

## Class Note 15: Mesh Current Analysis with Current Source in a mesh – who cares if they call it “super-mesh” case?

### A. Background

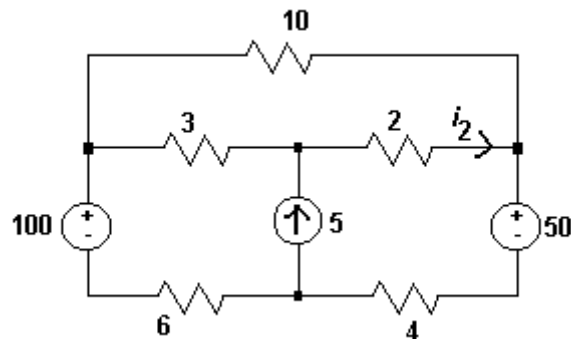
When we apply the mesh current method, if a current source is directly connected between two essential nodes, there exists a problem of expressing the current source in terms of a voltage drop. In such a case, the two adjacent forms to a new mesh, so-called a *supermesh*. However, as in the node voltage method, we use the same old mesh current method, without explicitly using the super mesh. Here again we use the "one more step" approach.

Let's solve an example problem, to clarify how we use the "one more step."

### B. Example Problem 1:

Let's consider a circuit shown below. Note that there is a current source connecting two nodes.

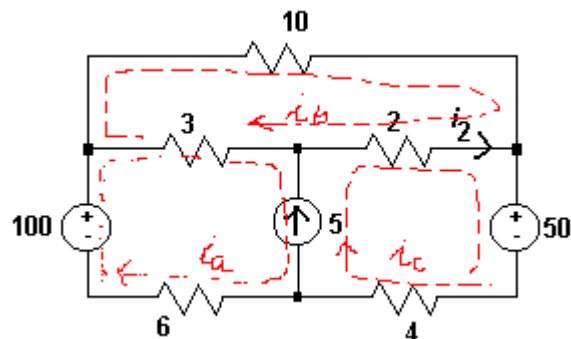
Q: We want to find the current through 2- $\Omega$  resistor,  $i_2$ .



### SOLUTION:

a. Let's have the three meshes  $I_a$ ,  $I_b$ , and  $I_c$  as shown below.

From the mesh currents, we have the following relationship for the current through the 2- $\Omega$  resistor:  $i_2 = i_c - i_b$



b. Let's apply KVL at each mesh:

@ mesh a: Apparently we have problem, since there is a current source.

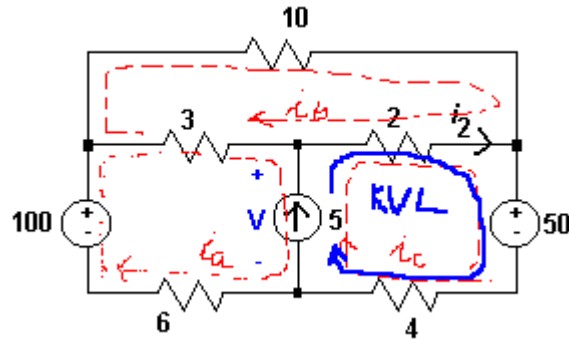
But let's have an equation anyway by defining the voltage across the 5[A] source as  $V$ :

$$-100 + 3(i_a - i_b) + V + 6i_a = 0$$

Now let's move our attention to the next mesh, mesh c:

Can you now express the voltage  $V$  in terms of the *mesh currents* by applying KVL?

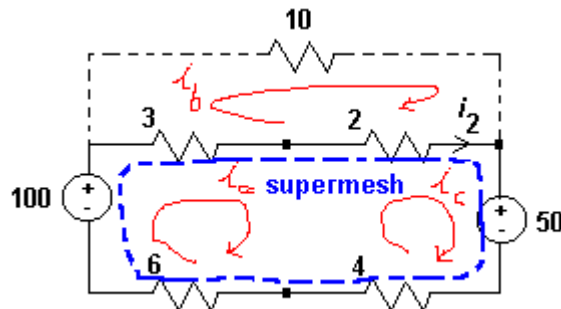
$$-V + 2(i_c - i_b) + 50 + 4i_c = 0 \Rightarrow V = 2(i_c - i_b) + 50 + 4i_c$$



Combining above two equations yields:

$$-100 + 3(i_a - i_b) + 2(i_c - i_b) + 50 + 4i_c + 6i_a = 0$$

c. Before simplifying above equation (1), let's have a close examination. The equation is also a mesh equation with voltage drops along the perimeter. If we reverse the equation into a circuit, the circuit would look like this:



e. There is no more the barrier between two meshes and they form a so-called **super-mesh**. OK, this is illustration purpose only.

e. Let's simplify the above equation:  $9i_a - 5i_b + 6i_c = 50$  -----(1)

f. Since equation (1) also covers mesh c, let's have an equation from mesh b:

@ mesh b:  $3(i_b - i_a) + 10i_b + 2(i_b - i_c) = 0$  ----->  $-3i_a + 15i_b - 2i_c = 0$  -----(2)

g. We have two equations and 3 variables, therefore, we need one more equation.

h. If you check the original circuit (by the way, this is why we do not use "super" thing; we have to check the original circuit anyway), we can find the following relationship:

$$i_c - i_a = 5 \text{ -----(3)}$$

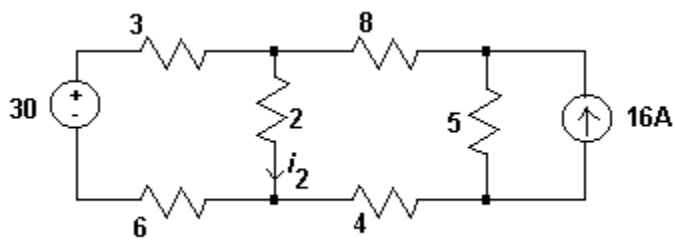
i. We solve the three equations (by Cramer's rule? Nah!) to get:

$$i_a = 1.75, \quad i_b = 1.25, \quad \text{and} \quad i_c = 6.75$$

j. Last words: If you cannot express a voltage drop along the perimeter, go *one more step* and express it using other mesh currents.

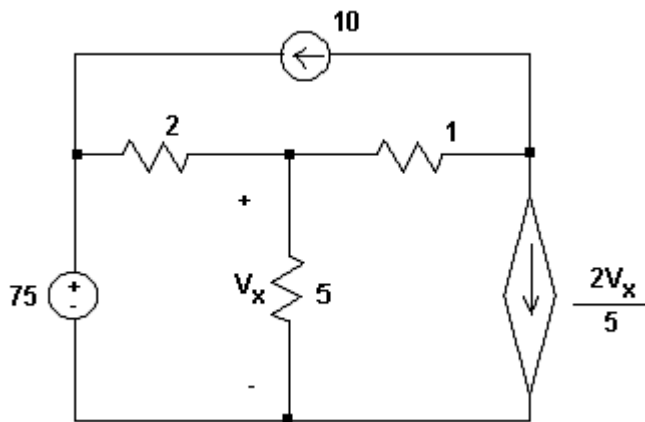
### C. Example Problem 2:

Q: Using Mesh Current method, find  $i_2$ .



**D. Example Problem 3:**

Q: Using Mesh Current method, find  $V_x$



**E. Example Problem 4:**

Q: Using Mesh Current method, find  $i_1$

