

ELEC-313
Lab 2: Diode Characterization

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1 Objective

The objective is to observe the basic operation of a diode. In addition, the Shockley 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: $330\ \Omega$, $470\ \Omega$, $680\ \Omega$

Resistive decade box: HeathKit IN-3117

Power supply: HP E3631A

Multimeter: Fluke 8010A (x2)

3 Schematics

3.1 Circuits Tested

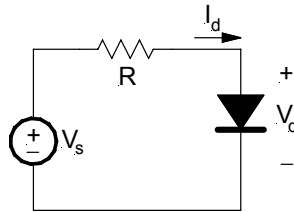


Figure 1: Circuit used for Part A and Part B.

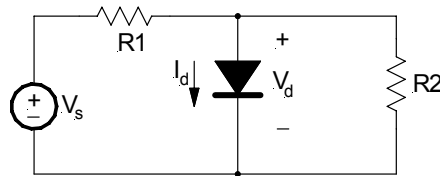


Figure 2: Circuit used for Part C.

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 V to 10 V . The step size from -5 V to 0 V and from 5 V to 10 V was 0.5 V , and 0.25 V from 0 V to 5 V . These values were recorded in Table 2 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 V_s (Figure 1) was set to 10V and V_d and the I_d 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 V_d and the I_d 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 V_s . V_d and the I_d 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

6 Conclusion

As seen in Table A, the measured values of V_d and the I_d 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

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.

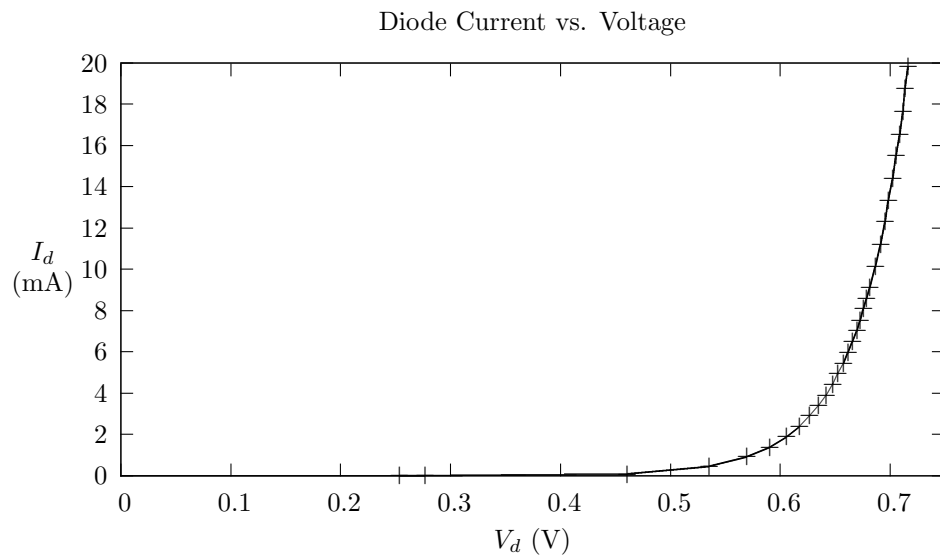


Figure 3: Diode characteristics measured in Part A.

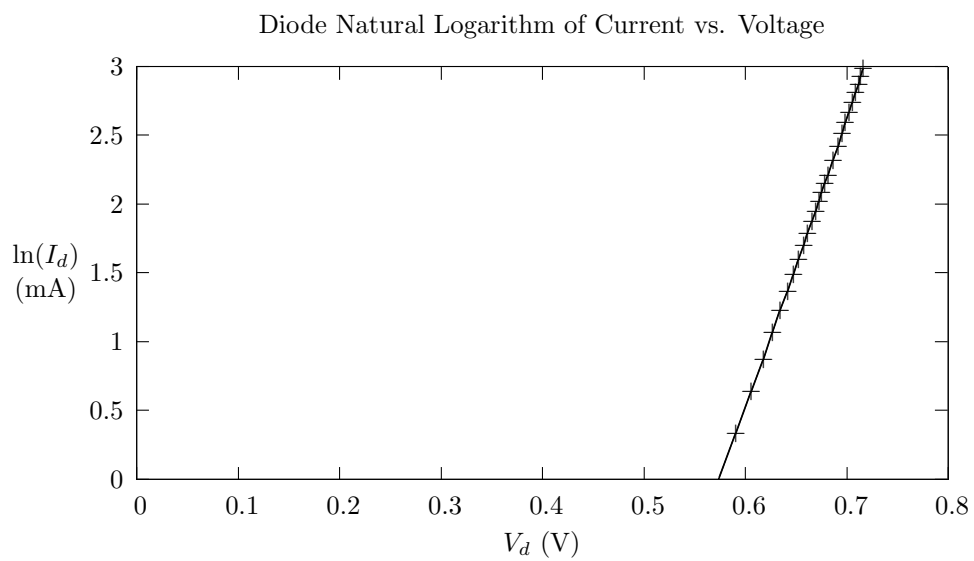


Figure 4: $\ln(I_d)$ vs. V_d .

$R\ (\Omega)$	$V_d\ (\text{V})$	$I_d\ (\text{mA})$
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.

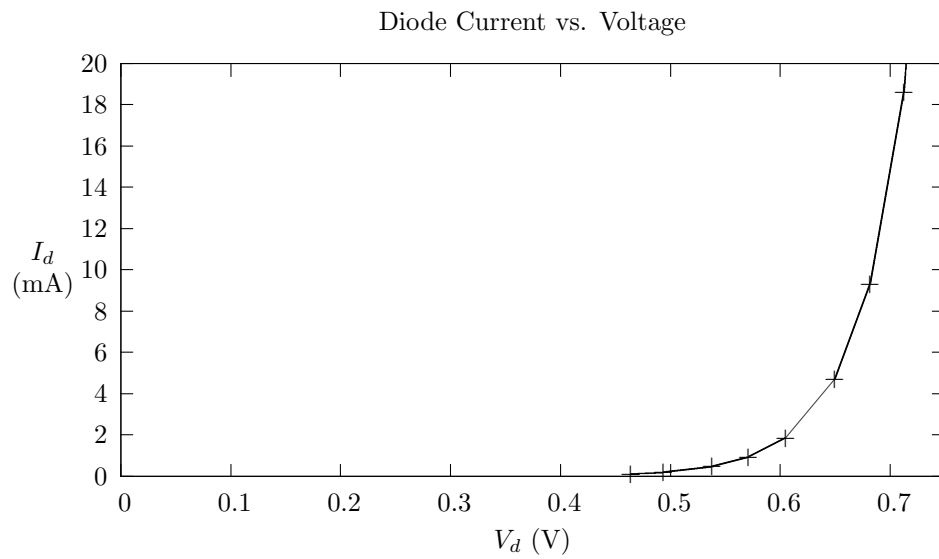


Figure 5: Diode characteristics measured in Part B.

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

Table 4: Diode characteristics measured in Part C.

values of V_d and the I_d 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

$$\%_{error} = \frac{|nominal - measured|}{nominal} 100\% \quad (1)$$

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