
Current Loops

a.k.a. Current Mesh

EE 206 Circuits I

Jake Glower - Lecture #7

Please visit [Bison Academy](#) for corresponding lecture notes, homework sets, and solutions



Current Loops

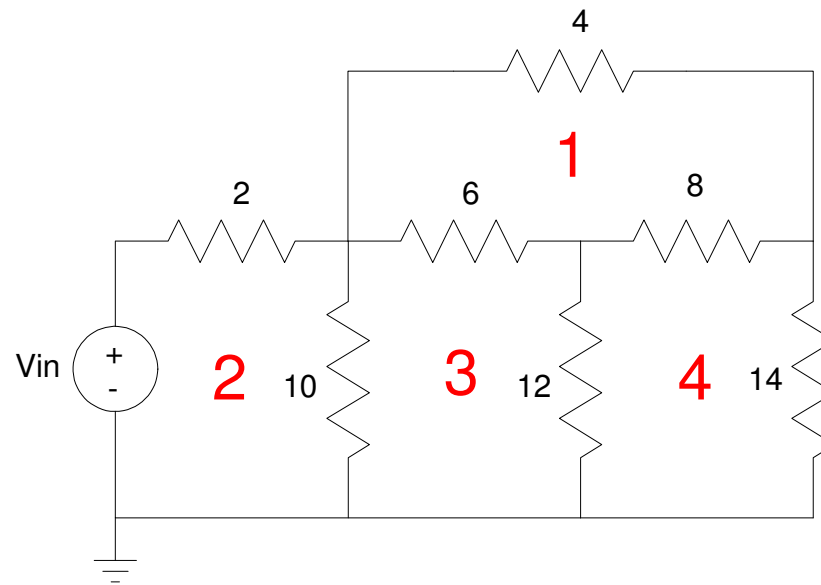
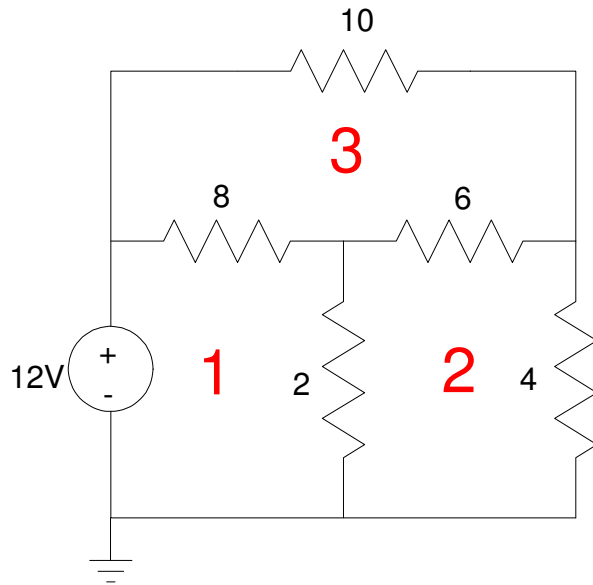
- Current Mesh
- Kirchoff's Current Loops
- Kirchoff's Voltage Law

Goal:

- Write N equations to solve for N unknown currents
 - Uses conservation of voltage
 - The sum of the voltages around any closed path must sum to zero
 - a.k.a. Kirchoff's Voltage law
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Step 1: Count Windows

- # of loop equations needed = # windows
- Not always possible



A circuit with 3 windows (left) and 4 windows (right).

Step 2: Label Currents

- Path
- Direction

Step 3: Write N equations for N unknowns

- Sum the voltage around each current loop
- Be consistent: Subtract if you hit the - sign first
- Make sure you end up where you started
- The voltages must add up to zero

$$-12 + (I_1 - I_3)8 + (I_1 - I_2)2 = 0$$

$$(I_2 - I_1)2 + (I_2 - I_3)6 + (I_2)4 = 0$$

$$(I_3 - I_1)8 + (I_3)10 + (I_3 - I_2)6 = 0$$

Note the signs of each term

- When you go around loop I1
 - All of the I1 terms are positive
 - All of the other terms are negative

Example 2: Find the currents for the 4-window circuit. Assume $V_{in} = +12V$.

First, write 4 equations for 4 unknowns:

$$4I_1 + 8(I_1 - I_4) + 6(I_1 - I_3) = 0$$

$$-12 + 2I_2 + 10(I_2 - I_3) = 0$$



Place in matrix form:

$$\begin{bmatrix} 18 & 0 & -6 & -8 \\ 0 & 12 & -10 & 0 \\ -6 & -10 & 28 & -12 \\ -8 & 0 & -12 & 34 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 12 \\ 0 \\ 0 \end{bmatrix}$$

Solving in MATLAB:

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A = [18,0,-6,-8; 0,12,-10,0; -6,-10,28,-12; -8,0,-12,34]
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B = [0;12;0;0]
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inv(A)*B
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I1:    0.5164104
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```
I2:    1.7860913
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```
I3:    0.9433096
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```
I4:    0.4544411
```

From Matlab

I1: 0.5164104
I2: 1.7860913
I3: 0.9433096
I4: 0.4544411

From CircuitLab

$$I_1 = \left(\frac{V_1 - V_3}{R_4} \right) = 0.5165A$$

$$I_2 = \left(\frac{V_0 - V_1}{R_1} \right) = 1.7860A$$

$$I_2 - I_3 = \left(\frac{V_1}{R_5} \right) = 0.8428A$$

$$I_4 = \left(\frac{V_3}{R_7} \right) = 0.4544A$$

Current Loops with Voltage Sources

Not a problem

- If you encounter the + sign first, add the voltage.
- If you encounter the - sign first, subtract the voltage.

Example: Write 3 equations for 3 unknowns:

$$-12 + 8(I_1 - I_3) + 2(I_1 - I_2) = 0$$

$$2(I_2 - I_1) + 6 + 4(I_2) = 0$$

$$-10 + 6 + 8(I_3 - I_1) = 0$$

