EECS 312 – Electronic Circuits I – Notes
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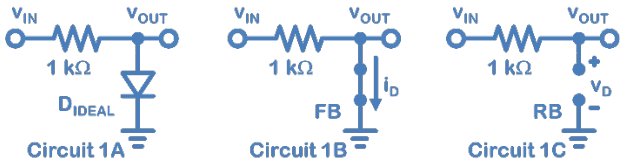
Transfer Functions with Ideal Diodes

The process for DC analysis of ideal diode circuits can be expanded to include the evaluation of transfer functions. By transfer function, we are trying to relate an output parameter in terms of an input parameter. A typical relationship would be the output voltage in terms of an input voltage ($v_{OUT}(v_{IN})$), but could also be in terms of currents or other parameters. Circuit 1A shows a simple example of a transfer function $v_{OUT}(v_{IN})$ with a resistor and ideal diode in series.



The steps to evaluating the transfer function a very similar to the steps for DC analysis.

Modified steps to solving Ideal Diode Transfer Functions:

1. Select a Bias for each diode in the circuit (there is no correct and incorrect bias).
2. Enforce the bias equality conditions (replace each diode with short for FB and open for RB).
   **make sure to label the direction of the ineq. var. (i_D for FB and v_D for RB) for each diode to help with step 4.*
3. Solve the circuit for the answer w.r.t the independent variable plus the find the values of the inequality variables w.r.t. the independent variable.
4. Apply inequality condition to the inequality variable to determine the range of the independent variable in which the bias is correct.
5. Go back to (1) to do the other bias states.

Using these steps, we initially start with FB (step 1) which is enforced in Circuit 1B (step 2). Next, we solve for $v_{OUT}(v_{IN})$ and $i_D(v_{IN})$ (step 3).

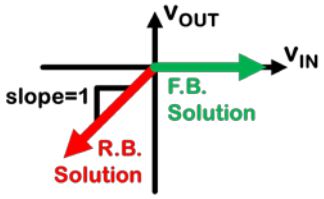
$$v_{OUT}(v_{IN}) = 0 \quad \text{and} \quad i_D(v_{IN}) = v_{IN}/1000$$

In applying the inequality condition for FB of $i_D>0$, we gen $v_{IN}/1000 > 0$ or $v_{IN} > 0$ (step 4). Redoing (step 5) for RB (step 1) is shown in Circtuit 1C (step 2), with a solution (step 3):

$$v_{OUT}(v_{IN}) = v_{IN} \quad \text{and} \quad v_D(v_{IN}) = v_{IN}$$

and inequality condition for RB of $v_D<0$, gives $v_{IN} < 0$ (step 4). The final answer includes solutions for both Circuits 1B and 1C. The result can also be described in a plot with v_{IN} on the x-axis and v_{OUT} on the y-axis.

$$v_{OUT}(v_{IN}) = 0, \quad \text{for } v_{IN}>0$$
$$v_{OUT}(v_{IN}) = v_{IN}, \quad \text{for } v_{IN}<0$$



NOTE: For this circuit there are two possible states, FB and RB. For a circuit with n-diodes there will be 2^n possible states.