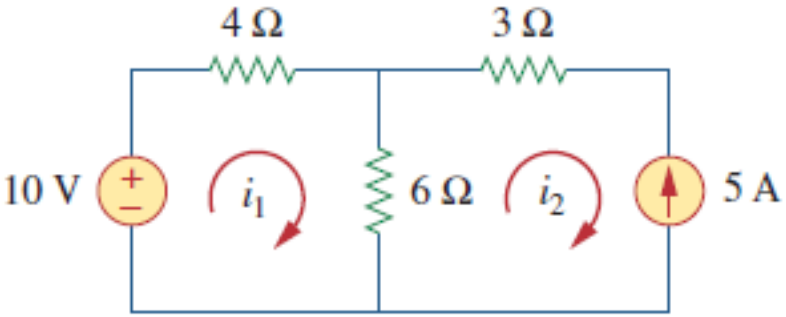
Electrical Circuits for Engineers (EC1000)

Lecture-3 (B2)
Super Mesh
(Ch.3.3)

Mesh Analysis with Current Sources

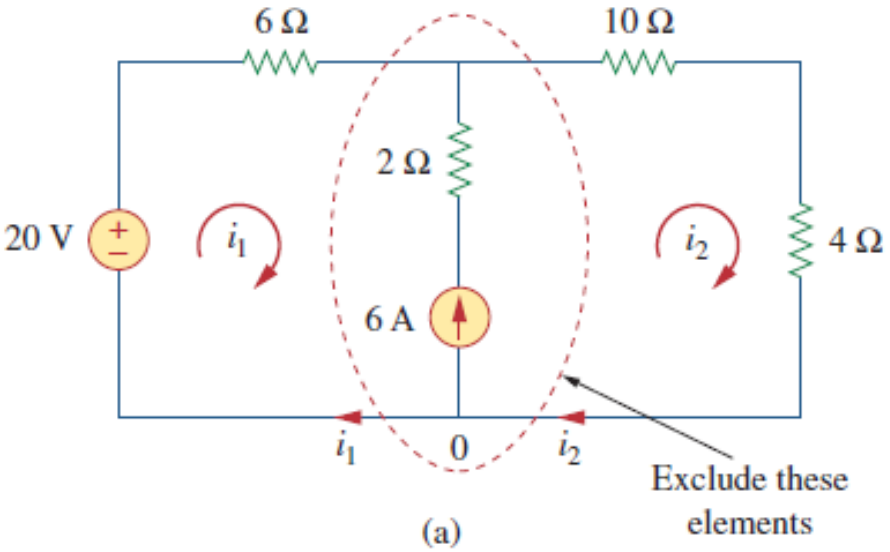
Applying mesh analysis to circuits containing current sources (dependent or independent) may appear complicated.

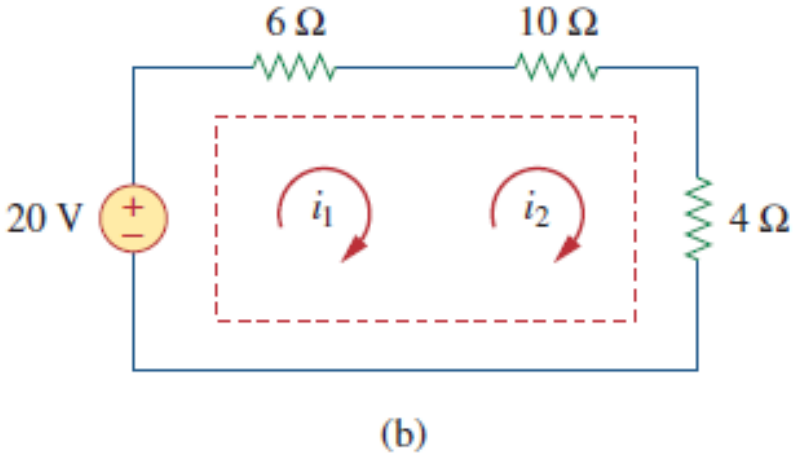


1. When a current source exists only in one mesh: Consider the circuit in above Figure, for example. We set I_2 =5a and write a mesh equation for the other mesh in the usual way; that is,

$$-10 + 4i_1 + 6(i_1 - i_2) = 0 \quad \Rightarrow \quad i_1 = -2\ \text{A}$$

2. When a current source exists between two meshes: Consider the circuit in Figure, for example. We create a ***supermesh*** by excluding the current source and any elements connected in series with it, as shown in Figure below. Thus,





Mesh Analysis with Current Sources

- Mesh analysis applies KVL—which requires that we know the voltage across each branch—and we do not know the voltage across a current source in advance.
- However, a supermesh must satisfy KVL like any other mesh.
- Therefore, applying KVL to the supermesh in Figure (b) gives

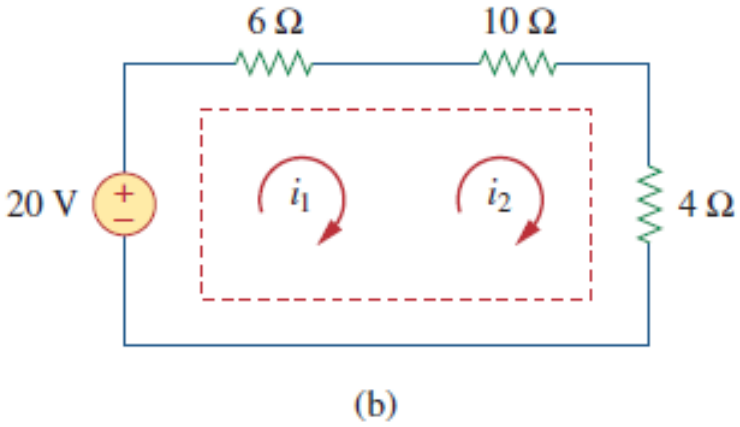
$$-20 + 6i_1 + 10i_2 + 4i_2 = 0 \quad \Rightarrow \quad 6i_1 + 14i_2 = 20$$

We apply KCL to a node in the branch where the two meshes

$$i_2 = i_1 + 6$$

Solving above equations

$$i_1 = -3.2\ \text{A}, \qquad i_2 = 2.8\ \text{A}$$



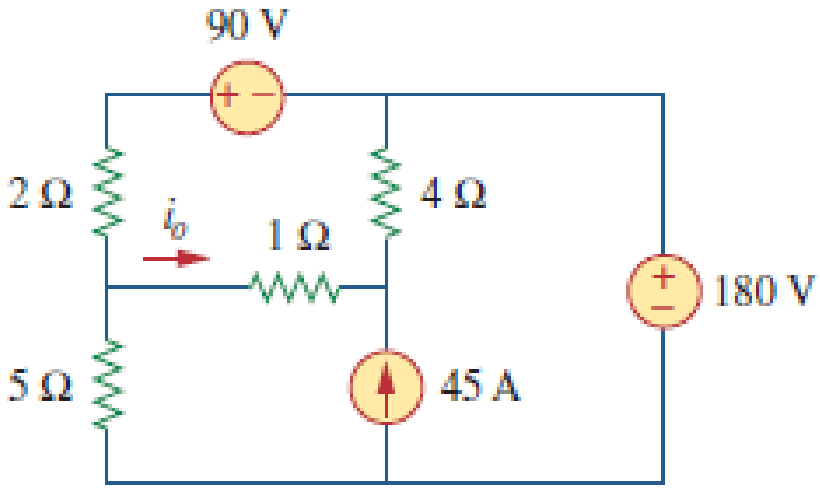
(b)

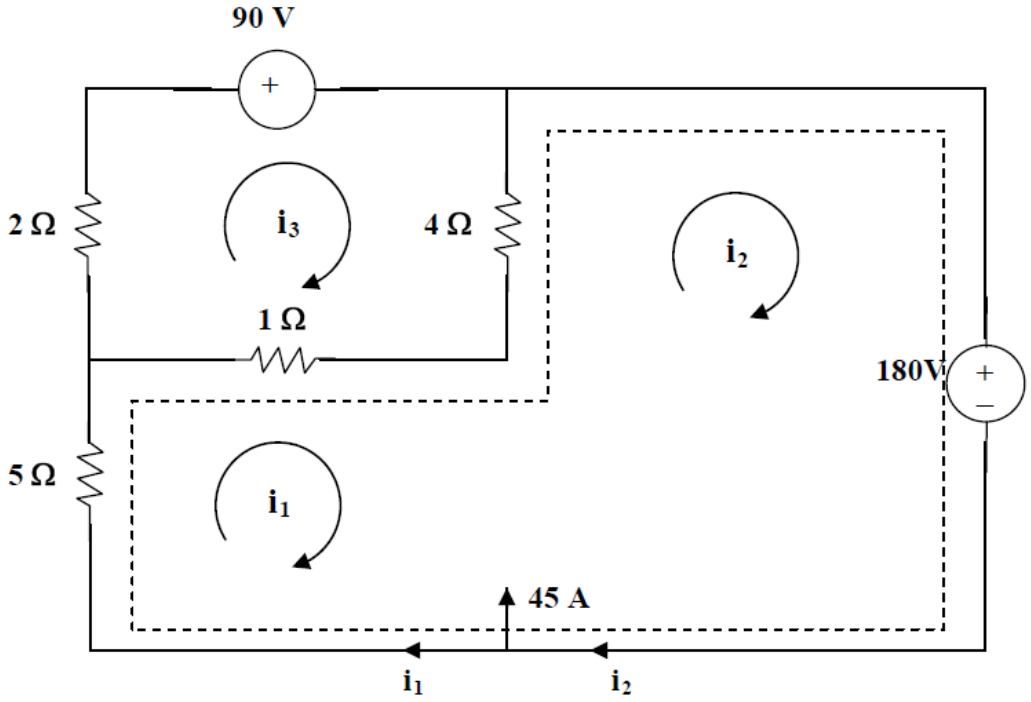
Note the following properties of a supermesh:

1. The current source in the supermesh provides the constraint equation necessary to solve for the mesh currents.
2. A supermesh has no current of its own.
3. A supermesh requires the application of both KVL and KCL.

Super Mesh

1. Use mesh analysis to determine i_0 in circuit.





Loop 1 and 2 form a supermesh. For the supermesh,

$$6i_1 + 4i_2 - 5i_3 + 180 = 0 \qquad (1)$$

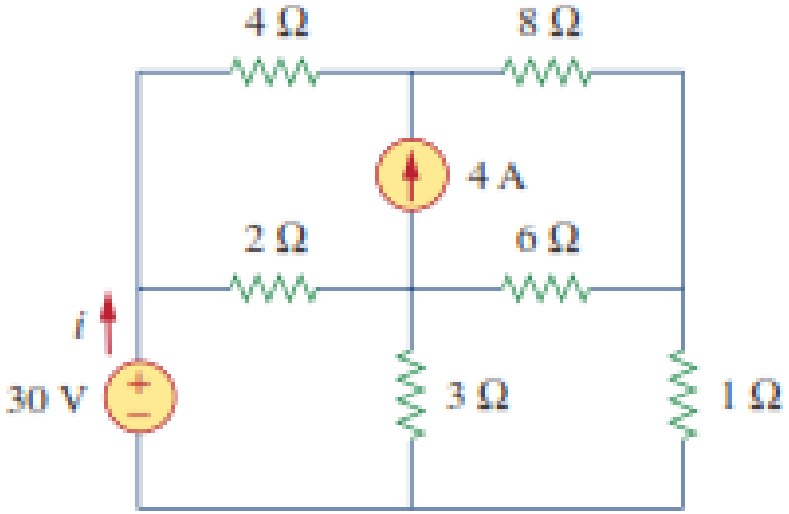
For loop 3, $$-i_1 - 4i_2 + 7i_3 + 90 = 0 \qquad (2)$$

Also, $$i_2 = 45 + i_1 \qquad (3)$$

Solving (1) to (3), $i_1 = -46$, $i_3 = -20$; $\quad i_o = i_1 - i_3 = \mathbf{-26\ A}$

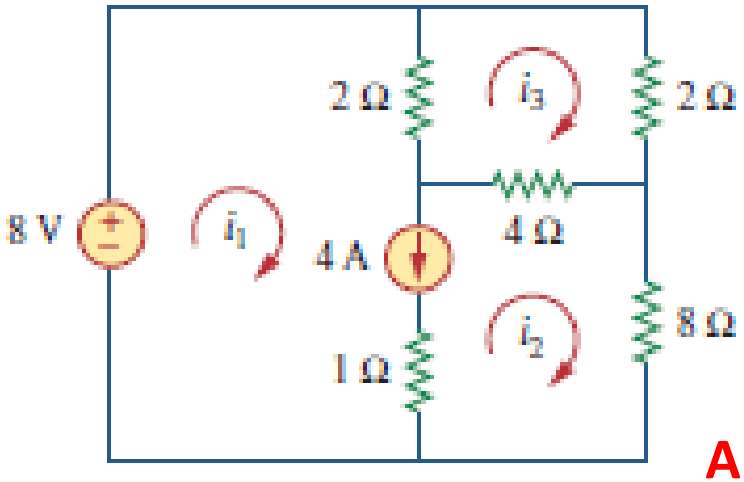
Problems

1. Find current i in the circuit of Figure below.



Ans: i=8.56 A

2. Use mesh analysis to obtain i_1, i_3, i_2 in the circuit.



Ans: i_1= 4.632 A, i_2 =631.6 mA, i_3 = 1.4736 A.