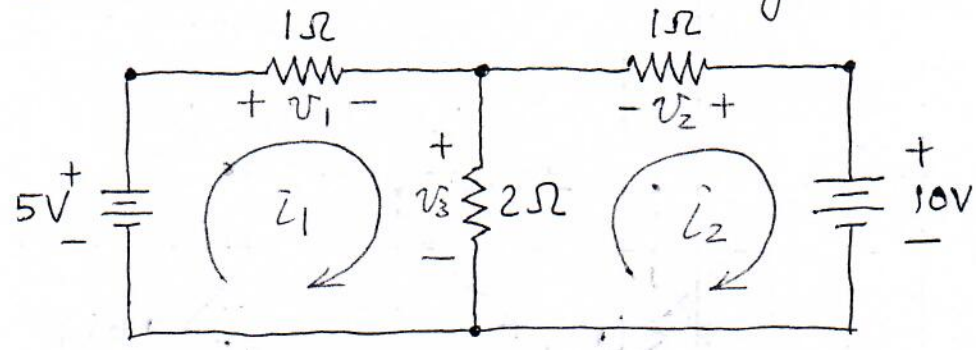
△ Mesh analysis -

A planar network partitions the plane into regions called "meshes".

The first step of mesh analysis is to use a "mesh current", around each mesh, either CW or CCW. To see this, consider the following circuit:



Two mesh currents, i_1 and i_2, are set up for the two meshes. Based on this setup, $(i_1 - i_2)$ represents the current going <u>down through</u> the 2-Ω resistor.

Now, use <u>KVL</u> to each mesh, :

"Mesh i_1": $v_1 + v_3 = 5$

By Ohm's Law : $\underbrace{1 i_1}_{v_1} + \underbrace{2(i_1 - i_2)}_{v_3} = 5$

$$\Rightarrow 3i_1 - 2i_2 = 5 \quad \text{------------} (\alpha)$$

"Mesh i_2": $v_2 + v_3 = 10$

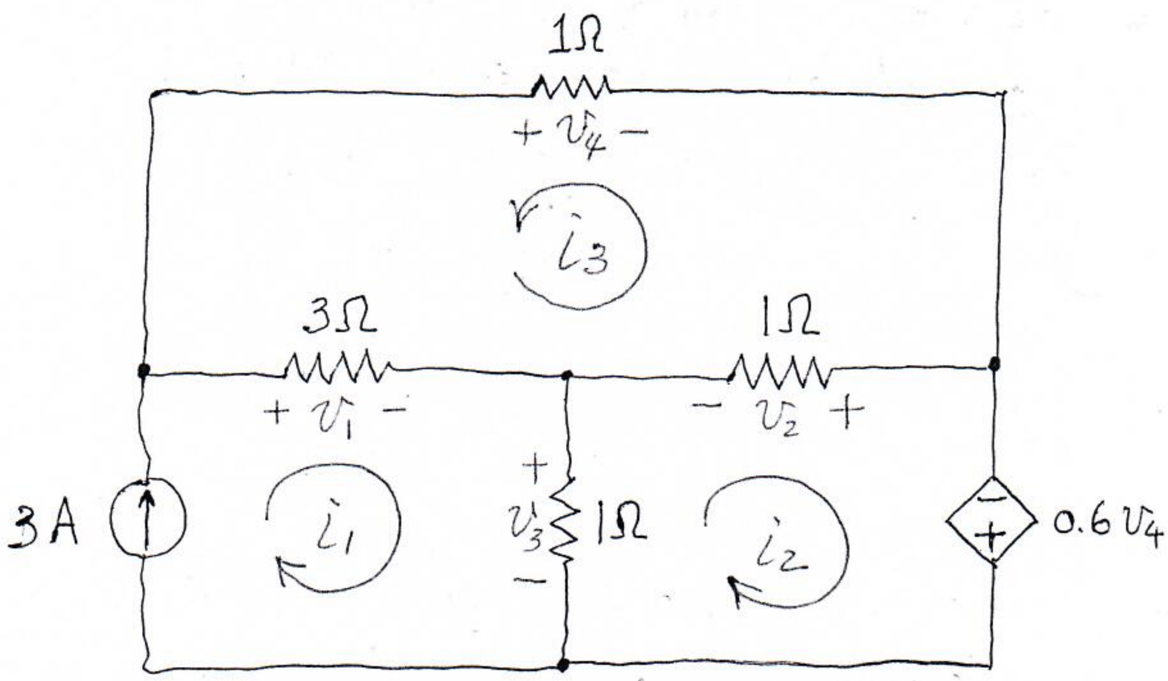
By Ohm's Law: $-1 i_2 + 2(i_1 - i_2) = 10$

$$\Rightarrow 2i_1 - 3i_2 = 10 \quad \text{------------} (\beta)$$

Using (α), (β) we can solve to get $i_1 = -1A$, $i_2 = -4A$.

Once all the mesh currents are found, we can find any current or voltage in the circuit. For example, $(i_1 - i_2) = 3A$; $v_1 = 1 i_1 = -1V$, $v_2 = -1 i_2 = 4V$, $v_3 = 2(i_1 - i_2) = 6V$.

△ Let's look at another more complex circuit:



Directions of mesh currents i_1, i_2, i_3 are arbitrarily chosen. By inspection, we see that $i_1 = 3A$. So, only i_2 and i_3 need to be found.

By KVL on "mesh i_2":

$$v_2 + v_3 + 0.6v_4 = 0$$

Ohm's law:

$$1(-i_2 - i_3) + 1(i_1 - i_2) + 0.6(-1i_3) = 0$$

$$\Rightarrow \quad 10i_2 + 8i_3 = 5i_1 = 5(3A) = 15 \cdots\cdots (\alpha)$$

By KVL on "mesh i_3":

$$v_1 - v_2 - v_4 = 0$$

$$3(i_1 + i_3) - 1(-i_2 - i_3) - (-1i_3) = 0$$

$$\Rightarrow \quad i_2 + 5i_3 = -3i_1 = -9 \cdots\cdots (\beta)$$

Solving $(\alpha), (\beta)$, we get $i_2 = 3.5A$, $i_3 = -2.5A$

By Ohm's law, since $i_1 = 3A$,

$$v_1 = 3(i_1 + i_3) = 1.5V$$

$$v_2 = 1(-i_2 - i_3) = -1V$$

$$v_3 = 1(i_1 - i_2) = -0.5V$$

$$v_4 = -1i_3 = 2.5V$$