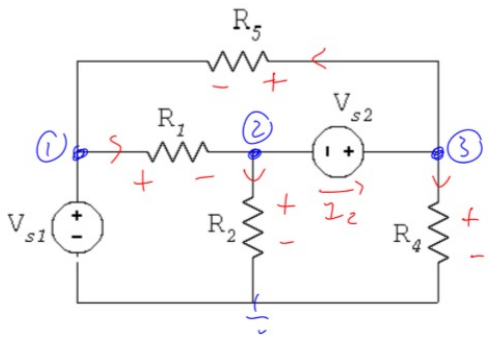
- Example #5-cont: Use the node-voltage method to determine all node voltages in this circuit



Assume : $R_i = 2\,\Omega$ for all i

$V_{s1} = 1V$

$V_{s2} = 2V$

$1 = V_1 \quad (1)$

$2 = V_3 - V_2 \quad (2)$

$0 = -V_1 + V_2 + V_3 \quad (3)$

$\vdots$

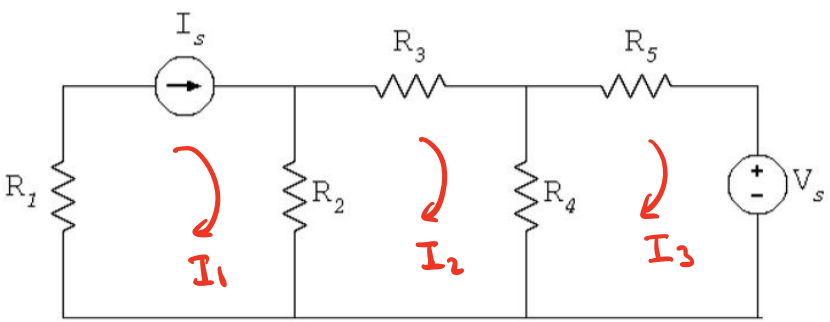
$V_3 = \frac{3}{2} V$

$V_2 = -\frac{1}{2} V$

- Loop-current method

- Step #1:

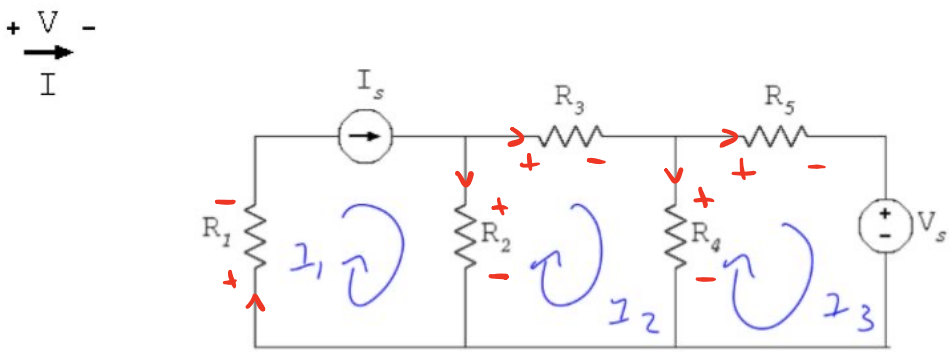
Assign loop currents I_1, I_2,..., I_n.



- Loop-current method

- Step #2:

Assign current directions and polarities to all elements (use SRS for simplicity).

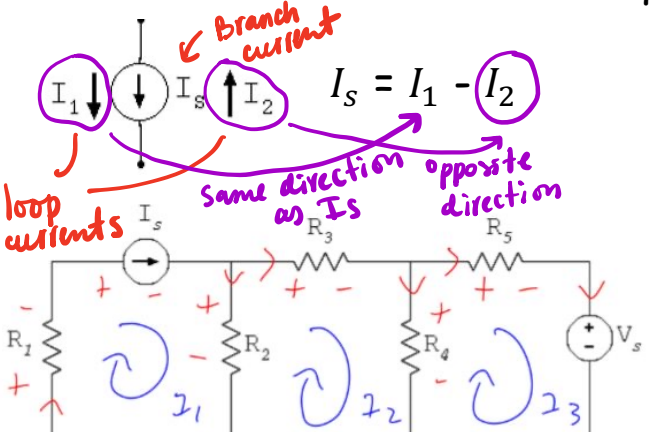


- Loop-current method

- Step #3:

Use current sources to obtain equations between their loop currents

Branch current vs loop current



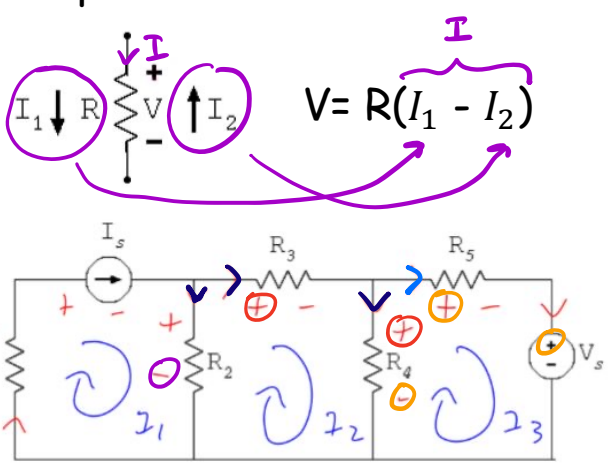
Branch current: net current through an element in a direction of arrow.

It might consist of multiple loop currents, some in the same direction, some in the opposite direction.

- Loop-current method

- Step #4:

Use KVL on remaining loops to get a total of n equations in terms of the loop currents.



$I_3 = I_1$ (1)

KVL @ (2): $-R_2(I_1 - I_2) + R_3(I_2)$

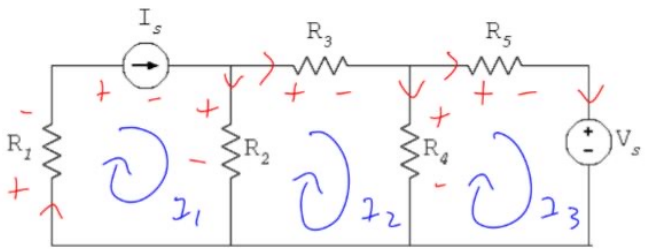
$+ R_4(I_2 - I_3) = 0$ (2)

KVL @ (3): $-R_4(I_2 - I_3) + R_5(I_3)$

$+ V_s = 0$ (3)

- Loop-current method

- Step #5:
  Solve equations



Assume $R_i = 2\Omega$ for all i

$I_s = 2A$

$V_s = 4V$

$2 = I_1$ (1)

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

$4 = 2I_2 - 4I_3$ (3)

$\vdots$

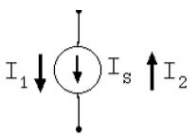
$I_2 = \frac{2}{5} A$

$I_3 = -\frac{4}{5} A$

- Loop-current method: summary

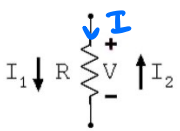
1. Assign loop currents $I_1, I_2, \ldots, I_n$.
2. Assign current directions and polarities to all elements (use SRS for simplicity)

3. Use current sources to obtain equations between their loop currents



$I_s = I_1 - I_2$

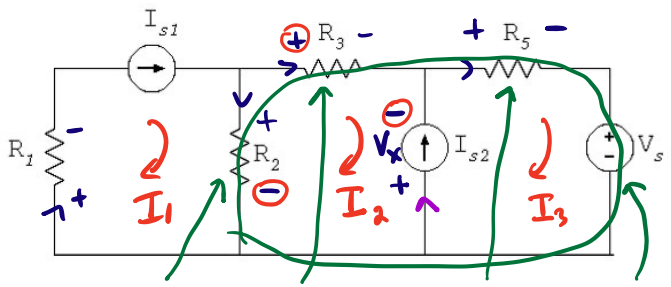
4. Use KVL on remaining loops to get a total of n equations in terms of the loop currents



$V = R(I_1 - I_2)$

5. Solve equations

- Example #6: Use the loop-current method to obtain all loop currents



$-R_2(I_1-I_2) + R_3 \cdot I_2 + R_5 \cdot I_3 + V_s = 0$

Superloop 2-3: combines loops 2 and 3 into a single loop KVL bypassing the I_{s2} current source. Superloop is formed around loops sharing common boundary that includes a current source.

$I_{s1} = I_1$ (1)

$I_{s2} = I_3 - I_2$ (2)

KVL on loop 2:

$-R_2(I_1-I_2) + R_3(I_2)$

$-V_x = 0$ (3)

KVL on loop 3:

$V_x + R_5 \cdot I_3 + V_s = 0$ (4)