ECE 203

Circuits I

Loop Analysis

Lecture 4-2

Loop Analysis

- **Loop analysis is similar to nodal analysis, but utilizes KVL**
- **Also called mesh analysis**
- **The variables are loop currents; we define loop currents throughout the circuit, and use KVL around each loop**
- **Choice of loops is fairly open, but each branch of the circuit must be included; ultimately, need as many loops as there are unknown currents in the circuit**
- **Once the loop currents are known, any circuit parameter can be calculated**

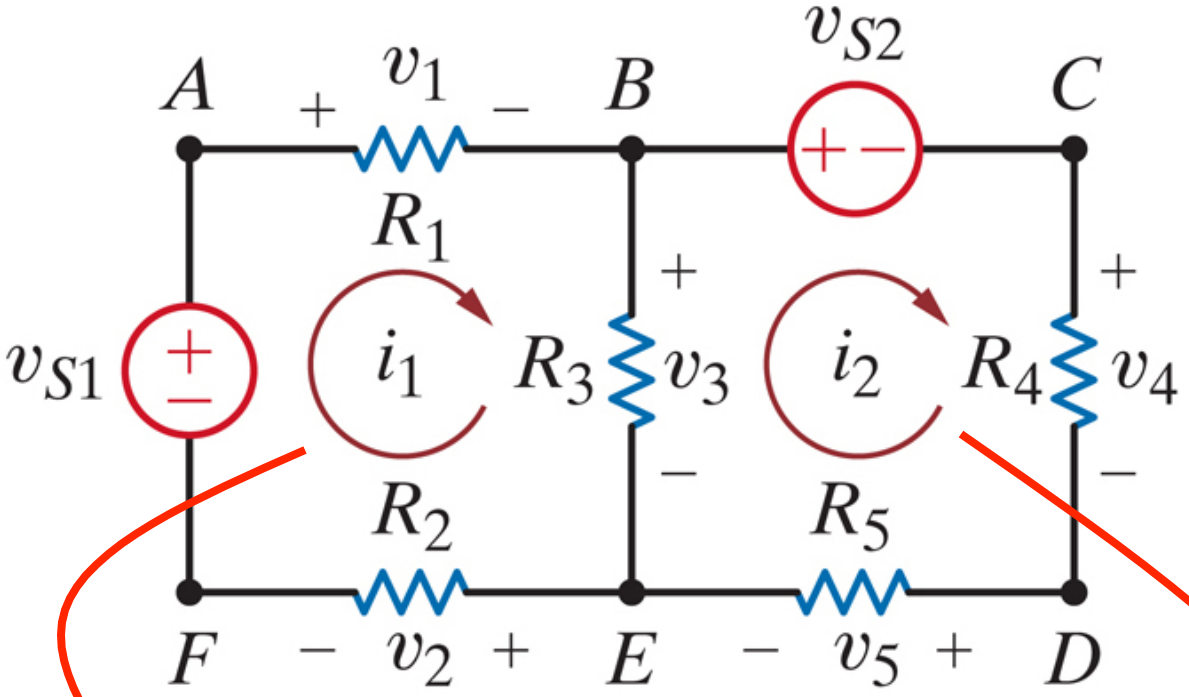
Step-by-step

1) Establish where each loop in the circuit is
2) Assign the current variable for each loop; for example, I_1, I_2, …
3) Write the equations for KVL for each loop
4) Use Ohm's law to rewrite the loop equation in terms of currents and resistances (you should have the same number of equations as loops)

Step-by-step continued

5) Solve for the unknown currents (you have a few choices of how to do this- substitution, matrix, etc)
6) Use Ohm's law to solve for unknown voltages in the circuit

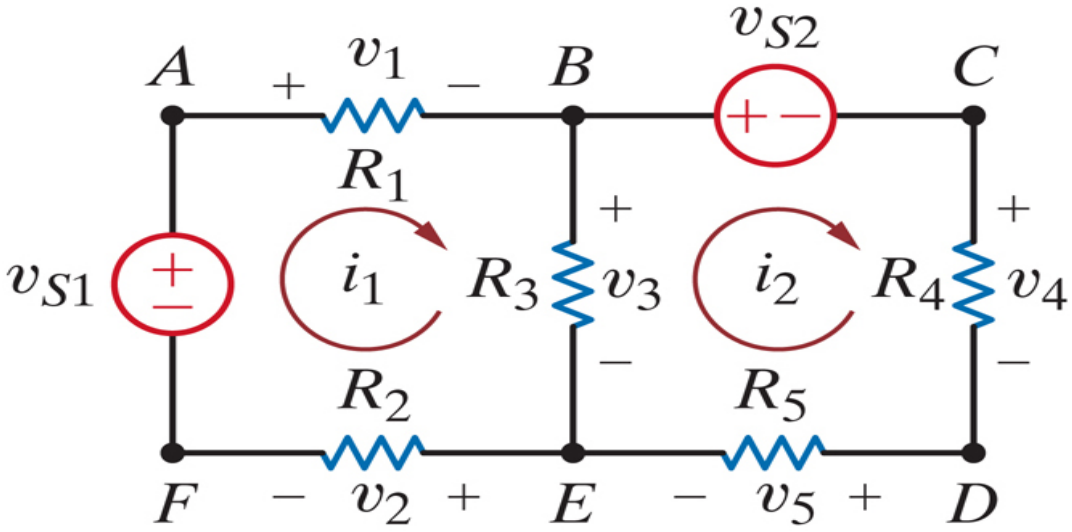
A Two-Loop Circuit



$$+v_1 + v_3 + v_2 - v_{S1} = 0$$

$$+v_{S2} + v_4 + v_5 - v_3 = 0$$

Two-loop circuit continued



$$i_1R_1 + (i_1\text{-}i_2)\,R_3 + i_1R_2 - v_{s1} = 0$$

$$V_{s2} + i_2R_4 + i_2\,R_5 - (i_1 - i_2)\,R_3 = 0$$

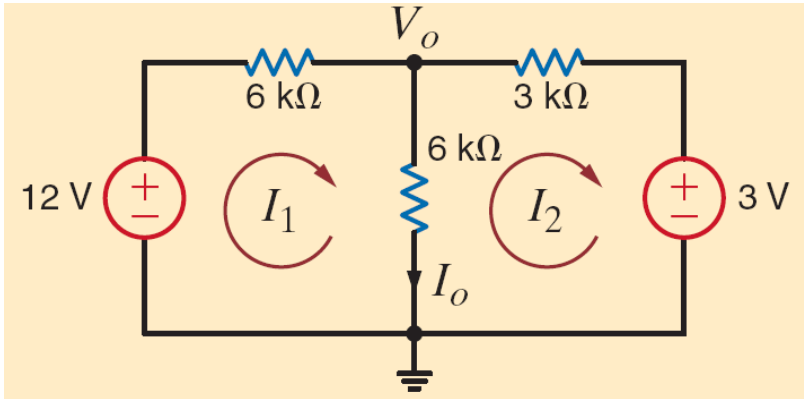
Matrix Representation

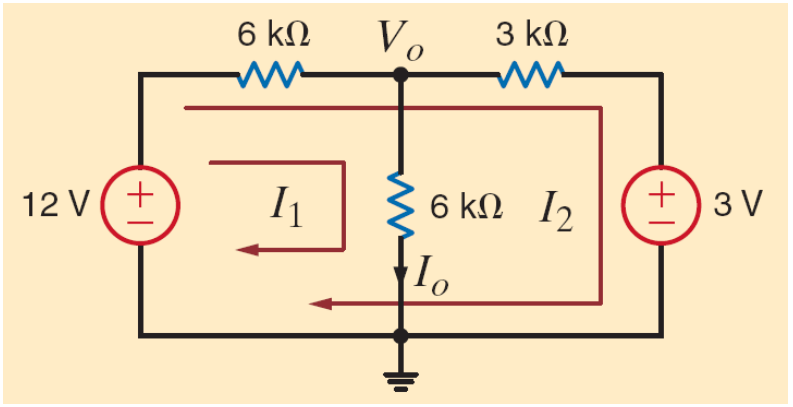
$$\begin{cases} +v_1 + v_3 + v_2 - v_{S1} = 0 \\ +v_{S2} + v_4 + v_5 - v_3 = 0 \end{cases} \Rightarrow \begin{cases} i_1(R_1 + R_2 + R_3) - i_2(R_3) = v_{S1} \\ -i_1(R_3) + i_2(R_3 + R_4 + R_5) = -v_{S2} \end{cases}$$

$$\Downarrow$$

$$\begin{bmatrix} R_1 + R_2 + R_3 & -R_3 \\ -R_3 & R_3 + R_4 + R_5 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} v_{S1} \\ -v_{S2} \end{bmatrix}$$

Loop Selection





Can I choose I_1 and I_2 loops this way, instead?

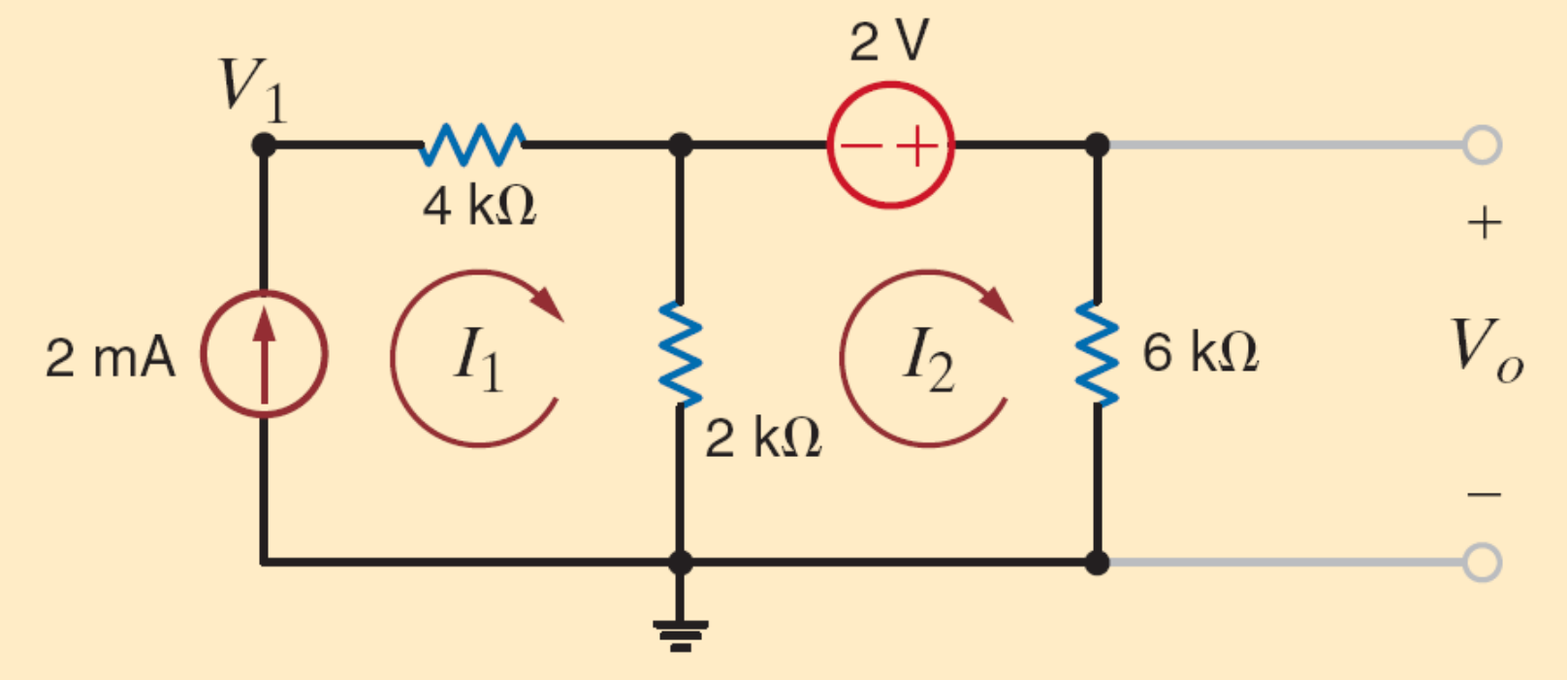
$$-12 + 6\text{k}(I_1 + I_2) + 6\text{k}I_1 = 0$$

$$-12 + 6\text{k}(I_1 + I_2) + 3\text{k}I_2 + 3 = 0$$

I_1 = 0.75 mA

I_2 = 0.5 mA

Circuits with Current Sources



$$2\text{k}(I_2 - I_1) - 2 + 6kI_2 = 0$$

$$I_1 = 2 \times 10^{-3}$$

$\Rightarrow$

I_1 = 2.0 mA

I_2 = 0.8 mA