ELEC-313
Lab 2: Diode Characterization

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Date Performed:	September 18, 2013
Partners:	Charles Pittman
	Stephen Wilson

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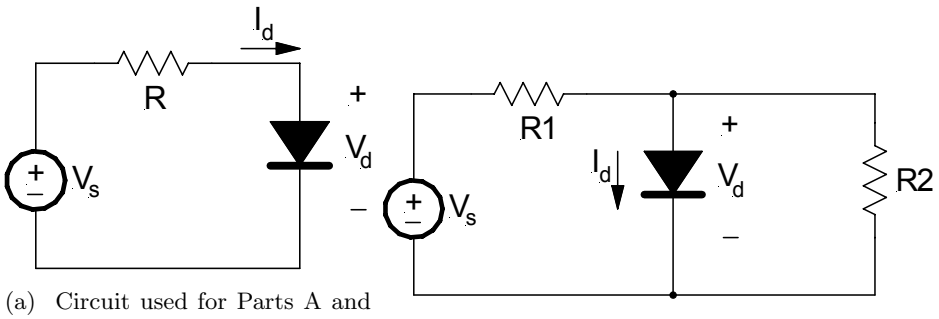
1 Objective

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



(a) Circuit used for Parts A and Part B.

(b) Circuit used for Part C.

Figure 1: Circuits used in this lab.

4 Procedure

4.1 Part A

The circuit in Figure 1a 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 2 and used to generate the graph in Figure 2.

4.2 Part B

The circuit in Figure 1a was constructed with the resistive decade box as R and the power supply as V_s. The multimeters were again used to measure diode

voltage (V_d) and current (I_d). This time V_s was held at 10 V and R varied: 200 Ω, 500 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, 50 kΩ, 100 kΩ. These values were recorded in Table 3 and used to generate the graph in Figure 4.

4.3 Part C

Thi circuit in Figure 1b was constructed with $R_1 = 330\,\Omega$, $R_2 = 680\,\Omega$, and the power supply as $V_s = 10\,\text{V}$. The multimeters were again used to measure diode voltage (V_d) and current (I_d). Finally, the diode was removed and a multimeter was used to measure the voltage at that node (V_{OC}). These values were recorded in Table 4.

5 Results

5.1 Part A

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

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

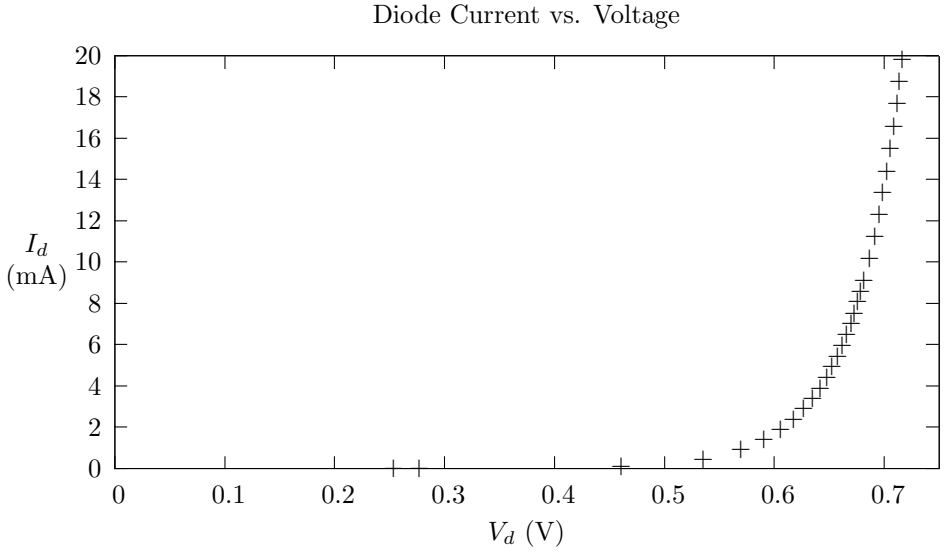


Figure 2: Diode characteristics measured in Part A.

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 2: Diode characteristics measured in Part A.

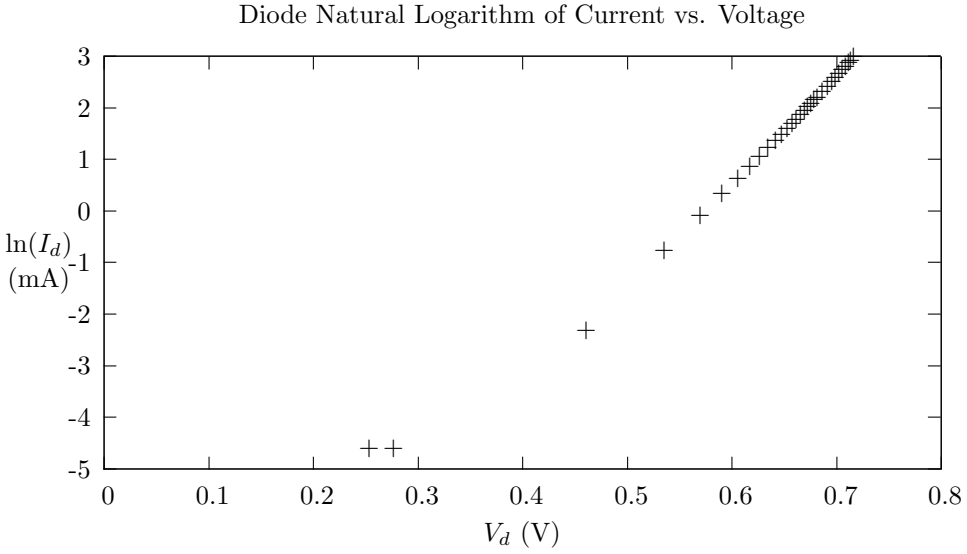


Figure 3: $\ln(I_d)$ vs. V_d.

5.2 Part B

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 3: Diode characteristics measured in Part B.

5.3 Part C

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

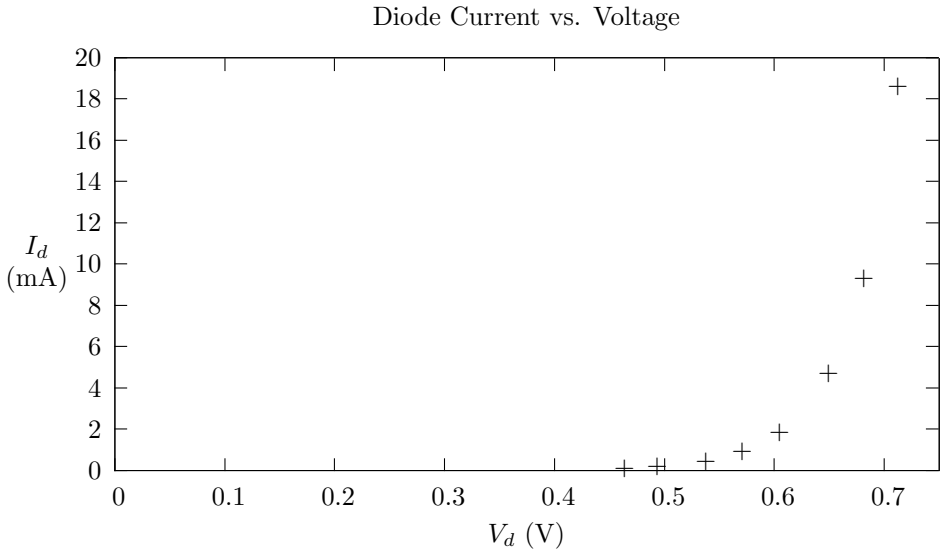


Figure 4: Diode characteristics measured in Part B.

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

Table 4: Diode characteristics measured in Part C.

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

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

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