Ex2.2 Use mesh analysis to find the current I0 in the circuit of Fig. 3.20.

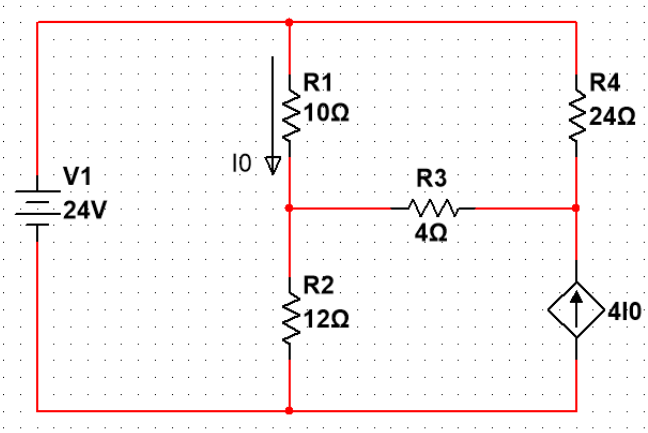

Figure 3.20

Solution:

Note that V2 at the right bottom side is a current controlled voltage source, the voltage of V2 equals to 4 times I0 as the illustration of Fig. explanation of current controlled voltage source.

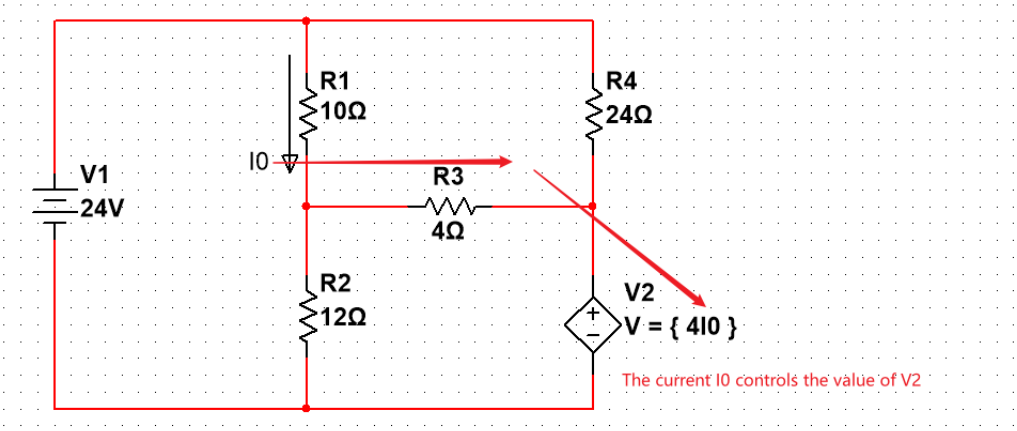

Figure3.21 explanation of current controlled voltage source

There are 3 meshes in the circuit as shown down below.

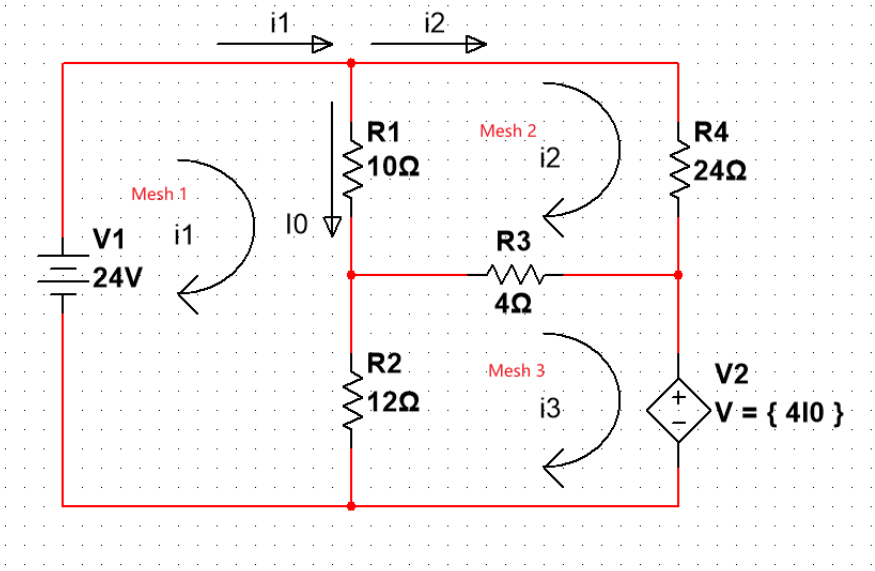

Figure3.22 Mesh explanation

We apply KVL to the 3 meshes in turn. For mesh 1,

$$-24 + 10(i_1 - i_2) + 12(i_1 - i_3) = 0$$
$$or$$
$$11i_1 - 5i_2 - 6i_3 = 12$$
$$11i_1 - 5i_2 - 6i_3 = 12$$

For mesh 2,

$$-24i_2 + 4(i_2 - 3) + 10(i_2 - i_1) = 0$$
$$or$$
$$-5i_1 + 19i_2 - 2i_3 = 0$$

For mesh 3,

$$4I_0 + 12(i_3 - i_1) + 4(i_3 - i_2) = 0$$

As at the top node, I0 = i1 - i2, so that,

$$4(i_1 - i_2) + 12(i_3 - i_1) + 4(i_3 - i_2) = 0$$
$$or$$
$$-i1 - i_2 + 2i_3 = 0$$

In matrix from all the three equations above, we can get,

$$\begin{bmatrix} 11 & -5 & -6 \\ -5 & 19 & -2 \\ -1 & -1 & 2 \end{bmatrix} \begin{bmatrix} i1 \\ i2 \\ i3 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \\ 0 \end{bmatrix}$$

We calculate the matrix,

$$i_1 = 2.25A$$
$$i_2 = 0.75A$$
$$I_0 = i_1 - i_2 = 1.5A$$