Lab 1 Report

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We are building a simple rectifier circuit with a constant supply voltage of 10 V and a 1 kΩ resistor. The point of this lab is to analyze the operating voltage and current of a certain diode. The diode we're using in this lab is the 1N4001 diode, and we're using one manufactured by Texas Instruments.

1 Calculation

There are three models that we can use to analyze the diode in a circuit, they are the *ideal*, *constant drop*, and the *exponential* models.

1.1 Ideal Model

In the ideal model we assume that there is no voltage drop over the diode, and that for any positive voltage across the diode, the current is infinite. We can use Ohm's Law to show the ideal model. This is $V = iR$.

This yields the following calculation.

$$\frac{10\text{ V}}{1\text{k}\Omega} = 10\text{ mA}$$

1.2 Constant Drop Model

For the constant drop model we assume that the voltage drop over the diode is 0.7 V, which is close to the actual operating point. When the diode faces any voltage drop greater than 0.7 V, the current is assumed to be infinite. We can use Ohm's Law while subtracting that constant voltage so that we get the following calculation.

$$\frac{10\text{ V} - 0.7\text{ V}}{1\text{k}\Omega} = 9.3\text{ mA}$$

1.3 Exponential Model

In the exponential model we use the equation $I_D = I_S e^{\frac{V_D}{V_{th}}}$ to find the current through the diode. V_{th} is known to be about 25.9 mA at about 300K, and we calculated I_S from values measured from the physical circuit.

2 Computer Calculation

Using python and the measured values we graphed two equations. The two equations are $I_D = \frac{V_{DD} - V_D}{R}$ and $I_D = I_S e^{\frac{V_D}{V_{th}}}$. Those two equations are considered because we derive from Kirkhoff's Current Law as we describe the relationship between the current through the resistor and the diode. The intersection of these two graphs shows the operating voltage and current of the diode.

In Figure 1 you can see the operating voltage of the diode is calculated at V= 0.698 V and I= 9.317 mA. These figures align well with the measured values as you will see later in the lab.

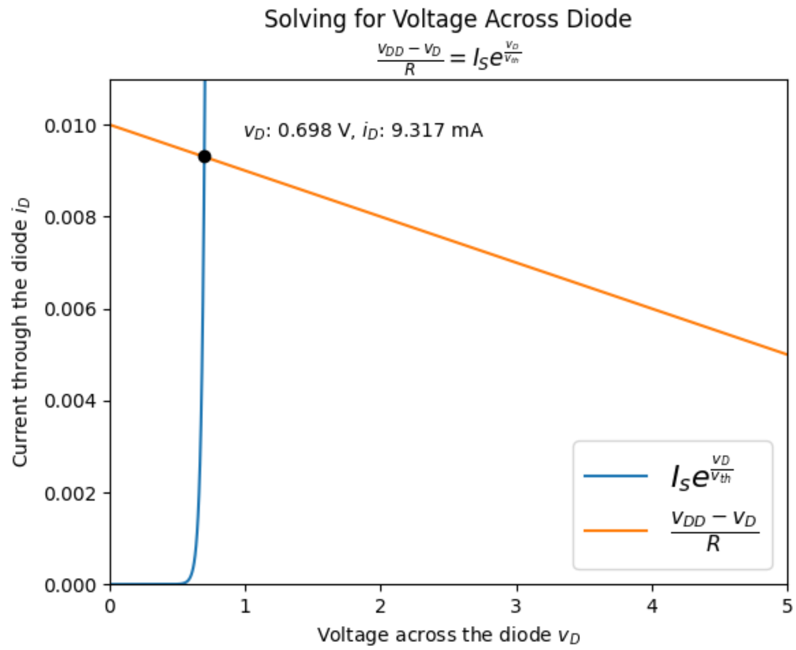

Figure 1: Intersection of current graphs for Diode and Resistor

3 Simulation

In Figure 2 we see the circuit that was modeled in LTSpice. The voltage measured at the node between R1 and D1 was 9.301 V, and the current was measured at 9.32 mA. These align well with our calculations, and were very similar to the values measured.

4 Summary

Overall, the best model for diodes is the exponential, but constant drop is easier to use, so we often use that one.

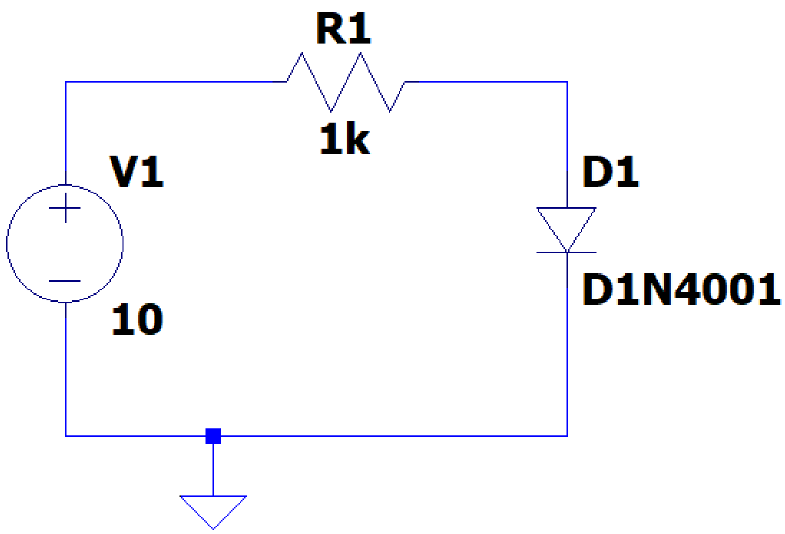

Figure 2: The circuit in LTSpice