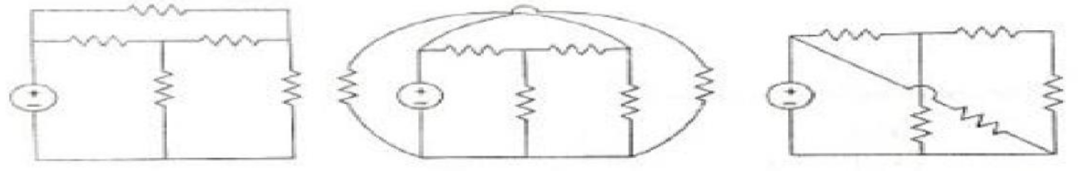
Introduction to Mesh Analysis:

Mesh Analysis:

Mesh analysis provides general procedure for analyzing circuits using mesh currents as the circuit variables. Mesh Analysis is applicable only for planar networks. It is preferably useful for the circuits that have many loops .This analysis is done by using KVL and Ohm's law.

Planar circuit: A planar circuit is one that can be drawn in a plane with no branches crossing one another. In the figure below (a) is a planar circuit.

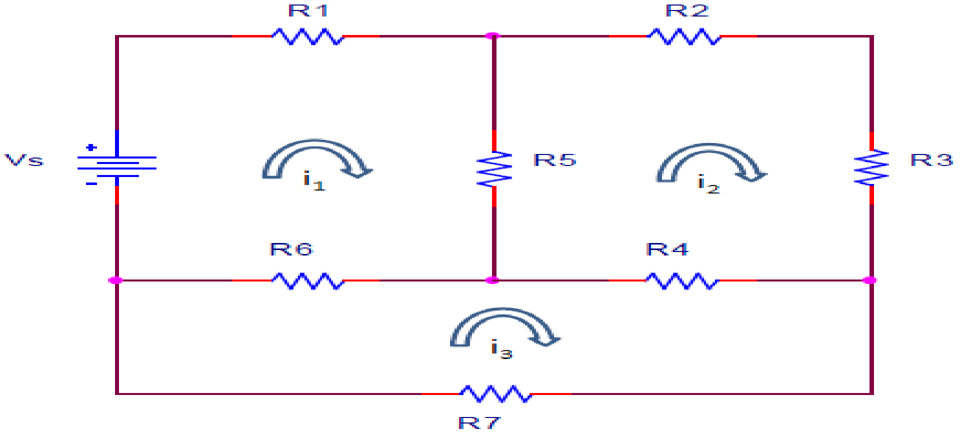
Non-Planar circuit: A non-planar circuit is one that cannot be drawn in a plane without the branches crossing one another. In the figure below (b) is a non-planar circuit and (c) is a planar circuit but appears like a non-planar circuit



(a) (b) (c)

Mesh: Mesh is a loop which does not contains any loop within it.

Mesh analysis with example: Determination of mesh currents:



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: $(R_1+R_5+R_6)i_1 - R_5 i_2 - R_6 i_3 = V_s$
- Mesh i_2: $-R_5 i_1 + (R_2+R_3+R_4+R_5)i_2 - R_4 i_3 = 0$
- Mesh i_3: $-R_6 i_1 - R_4 i_2 + (R_4+R_6+R_7)i_3 = 0$

Step 4:

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

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

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

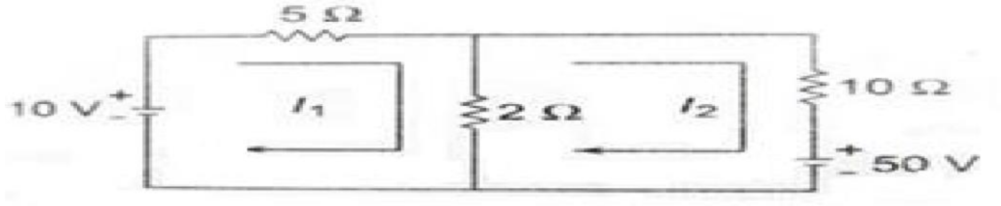
Currents

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

Voltages

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

Problem: Write down the mesh current equations for the circuit shown in the figure below and determine the currents I1 and I2.



Solution:

By applying KVL to the two meshes, we get

5 I1 + 2(I1- I2)=10

10 I2 + 2(I2- I1)= -50.

Solving the above equations gives.... I1 = 0.25 A and I2 = -4.125 A.