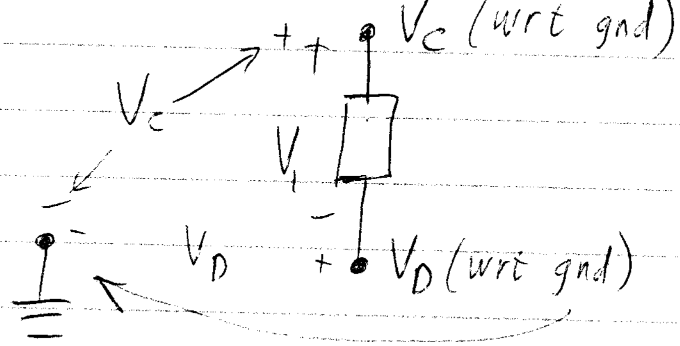
We need to move on to Ch. 3 to get some tools for analyzing larger circuits systematically, ~~Many large~~ and for designing ckts. to meet specific needs. There are 6 important sections, some longer, some shorter, so let's get started:

The first general technique is called, in this text, Node-Voltage Analysis, which I will sometimes call Nodal Analysis. This is a very general method, it can be applied to all circuits, and is the basis for all the computer circuit analysis programs I know of.

Node Voltage Analysis:

1.) Uses the ~~idea~~ "altitude" idea and ~~eq~~ finds the Voltage of every node of a circuit with respect to one node, called the reference, or ground.

2.) The voltage drop across any element is then the Voltage of the node at the + end, minus the Voltage of the node at the − end.



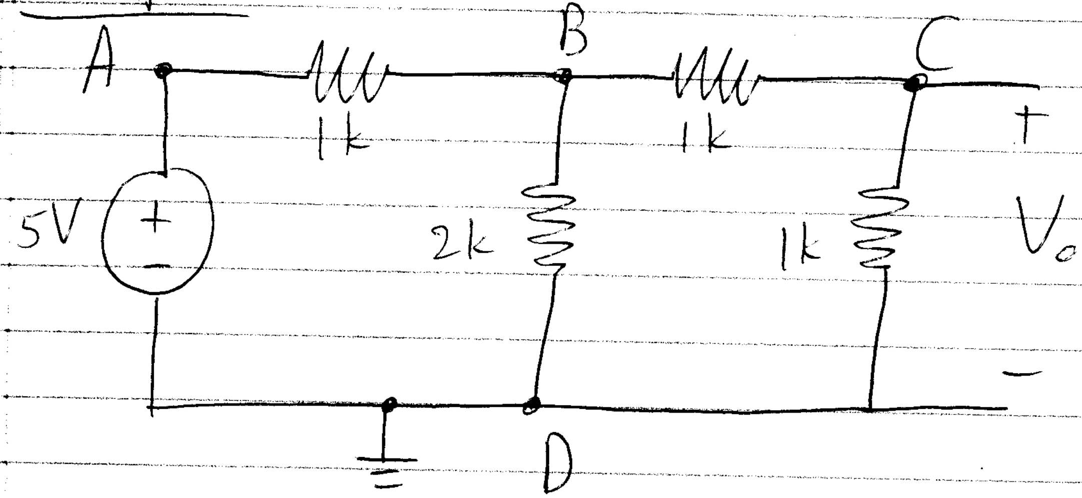
$$V_1 = V_C - V_D$$

3.) Write KCL at every node except the reference node.

4.) Express each I in the KCL expressions in terms of the node voltages.

5.) Collect terms and solve for the node voltages.

Example



Label nodes − 4

Select Reference − D

Write desired output in terms of node V's: $V_o = V_c - \ldots$

$\underline{V_o = V_c}$

Remaining: 3 nodes

Voltage sources connected to Reference?

Yes − 5V $\Rightarrow$ $\underline{V_A = 5V}$ one is done.

Remaining 2 nodes (B+C)

$$B: \quad \frac{V_B - V_A}{1k} + \frac{V_B - 0}{2k} + \frac{V_B - V_c}{1k} = 0$$

$$\times 2k: \quad 2(V_B - V_A) + V_B + 2(V_B - V_c) = 0$$

$$2V_B - 2V_A + V_B + 2V_B - 2V_c = 0$$

known

$$\underline{5V_B - 2V_c = 2V_A = 2(5V) = 10V}$$

C: $\frac{V_C - V_B}{\cancel{1}k} + \frac{V_C - 0}{1k} = 0$

x1k: $V_C - V_B + V_C = 0$

$2V_C - V_B = 0$ usual form. Now to solve for $V_B + V_C$

$2V_C = V_B$

Back Substitute: $5V_B - 2V_C = 10V$

$5V_B - V_B = 10V$

$4V_B = 10V$

$V_B = \frac{10}{4}V = 2.5V$

$V_C = \frac{1}{2}V_B = \frac{2.5V}{2} = 1.25V$

Another way to solve:

2 Eqn's $5V_B - 2V_C = 10V$

$-1V_B + 2V_C = 0$

Write as matrix: $\begin{pmatrix} 5 & -2 \\ -1 & 2 \end{pmatrix} \begin{pmatrix} V_B \\ V_C \end{pmatrix} = \begin{pmatrix} 10V \\ 0 \end{pmatrix}$

Add row 1 + row 2: $\begin{pmatrix}(5-1) & (2-2)\end{pmatrix}\begin{pmatrix}V_B \\ V_C\end{pmatrix} = \begin{pmatrix}10V\end{pmatrix}$

$$\begin{pmatrix}4 & 0\end{pmatrix}\begin{pmatrix}V_B \\ V_C\end{pmatrix} = 10V$$

$$4V_B = 10V$$

$$V_B = 2.5V$$

$$2V_C = V_B$$

$$V_C = \frac{1}{2}V_B = \frac{2.5V}{2} = 1.25V$$