negligible resistance
  - Each node has one voltage (w.r.t. ground)
- Branch – a circuit element between two nodes
- Loop – a collection of branches that form a closed path returning to the same node without going through any other nodes or branches twice

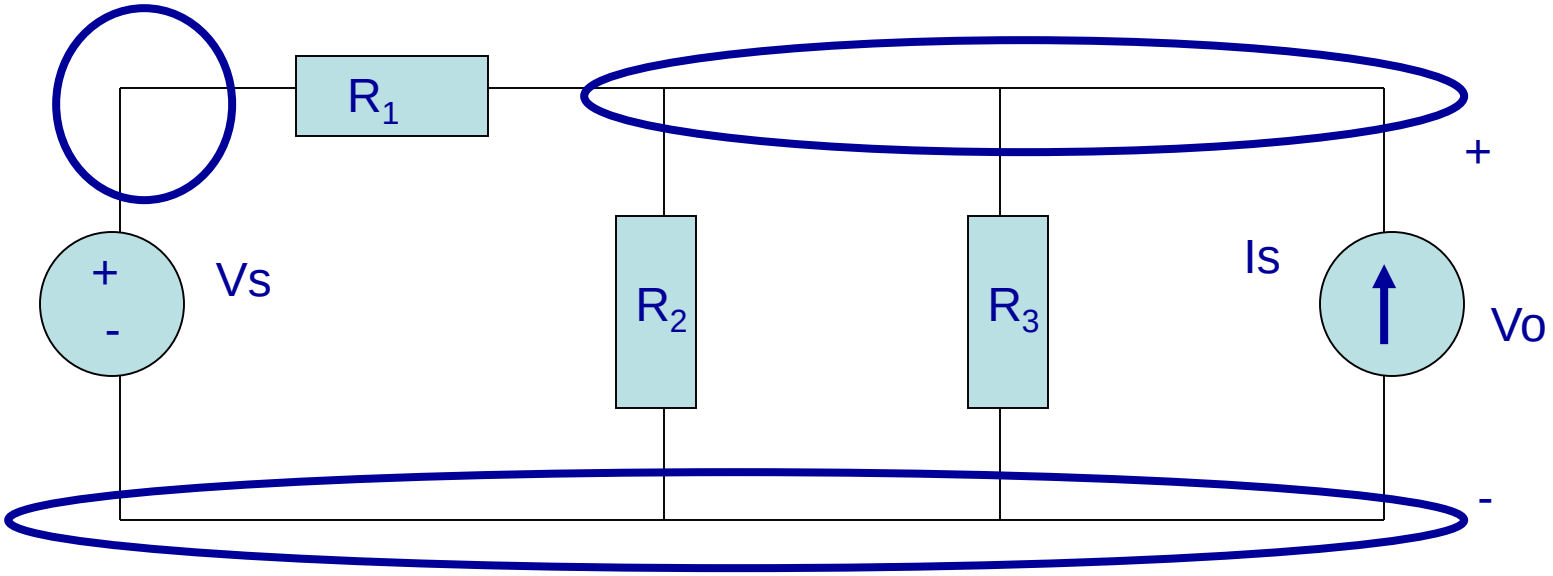
Example

- How many nodes, branches & loops?



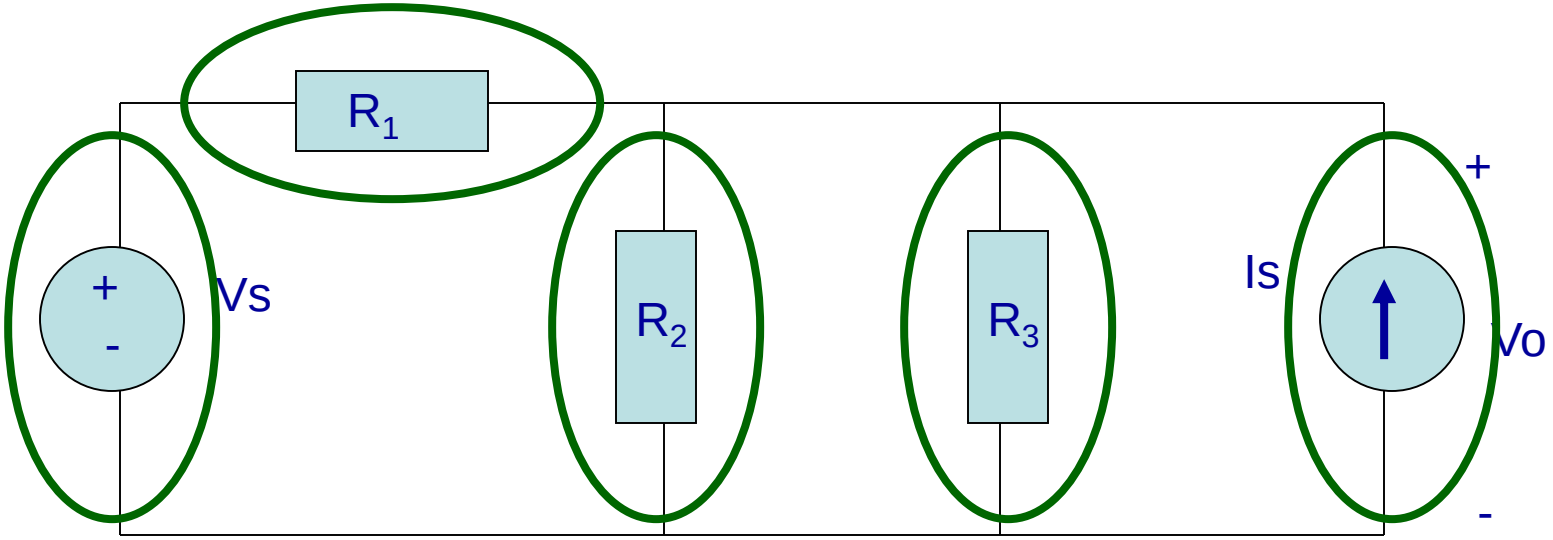
Example

- Three nodes



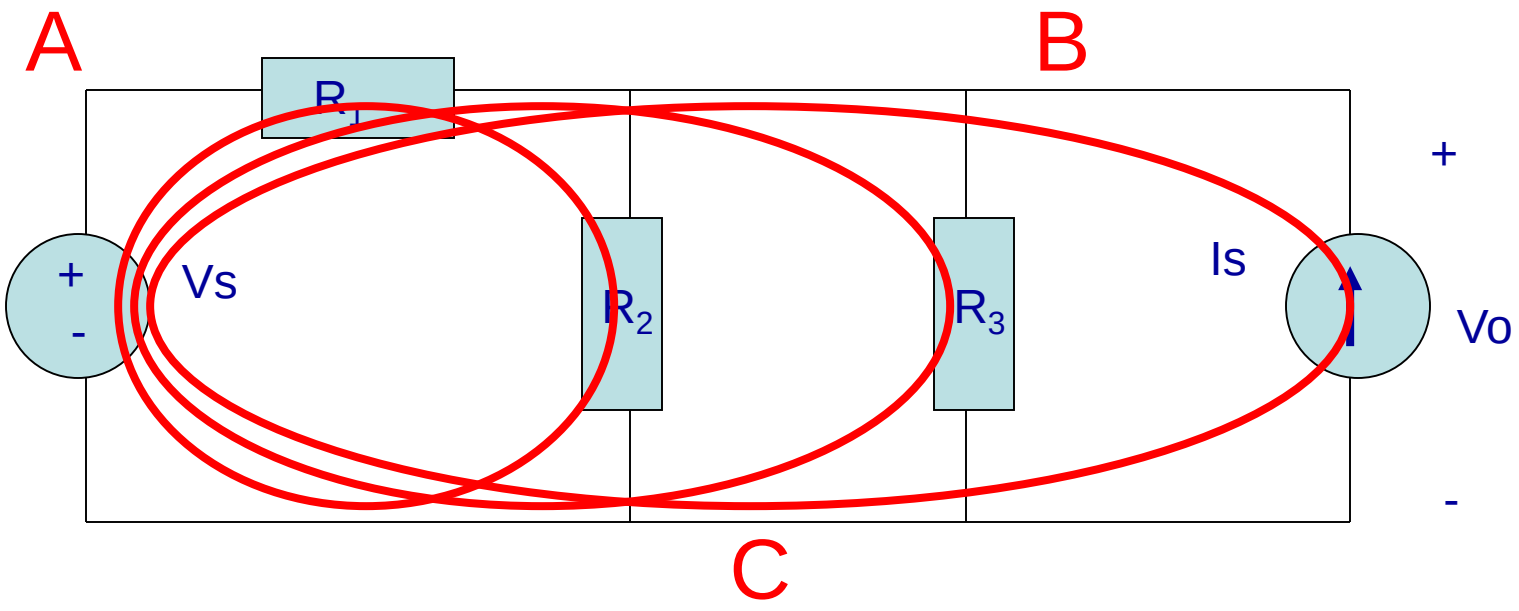
Example

- 5 Branches



Example

- Three Loops, if starting at node A

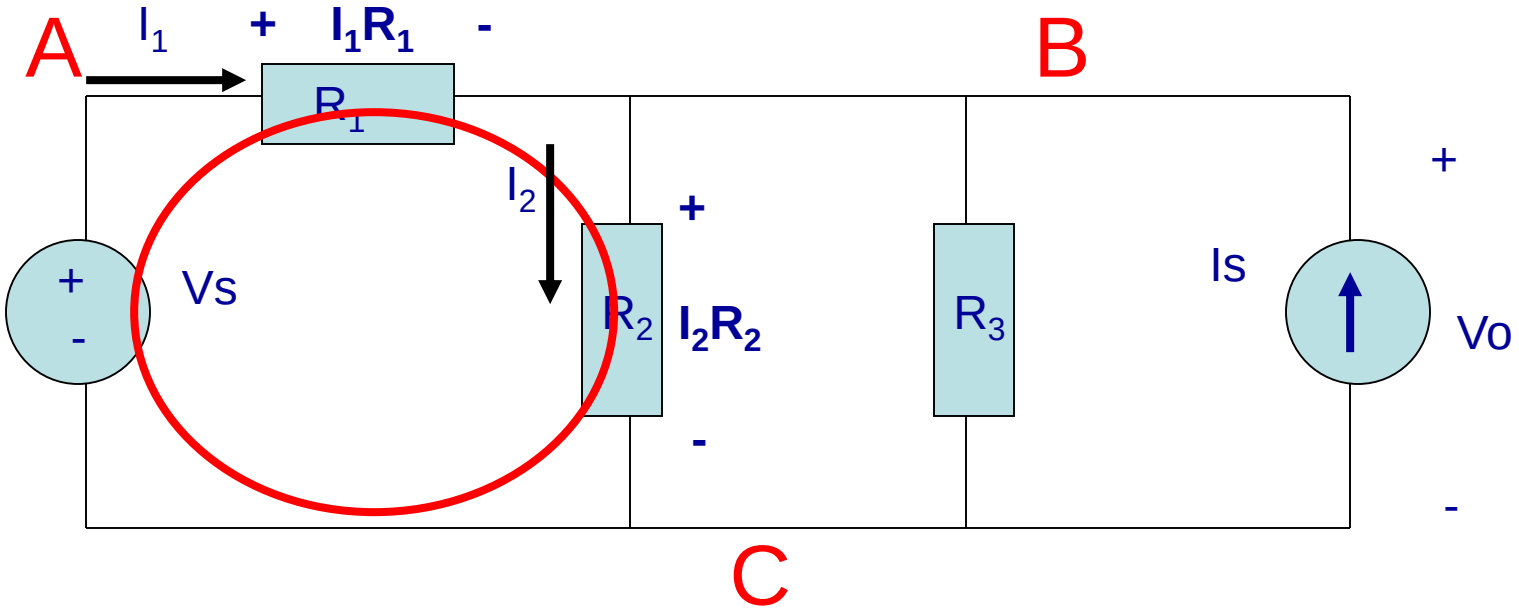


Kirchoff's Voltage Law (KVL)

- The algebraic sum of voltages around each loop is zero
  - Beginning with one node, add voltages across each branch in the loop (if you encounter a + sign first) and subtract voltages (if you encounter a – sign first)
- Σ voltage drops - Σ voltage rises = 0
- Or Σ voltage drops = Σ voltage rises

Example

- Kirchoff's Voltage Law around 1st Loop

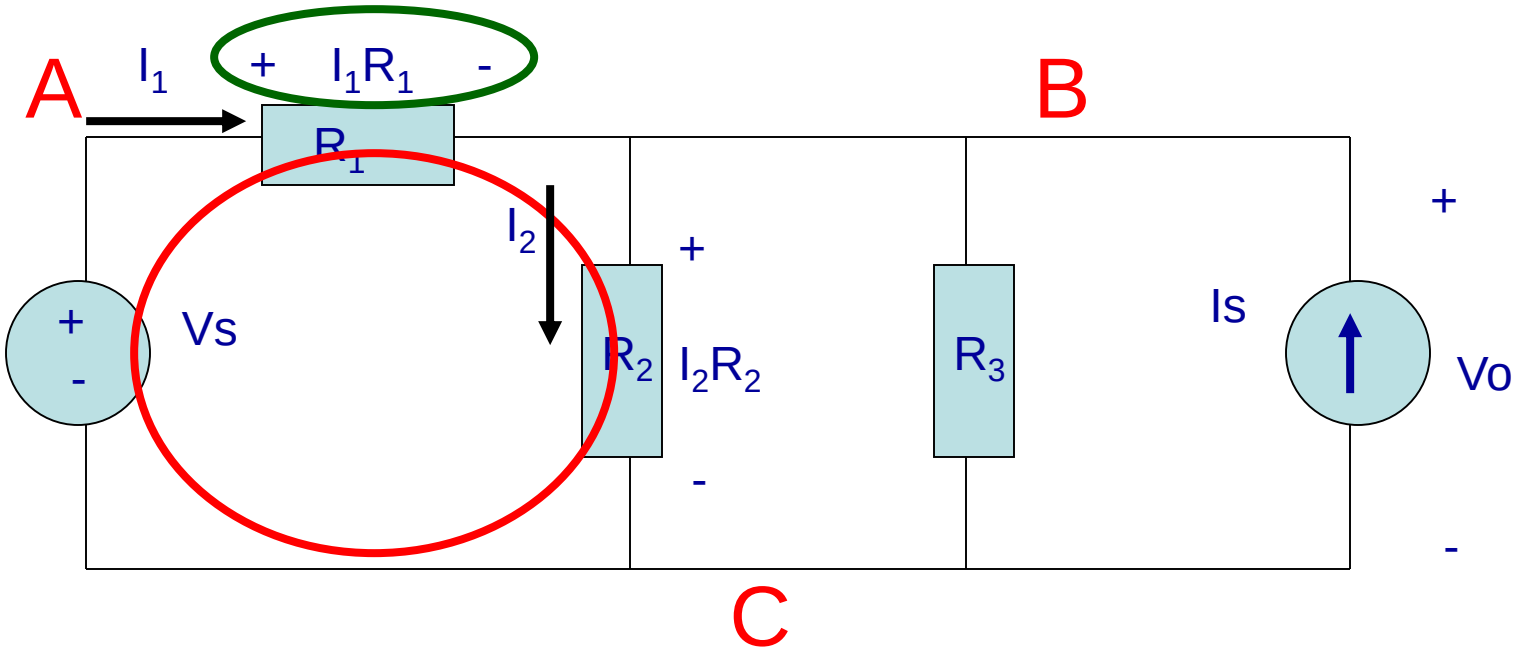


Assign current variables and directions

Use Ohm's law to assign voltages and polarities consistent with passive devices (current enters at the + side)

Example

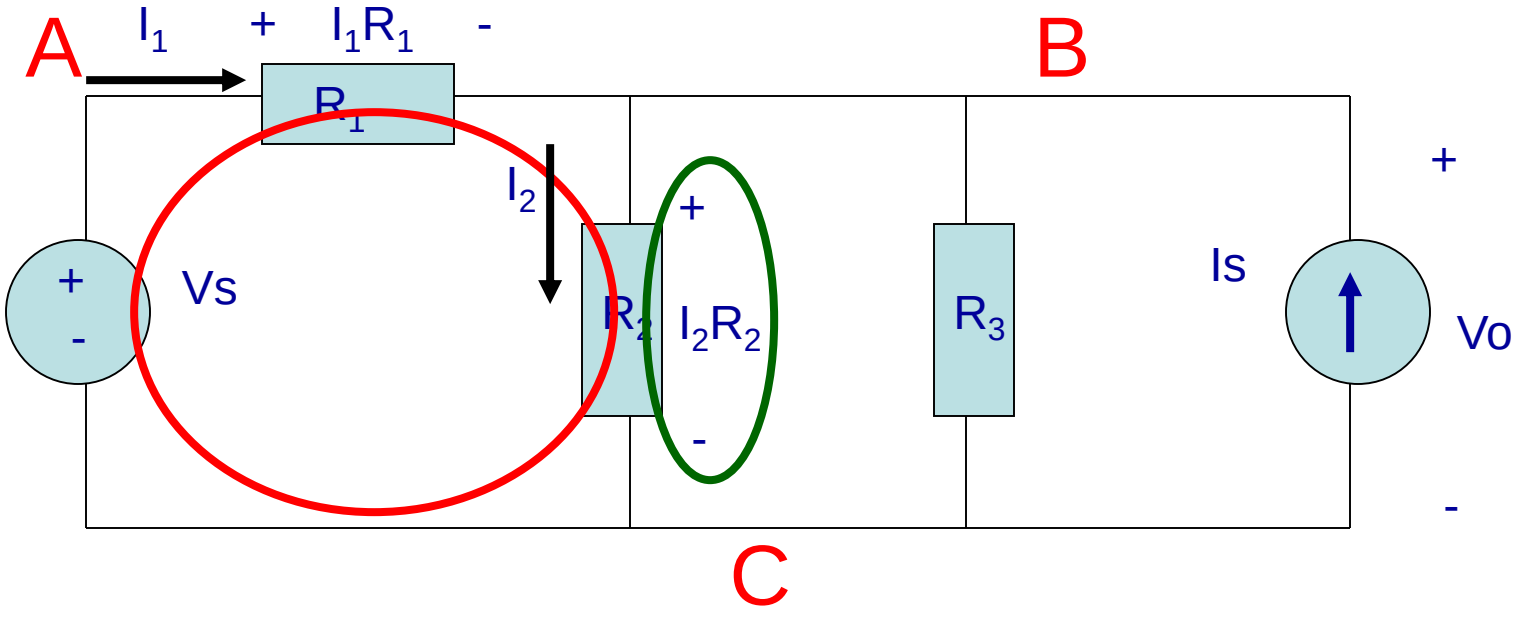
- Kirchoff's Voltage Law around 1st Loop



Starting at node A, add the 1st voltage drop: + I_1R_1

Example

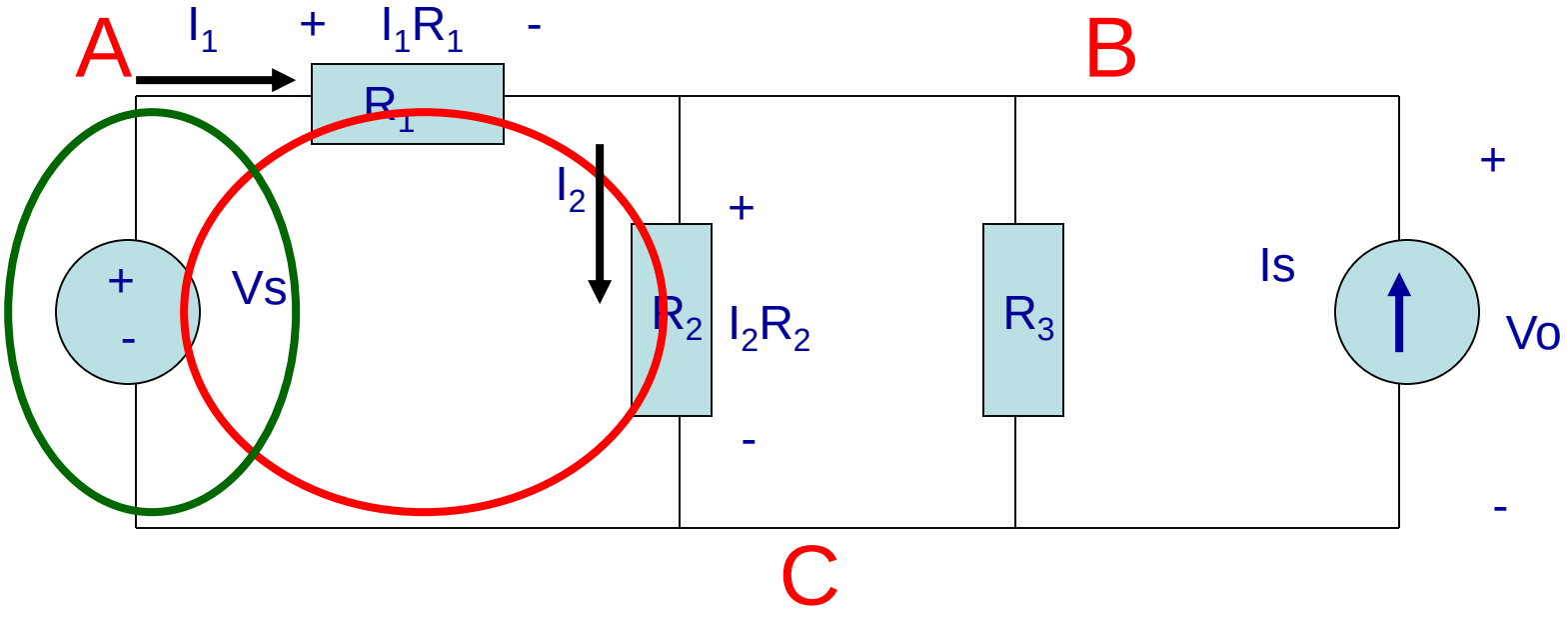
- Kirchoff's Voltage Law around 1st Loop



Add the voltage drop from B to C through R_2: $+ I_1R_1 + I_2R_2$

Example

- Kirchoff's Voltage Law around 1st Loop

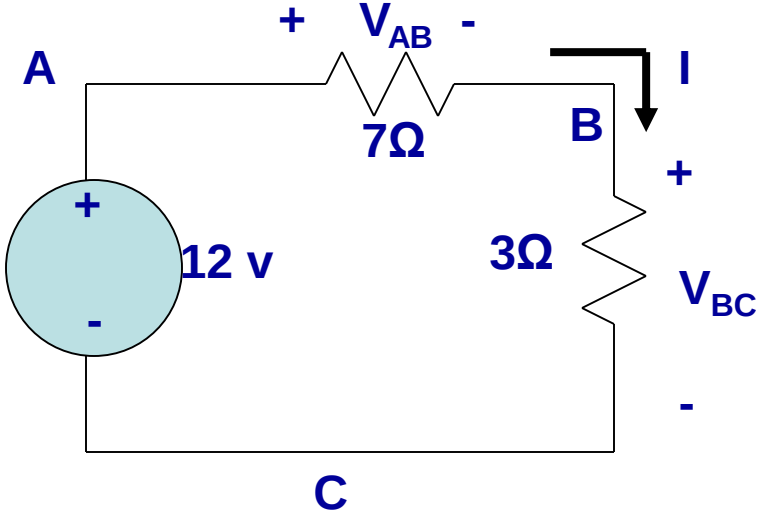


Subtract the voltage rise from C to A through Vs: $+ I_1R_1 + I_2R_2 - Vs = 0$

Notice that the sign of each term matches the polarity encountered 1st

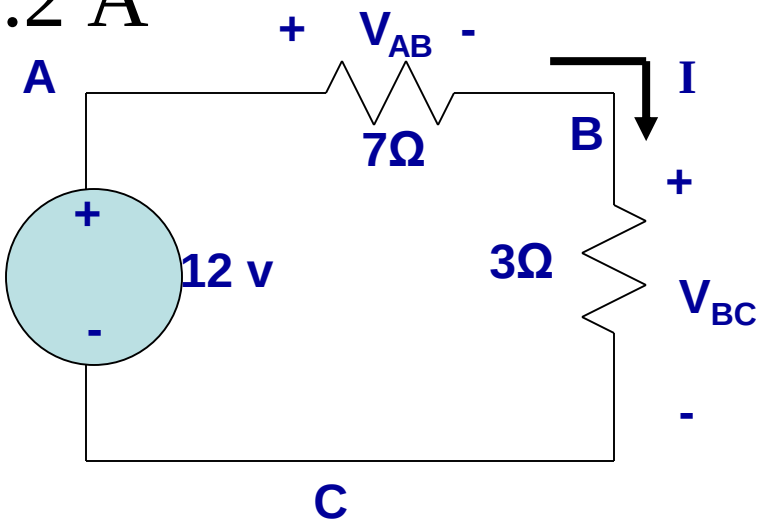
Circuit Analysis

- When given a circuit with sources and resistors having fixed values, you can use Kirchoff's two laws and Ohm's law to determine all branch voltages and currents



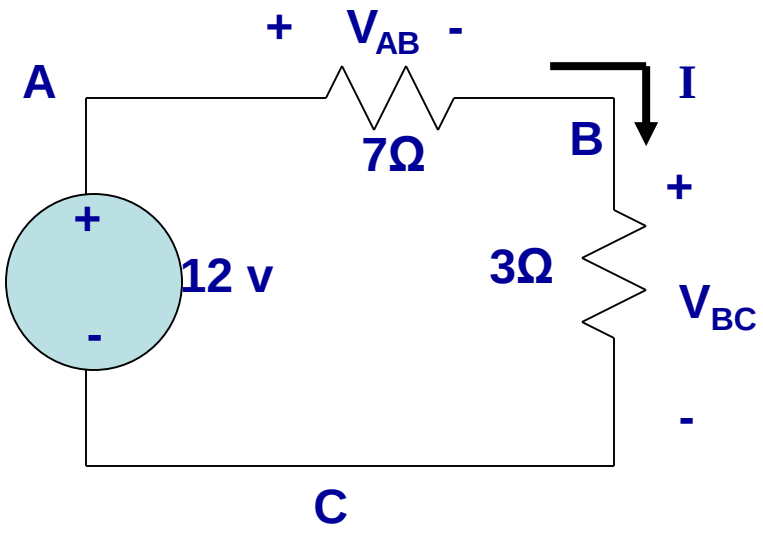
Circuit Analysis

- By Ohm's law: $V_{AB} = I \cdot 7\Omega$ and $V_{BC} = I \cdot 3\Omega$
- By KVL: $V_{AB} + V_{BC} - 12\ v = 0$
- Substituting: $I \cdot 7\Omega + I \cdot 3\Omega - 12\ v = 0$
- Solving: $I = 1.2\ A$



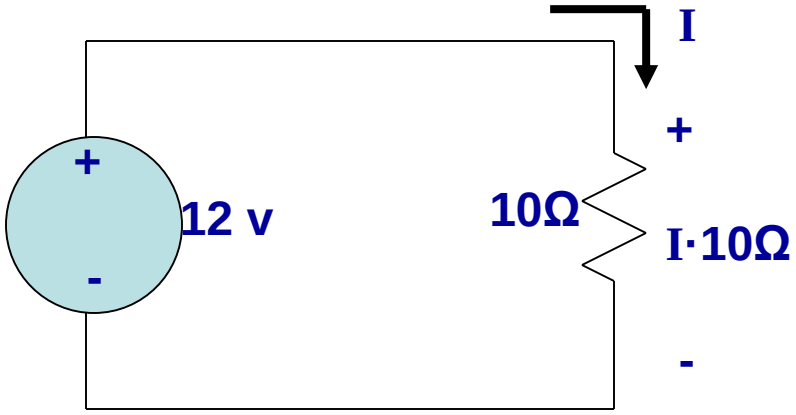
Circuit Analysis

- Since $V_{AB} = I \cdot 7\Omega$ and $V_{BC} = I \cdot 3\Omega$
- And $I = 1.2\ A$
- So $V_{AB} = 8.4\ v$ and $V_{BC} = 3.6\ v$



Series Resistors

- KVL: $+I \cdot 10\Omega - 12\ v = 0$, So $I = 1.2\ A$
- From the viewpoint of the source, the 7 and 3 ohm resistors in series are equivalent to the 10 ohms



Series Resistors

- To the rest of the circuit, series resistors can be replaced by an equivalent resistance equal to the sum of all resistors