EE40
Lecture 8
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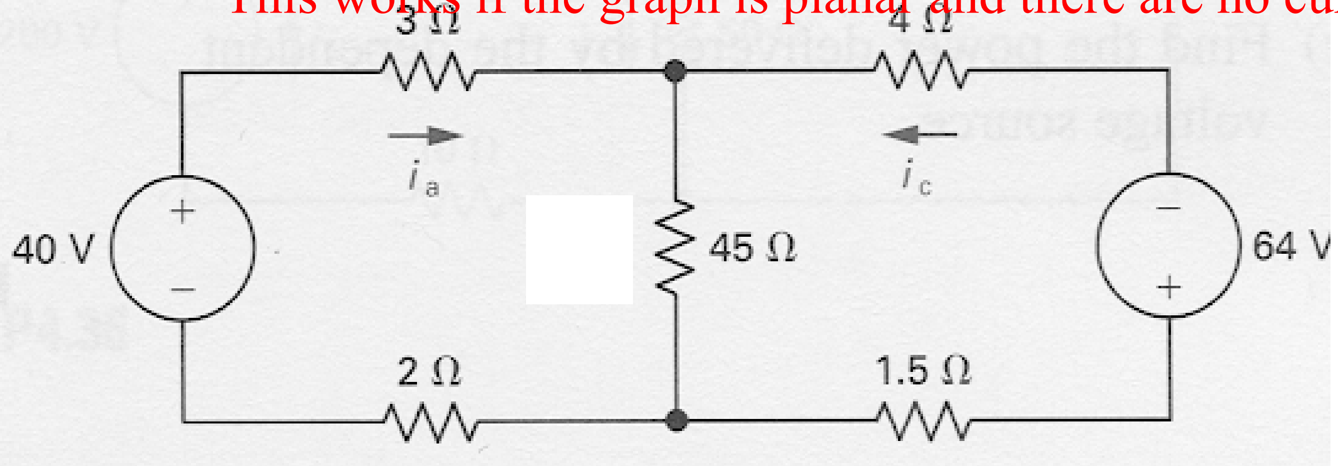
Reading: Chap. 2

Mesh Analysis, Superposition, Equivalent Circuits, Dependent sources

Mesh Analysis: Example #1

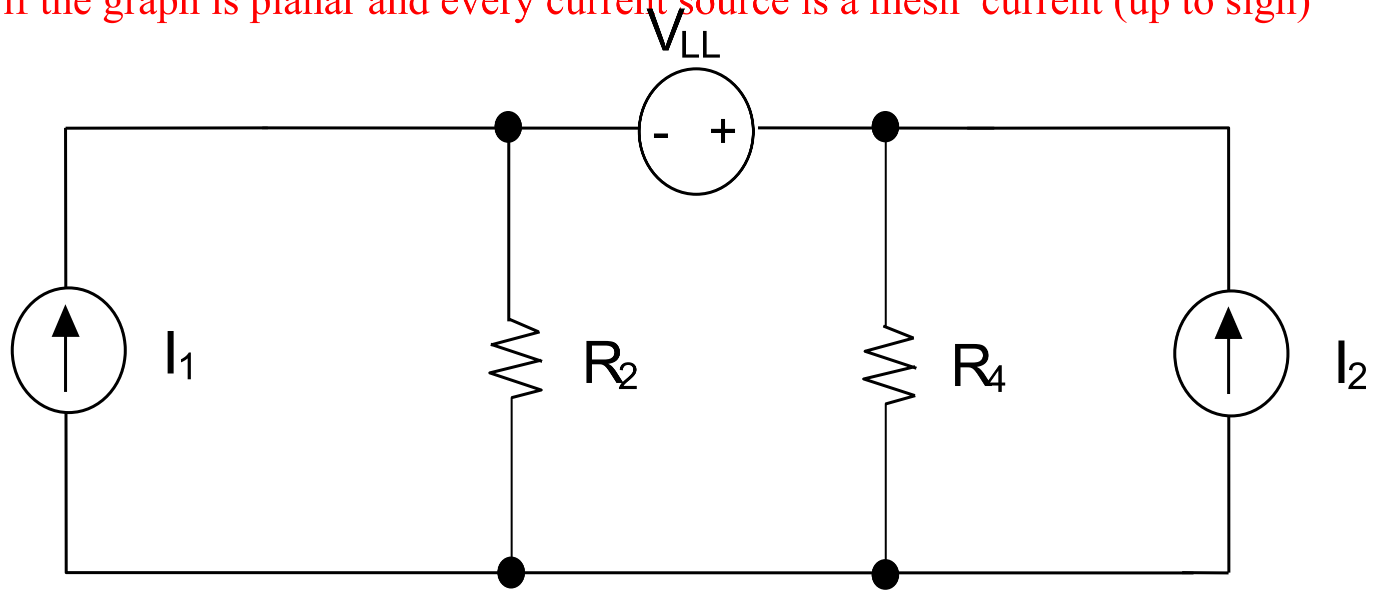
This works if the graph is planar and there are no current sources



1. Select mesh currents. Here these are ia and ic. In general there will be l-n+1 mesh currents when there are l links and n nodes. The current ia is thought of as going around the left loop clockwise and the current ib as going around the right loop counterclockwise. *(You could have chosen any direction of rotation you liked.)*
2. Apply KVL to each loop defined by each mesh current. *(You will need to use the defining relations of each circuit element encountered in this loop to write the voltage across it in terms of the current through it. For elements that have multiple mesh currents through them you will need to use the net current through that element for this. For instance the 45 ohm resistor has current ia+ic going from the its top terminal to its bottom terminal.)*
3. Solve for the mesh currents.

Mesh Analysis: Example #2

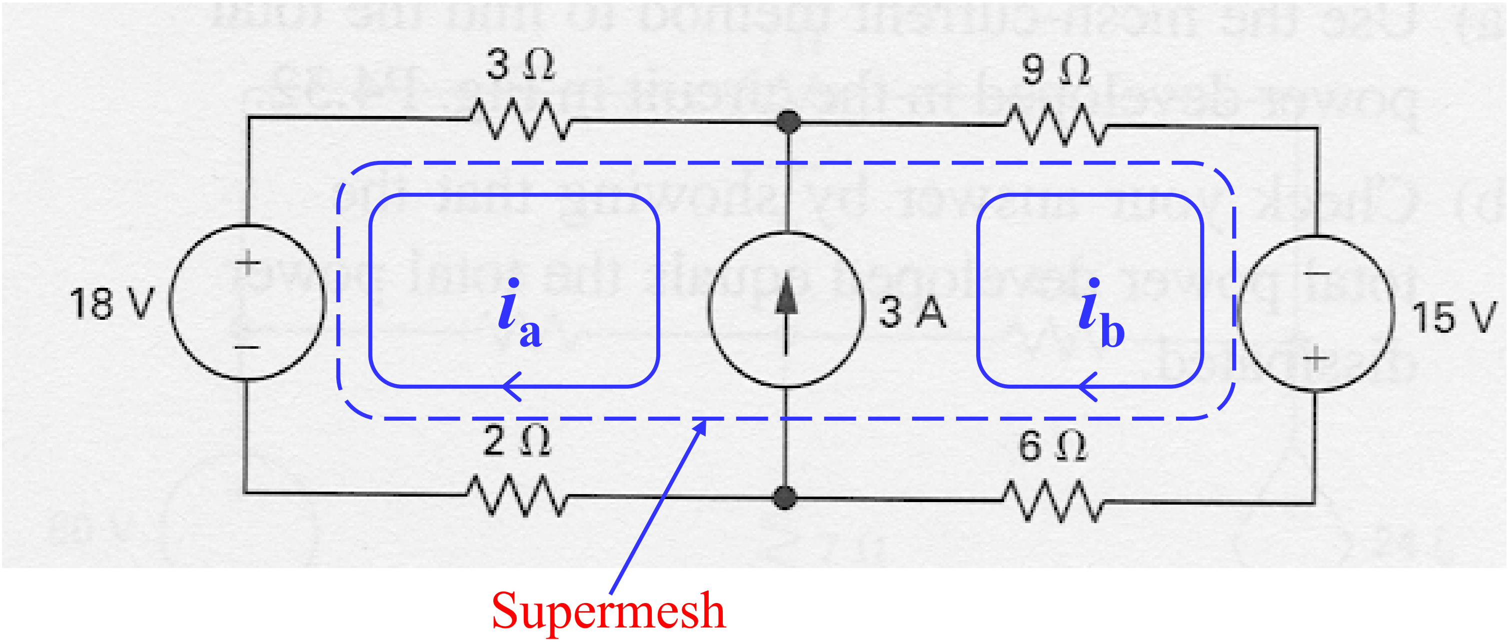
This works if the graph is planar and every current source is a mesh current (up to sign)



1. Select mesh currents. You need only do this for the mesh loops that do not involve a current source. Here there is only one such current, circulating through the voltage source, R4 and R2. Call it ia and assume it circulates clockwise. In general there will be l – n+ 1 –(#current sources) such currents.
2. Apply KVL to each loop defined by each mesh current. You will need to first identify the total current flowing through each element and then use the I/V characteristic of each element that is not a current source to find the voltage drop across it. For instance the current flowing through R2 from its top terminal to its bottom terminal is I1 – ia.
3. Solve for mesh currents. Use the remaining KVL equations to find the voltages across the current sources.

There is only one equation in one variable in this example!

Mesh Analysis: Example #3



If you start with a planar graph and initially choose mesh currents so that some current source falls in more than one mesh loop you will need to replace some of the mesh KVL equations by supermesh equations. You will also need to write one equation for each current source, which expresses it in terms of the mesh currents.

You should ensure that each current source appears in exactly one mesh/supermesh.

You can then solve for the mesh currents. See the book for details. There are l-n+1 equations in an equal number of variables.

Mesh Analysis: general case (planar or not)

- Pick any tree in the graph of the circuit that does not contain any current sources
(you will always be able to do this)
- Each link that is not in the tree will define a unique loop. For each such link that is not a current source, introduce one loop current variable, thought of as circulating in that loop. *(The total number of such loop current variables will equal l –n + 1 –(#current sources).)*
- Write KVL around each loop defined by an unknown loop current. *(You will need to use the current/voltage relationship of each link that is not a current source in order to write the voltage across it in terms of the current through it. To find the current through it you will need to add –with appropriate sign– all the loop currents going through it -- including the current sources).*
- *Solve the resulting l-n+1 –(#current sources) equations in an equal number of variables.*
- *Finally, to find the voltage drop across each current source, write KVL in the unique loop that it defines when added to the chosen tree.*

Mesh Analysis: exercise

- *It is a very useful exercise for you to go back to the first three special cases, i.e. (1) the case of planar graphs with no current sources; (2) the case of planar graphs where each current source is in a unique mesh loop; and (3) the case where you need to use supermeshes, and to understand what the algorithm in each special case actually means when thought of in terms of the general algorithm using trees that was just presented.*

Dependent Sources

Treat each dependent source (of any of the four kinds) as a new variable, associated to a ``known" source and proceed as before. At the end, you get an extra equation from the dependency that defines the source, for each dependent source.

These extra equations will allow you to solve for all the unknown mesh current (mesh analysis) variables.

Dependent Sources: Exercise

Try solving this circuit using both nodal analysis and mesh analysis and verify that you get the same answer.