## Exercise 1:

This circuit consists of 6 elements connected together at 4 nodes:


Write 6 element equations, one for each element.

Write 4 KCL equations, one at each of the 4 nodes.

Write 4 KVL equations, one for each mesh and one for the outside loop.

Describe the following: $v_{1} i_{1}, v_{2} i_{2}, v_{3} i_{3}$ and $v_{6} i_{6}$.

## Solution 1:

This circuit consists of 6 elements connected together at 4 nodes:


Write 6 element equations, one for each element.

$$
v_{1}=20 i_{1}, \quad v_{2}=-5 i_{2}, \quad i_{3}=3 \mathrm{~A}, \quad v_{4}=12 i_{4}, \quad v_{5}=-4 i_{5}, \quad v_{6}=8 \mathrm{~V}
$$

Write 4 KCL equations, one at each of the 4 nodes.

$$
i_{2}+i_{3}=i_{1}, \quad i_{5}=i_{3}+i_{6}, \quad i_{4}+i_{6}=i_{5}, \quad i_{1}=i_{2}+i_{4}
$$

Write 4 KVL equations, one for each mesh and one for the outside loop.

$$
v_{2}-v_{1}=0, \quad v_{3}+v_{5}-v_{4}-v_{2}=0, \quad v_{6}-v_{5}=0 \quad v_{3}+v_{6}-v_{4}-v_{1}=0
$$

Describe the following: $v_{1} i_{1}, v_{2} i_{2}, v_{3} i_{3}$ and $v_{6} i_{6}$.
$v_{1} i_{1}$ is the power received by the $20 \Omega$ resistor,
$v_{2} i_{2}$ is the power supplied by the $5 \Omega$ resistor,
$v_{3} i_{3}$ is the power supplied by the current source,
$v_{6} i_{6}$ is the power received by the voltage source

## Remark:

There are 12 unknowns in this exercise, $v_{1,} v_{2}, v_{3}, v_{4}, v_{5}, v_{6}, i_{1}, i_{2}, i_{3}, i_{4}, i_{5}$, and $i_{6}$, the element voltages and currents of 6 elements. We've written 6 element equations and 8 Kirchhoff's law equations for a total of 14 equations in 12 unknowns. That's a lot of equations, too many equations.

## Exercise 2:

This circuit consists of 6 elements connected together at 4 nodes:


Write 6 element equations, one for each element.

Write 4 KCL equations, one at each of the 4 nodes.

Write 4 KVL equations, one for each mesh and one for the outside loop.

Describe the following: $v_{1} i_{1}, v_{3} i_{3}, v_{5} i_{5}$ and $v_{6} i_{6}$.

## Solution 2:

It's helpful to add the names of the controlled voltage of the VCCS and the controlled current of the CCVS to the labels of these elements.


Write 6 element equations, one for each element.

$$
v_{1}=-20 i_{1}, \quad i_{2}=-0.012 \frac{d v_{2}}{d t}, \quad v_{3}=5 i_{1}, \quad i_{4}=3 \mathrm{~A}, \quad i_{5}=0.5 v_{4}, \quad v_{6}=8 \mathrm{~V}
$$

Write 4 KCL equations, one at each of the 4 nodes.

$$
i_{1}+i_{2}=i_{3}, \quad i_{3}=i_{5}+i_{6}, \quad i_{5}+i_{6}=i_{4}, \quad i_{4}=i_{1}+i_{2}
$$

Write 4 KVL equations, one for each mesh and one for the outside loop.

$$
v_{2}-v_{1}=0, \quad-v_{3}+v_{5}-v_{4}-v_{2}=0, \quad v_{6}-v_{5}=0 \quad-v_{3}+v_{6}-v_{4}-v_{1}=0
$$

Describe the following: $v_{1} i_{1}, v_{3} i_{3}, v_{5} i_{5}$ and $v_{6} i_{6}$.
$v_{1} i_{1}$ is the power supplied by the $20 \Omega$ resistor,
$v_{3} i_{3}$ is the power supplied by the CCVS,
$v_{5} i_{5}$ is the power received by the VCCS,
$v_{6} i_{6}$ is the power received by the (independent) voltage source

