Lehne Part 2 - Nodal Analysis

Administrivia: Let change HW problem 2.72 (Chevers) & 2.85 (superposition) to be due along with HW #2. Note: Cancelled 2.53! (no need: analog)

Nodal analysis cor node-voltage analysis

Goal: Find unknown voltage in the circuit.

Very general memo: PSpice use it, everyone use it.
It is very algorithmic. Note: On the test, I won't ask you to solve (i.e. explicitly find) voltages for more than 2 unknown voltages.

Example: (P.247 p. 109)

(Q1) Find unknown node voltages using node analysis.
Note: (1) I use the convention in kV.

\[ \sum (\text{current into a node}) = \sum (\text{current out of a node}) \]

(2) Bal. use mostly: \( \sum (\text{current out of a node}) = 0 \)

You are free to use (1) or (2), but (1) is more intuitive.

Let's go through step-by-step the model analysis technique.
Step 1: Mark ground node. If it is not given, bottom node in a circuit is usually a good choice. Try to minimize number of unknown node voltages. It will become obvious through practice!

Step 2: Label unknown node voltage.
Step 3: \text{KCL at each unknown node (except ground node)}

\text{KCL at node } v_1: \quad -5 + i_1 + i_2 = 0
\quad \Rightarrow \quad i_1 + i_2 = 5

\text{KCL at node } v_2: \quad 3 = i_2 + i_3
\quad \Rightarrow \quad i_3 = 3 - i_2

3 + i_2 = i_3
Step 4: Replace current source with unknown node voltage.

Node $v_1$: $5 = i_1 + i_2$

$i_1 = \frac{v_1}{10 \ \Omega}$, $i_2 = ? = \frac{v_1 - v_2}{20}$

$x$
Notice you cannot write an expression for \( i_2 \), because \( i_2 \) is going through a dependent voltage source. In other words, you cannot find the current through a voltage source using the voltage source alone.

Because:

\[
\begin{align*}
10V & \quad U = 10\, V \\
\text{No } i & \quad \text{dependency}
\end{align*}
\]

Note: Be **not** of this statement! You don't know voltage across a current source, do **not**
Given the voltage across the current sources is 2.5

Going back, @ \( V_1 \):
\[
5 = \frac{V_1}{10} + l_2
\]

Now, @ \( V_2 \):
\[
3 + l_2 = i_3
\]

\[
\Rightarrow 3 + i_2 = \frac{V_2}{20}
\]

Eliminate \( i_2 \) using (1) & (2):
\[
3 + \left( 5 - \frac{V_1}{10} \right) = \frac{V_2}{20}
\]
Step 5: Constraint equation. Since 500 still have too many unknowns, look for constraint equation.

\[ V_1 - V_2 = 5 \text{V} \]

Step 6: Finally, we eliminate variables in dependent source. Here, \( x = 1 \).

\[
\begin{align*}
3 + \left(5 - \frac{V_2}{10}\right) &= \frac{V_2}{20} \\
\end{align*}
\]
\[ V_1 - V_2 = 5 \sqrt{2} \]
\[ i_3 = i_1 = \frac{V_1}{10} \]

Solving:

\[ V_1 - V_2 = 5 \left( \frac{V_1}{\sqrt{10}} \right) \Rightarrow V_1 - V_2 = \frac{V_1}{2} \]
\[ \Rightarrow \frac{1}{2} V_1 = V_2 \implies V_1 = 2V_2 \]

\[ 3 + 5 - \frac{2V_1}{10} = \frac{V_2}{20} \Rightarrow 8 = \frac{2V_2}{10} + \frac{V_2}{20} \]
\[ \Rightarrow 8 = \frac{4V_2}{20} + \frac{V_2}{20} \]
\[ 8 = \frac{5V_2}{20} \Rightarrow V_2 = \frac{32 \sqrt{2}}{5} \]
\[ V_1 = 64 \sqrt{2} \]
Now, let's solve this problem. Why ASPIRE!

You have the student version of PSpice on one of the CDs which came with the book (Appendix D in your book has the hybrid). USE Pspice!
I will post signed proof online.

Next week: Monday → Chapter 2, Chapter 3

Finish Wednesday → Chapter 4

Friday →

Note: (1) Office hours on Sunday by check Google groups!
(2) How #1 change:

change hw problem 2.72 (Chevain)
& 2-85 (superposition) to be due along with hw #2. Note: Cancelled 2-53! (no need, analyze)