ELEC-313
Lab 2: Diode Characterization

September 24, 2013

Date Performed:	September 18, 2013
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1 Objective

The objective is to observe the basic operation of a diode. In addition, the Schlockley equation (Eq 2) is used to find the diode's reverse saturation current (I_S) and thermal voltage (V_T) using values measured in the lab.

2 Equipment

Diode: 1N4002
Resistors: 330 Ω, 470 Ω, 680 Ω
Resistive decade box: HeathKit IN-3117
Power supply: HP E3631A
Multimeter: Fluke 8010A (x2)

3 Schematics

3.1 Circuits Tested

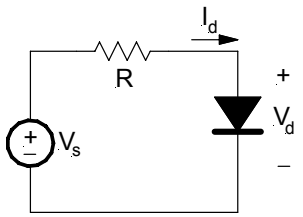

Figure 1: Circuit used for Part A and Part B.

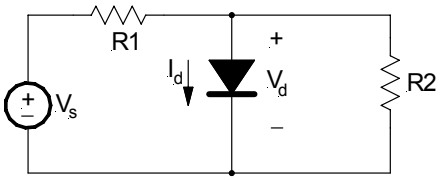

Figure 2: Circuit used for Part C.

4 Procedure

4.1 Part A

The circuit in Figure 1 was constructed, with $R = 470\,\Omega$ and the power supply as V_s. The actual resistance was measured with one a multimeter and recorded in Table 1 along with the percent error calculated (Eq 1). Next, the multimeters were used to measure voltage across and current through the diode (V_d and I_d,

respectively) while V_s was swept from $-5\,\text{V}$ to $10\,\text{V}$. The step size from $-5\,\text{V}$ to $0\,\text{V}$ and from $5\,\text{V}$ to $10\,\text{V}$ was $0.5\,\text{V}$, and $0.25\,\text{V}$ from $0\,\text{V}$ to $5\,\text{V}$. These values were recorded in Table 3 and used to generate the graph in Figure 3.

4.2 Part B

The circuit in Figure 1

4.3 Part C

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In part B, the 470 ohm resistor (Figure 1) was replaced with a 200 resistor using a decade box and Vs (Figure 1) was set to 10V and Vd and the Id were measured and recorded in Table 1. The decade box was adjust with the voltages listed in Table 1 by adjusting the decade box , and the Vd and the Id were measured and recorded for each setting of resistance. In part C of the experiment, the circuit in Figure 2 was built on a breadboard using the HP power supply as the Vs. Vd and the Id were measured and recorded in Table 2. The diode was then removed and the open circuit voltage (VOC) was recorded (Table 2).

5 Results

5.1 Part A

Name	**Nominal** (Ω)	**Measured** (Ω)	**% Error**
R_1	470	465.3	1.00

Table 1: Comparison of nominal and measured resistance in Part A.

5.2 Part B

5.3 Part C

V_d (V)	I_d (mA)	V_{OC} (V)
0.712	27.2	6.70

Table 2: Diode characteristics measured in Part C.

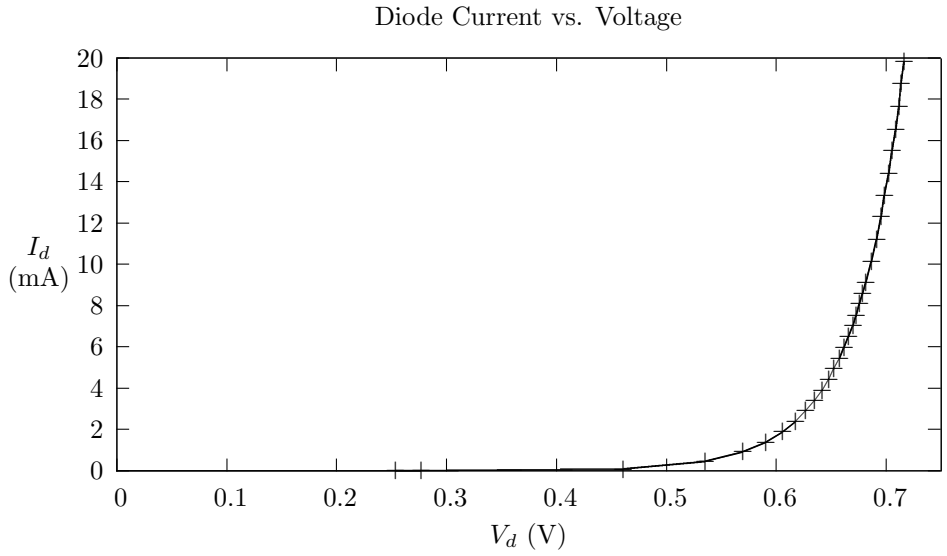

Figure 3: Diode characteristics measured in Part A.

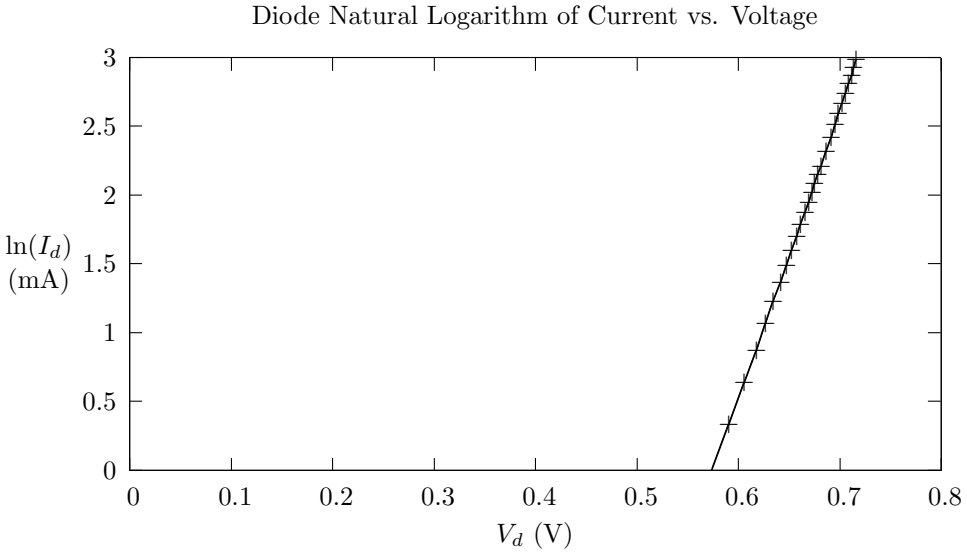

Figure 4: $\ln(I_d)$ vs. V_d.

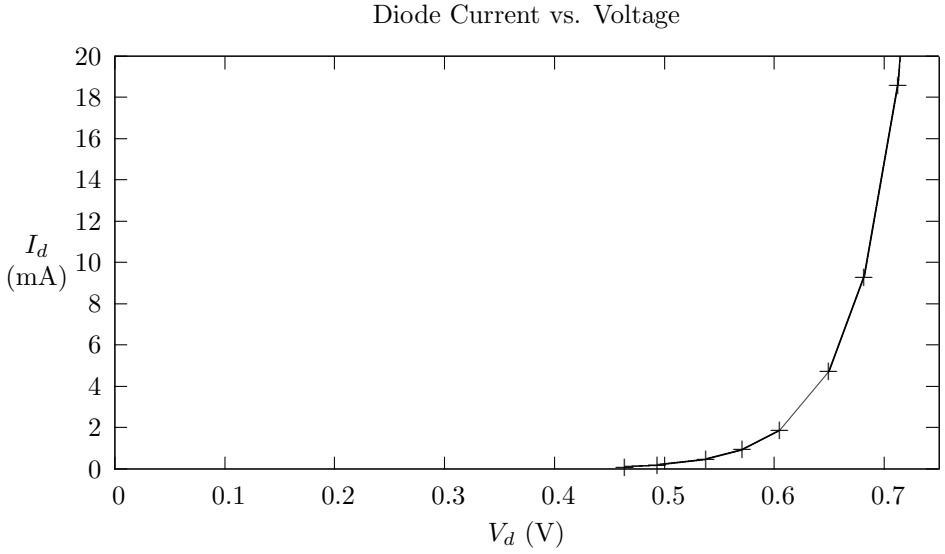

Figure 5: Diode characteristics measured in Part B.

6 Conclusion

As seen in Table A, the measured values of Vd and the Id taken in Part B of the experiment were very close to the theoretical values calculated in PSpice. The largest %difference was only 2.65%. As seen in Table B, the measured values of Vd and the Id taken in Part C of the experiment were very close to the theoretical values calculated in PSpice. The largest %difference was on 4.17

7 Equations

$$\%_{error} = \frac{|nominal - measured|}{nominal} 100\% \tag{1}$$

$$I_D = I_S \left(e^{\frac{V_D}{V_T}} - 1 \right) \tag{2}$$

8 Apendix

V_s (V)	V_d (V)	I_d (mA)	$ln(I_d)$ (mA)
-5.00	-5.000	0.01	-4.605170
-4.50	-4.500	0.01	-4.605170
-4.00	-4.000	0.01	-4.605170
-3.50	-3.500	0.01	-4.605170
-3.00	-3.000	0.01	-4.605170
-2.50	-2.500	0.01	-4.605170
-2.00	-2.000	0.01	-4.605170
-1.50	-1.500	0.01	-4.605170
-1.00	-1.000	0.01	-4.605170
-0.50	-0.500	0.01	-4.605170
0.00	0.277	0.01	-4.605170
0.25	0.254	0.01	-4.605170
0.50	0.461	0.10	-2.302585
0.75	0.536	0.46	-0.776529
1.00	0.570	0.92	-0.083382
1.25	0.591	1.40	0.336472
1.50	0.606	1.89	0.636577
1.75	0.618	2.39	0.871293
2.00	0.627	2.90	1.064711
2.25	0.635	3.41	1.226712
2.50	0.642	3.92	1.366092
2.75	0.648	4.44	1.490654
3.00	0.653	4.95	1.599388
3.25	0.658	5.47	1.699279
3.50	0.662	5.99	1.790091
3.75	0.666	6.51	1.873339
4.00	0.670	7.03	1.950187
4.25	0.673	7.55	2.021548
4.50	0.676	8.08	2.089392
4.75	0.679	8.60	2.151762
5.00	0.682	9.13	2.211566
5.50	0.687	10.18	2.320425
6.00	0.692	11.23	2.418589
6.50	0.696	12.30	2.509599
7.00	0.699	13.36	2.592265
7.50	0.703	14.42	2.668616
8.00	0.706	15.49	2.740195
8.50	0.709	16.56	2.806990
9.00	0.712	17.66	2.871302
9.50	0.714	18.75	2.931194
10.00	0.717	19.84	2.987700

Table 3: Diode characteristics measured in Part A.

R (Ω)	V_d (V)	I_d (mA)
200	0.751	46.00
500	0.713	18.60
1k	0.682	9.30
2k	0.650	4.70
5k	0.605	1.85
10k	0.571	0.94
20k	0.538	0.47
50k	0.494	0.19
100k	0.464	0.10

Table 4: Diode characteristics measured in Part B.