# Solving Circuits by Mesh Analysis Example Problem

ECE 1020

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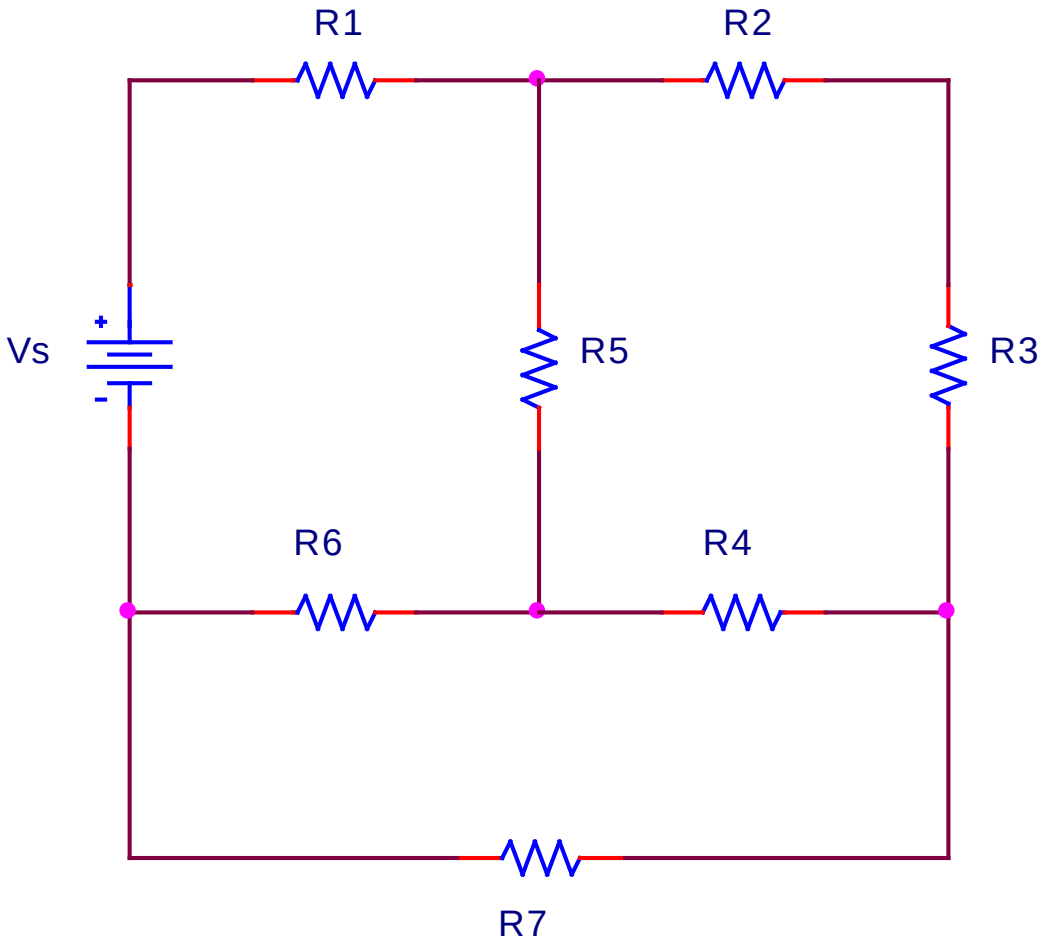
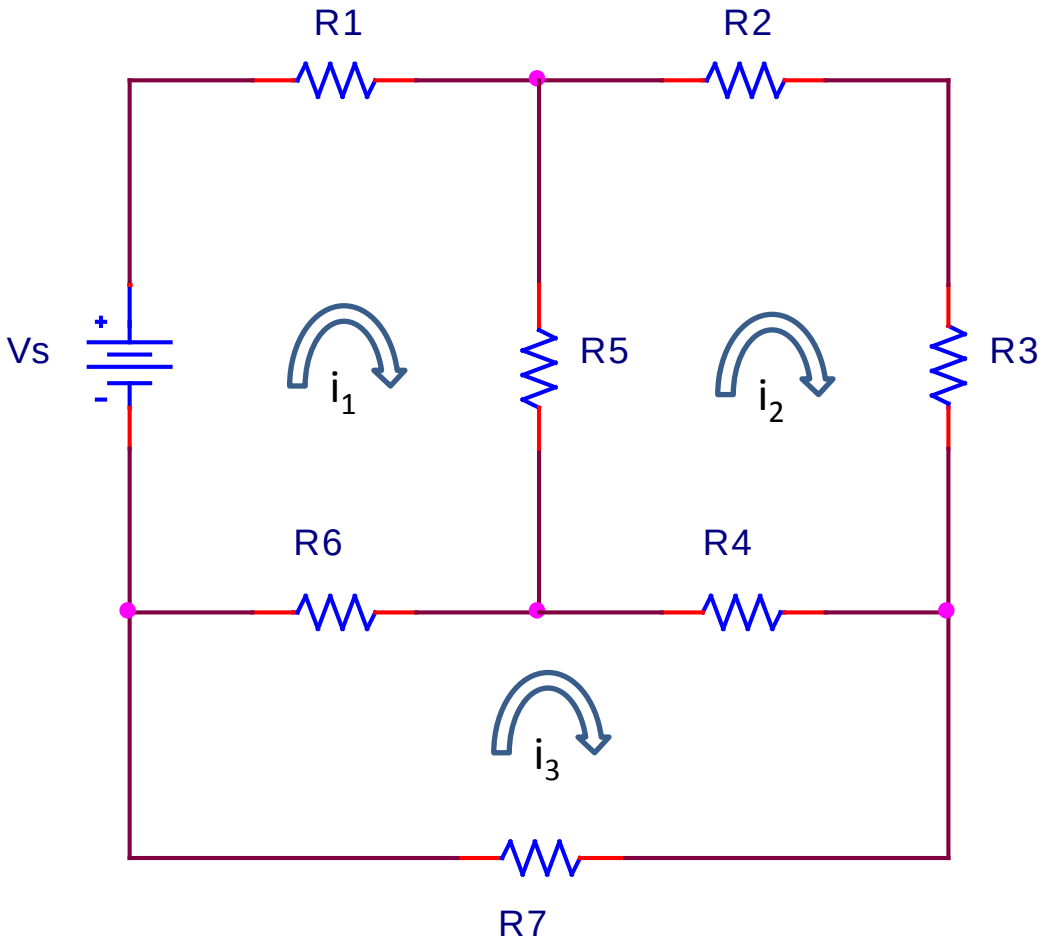



## Problem

Solve for all the currents and voltages in this circuit




## Step 1

Assign the mesh currents. Since there are 3 loops, we will assign 3 mesh currents.

# Step 2

- Apply KVL for $i_1$, $i_2$, and $i_3$
  - *Convention: Voltage rises are negative and voltage drops are positive*
- Mesh $i_1$: $-V_s + R_1 i_1 + R_5(i_1-i_2) + R_6(i_1-i_3) = 0$
- Mesh $i_2$: $R_2 i_2 + R_3 i_2 + R_4(i_2-i_3) + R_5(i_2-i_1) = 0$
- Mesh $i_3$: $R_4(i_3-i_2) + R_6(i_3-i_1) + R_7 i_3 = 0$

# Step 3

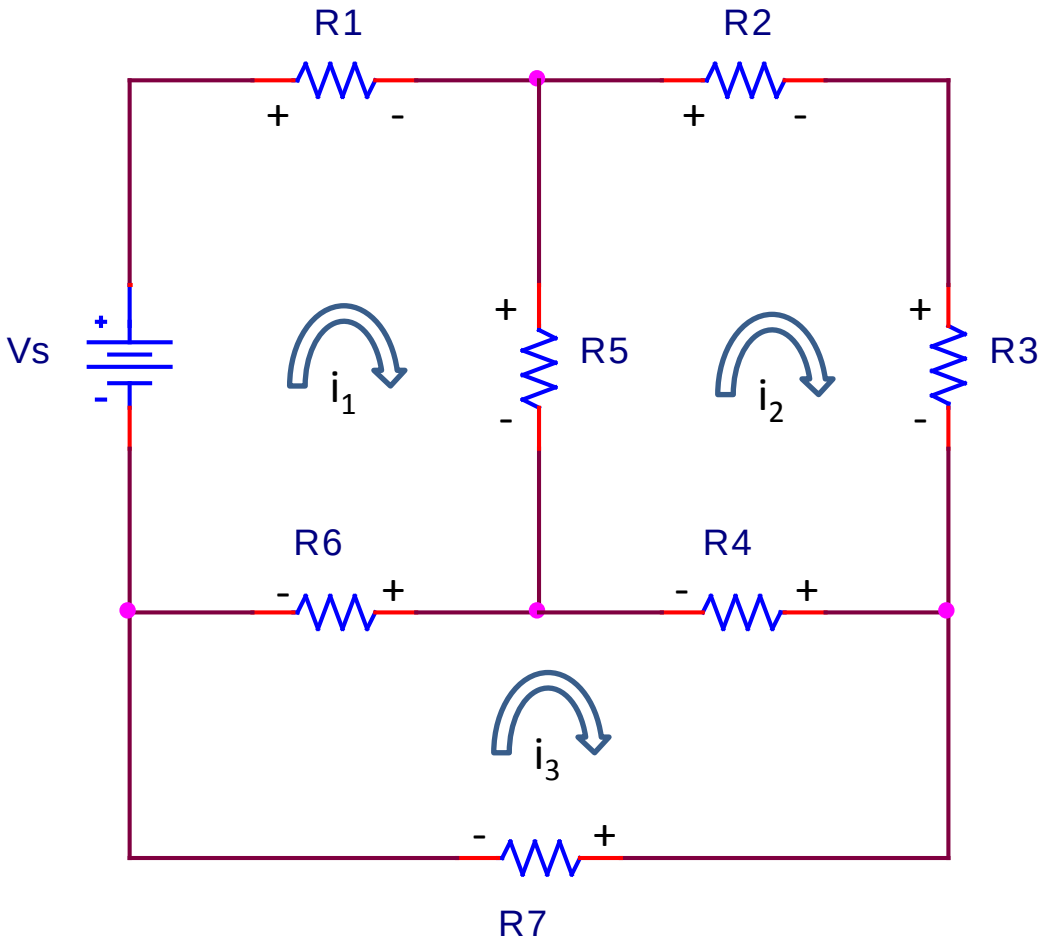
- Rearrange the mesh equations by consolidating terms
- Mesh $i_1$: $(R_1+R_5+R_6)i_1 - R_5i_2 – R_6i_3 = V_s$
- Mesh $i_2$: $-R_5i_1 + (R_2+R_3+R_4+R_5)i_2 – R_4i_3 = 0$
- Mesh $i_3$: $-R_6i_1 – R_4i_2 + (R_4+R_6+R_7)i_3 = 0$

# Step 4

- Place mesh equations into matrix form and solve for the i (current) vector

$$\begin{pmatrix} R_1+R_5+R_6 & -R_5 & -R_6 \\ -R_5 & R_2+R_3+R_4+R_5 & -R_4 \\ -R_6 & -R_4 & R_4+R_6+R_7 \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \\ i_3 \end{pmatrix} = \begin{pmatrix} V_s \\ 0 \\ 0 \end{pmatrix}$$

R i V




## Step 5

Assign a choice of polarity for your voltages. This will decide how you will sum the mesh currents for shared resistors. If the chosen direction of the mesh current follows the chosen polarity ( + → - ), then that mesh current is positive. If the mesh current is opposite, then it is negative.

# Step 6 – Calculate the individual currents and voltages

**Currents**

- $i_{R1} = i_1$
- $i_{R2} = i_2$
- $i_{R3} = i_2$
- $i_{R4} = i_2 - i_3$
- $i_{R5} = i_1 - i_2$
- $i_{R6} = i_1 - i_3$
- $i_{R7} = i_3$

**Voltages**

- $V_{R1} = R_1 i_{R1}$
- $V_{R2} = R_2 i_{R2}$
- $V_{R3} = R_3 i_{R3}$
- $V_{R4} = R_4 i_{R4}$
- $V_{R5} = R_5 i_{R5}$
- $V_{R6} = R_6 i_{R6}$
- $V_{R7} = R_7 i_{R7}$