Re: Analysis of circuits containing diodes

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- *From*: <jwelser@xxxxxxxxxxxxxxxxx>

- *Date*: Tue, 24 Jan 2006 18:26:45 +0000 (UTC)

longjohnstuartmill@xxxxxxxxxxx wrote:
: Hi,

: For the past couple of weeks I've been working through a book called
: "Network Analysis" by M.E. Van Valkenburg. Specifically, I've learned
: how to use Mesh/Nodal Analysis and Laplace Transforms to analyze simple
: circuits. I'm pretty amazed at the power of these techniques (thank
: you, Mr. Heaviside), even though I still have to learn more about
: differential equations and other things.

: Anyway, the book doesn't cover semiconductor components, and I would
: like to know how you would perform Nodal/Mesh Analysis on circuits that
: contain diodes. Is it difficult to do this type of analysis? I'm
: hoping to apply these techniques to a voltage doubler circuit to help
: me understand how it works, but I can't really do that without knowing
: how to address diodes.

: Thank you very much for your help!

Nodal Analysis is a technique that is applied to solve linear
circuits.

Diodes, BJTs, MOSFETs are non−linear elements, with multiple
regions of operation. In order to solve circuits containing these
elements, they must be replaced with linear models. The problem is that
they use a different linear model for different regions of operation.

A diode (to answer your initial question) can be modeled in one of
two regions of operation: Forward or reverse biased (let's ignore
avalance breakdown now, for simplicity.) A forward−biased
can be modeled as a voltage source with the value of the forward voltage
drop of the diode. A reverse biased diode can be modeled as an open
circuit.

To solve the circuit, you have to guess at which of the two
regions of operation the diode is operating in, replace the diode with the
appropriate linear model, and then solve the circuit with nodal analysis.
Once the circuit has been solved, you need to check to see whether your
guess was correct.

In the case of the diode, if you guessed forward−biased, but the current through the diode was negative (i.e. flowing from cathode to anode) when you solved the circuit, you guessed wrong −− forward biased diodes necessarily must have positive current. Then you would re−solve the circuit using the reverse−biased model. Conversely, if you guessed reverse−biased, but found a voltage drop across the diode (modeled as an open circuit) greater than the forward voltage drop of the diode, you guessed wrong, because a diode with a large voltage drop (in the correct direction) across it would be forward−biased. Therefore, you would re−solve the circuit using the forward−biased model.

This process is identical for other non−linear elements, the only difference is that the linearized models for those elements are more complicated, and have more regions of operation.

Joe

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- ***References***:
  - ♦ ***Analysis of circuits containing diodes***
    - ◊ *From:* longjohnstuartmill

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