CMPE 110 Lab 3: Diode Circuits

Leonardo Blas

***Abstract*—The purpose of this lab project is to learn about simple diode, Zener diode, LED, and simple bipolar transistor circuits.**

I. INTRODUCTION

This lab project is based on the implementation of 4 different diode circuits: A simple diode, a Zener diode, a LED, and a simple bipolar diode circuits. Following Lab 3's handout, we are asked to find resistance values to meet specific current or voltage criteria in our diode circuits.

Before assembling the 4 diode circuits, we calculate the resistance values for each of the 4 parts in the handout:

- Part 1:

R	I_{max}
4.5 $K\Omega$	1 mA
450 Ω	10 mA
45 Ω	100 mA

Table 1. Table for the series DC circuit. Calculated using $I_D = \frac{V_{CC}-0.7V}{R_D}$.

R	I_{max}
930 Ω	10 mA

Table 2. Table for the series AC circuit. Calculated using $I_D = \frac{V_{CC}-0.7V}{R_D}$.

C	V_r
100 μF	100 mV

Table 3. Table for the series AC circuit. Calculated using $V_r = \frac{V_{max}}{RCf}$.

- Part 2:

R	I	Voltage rating
1.3 $K\Omega$	1 mA	4.7 V
2.7 $K\Omega$	10 mA	6.2 V

Table 4. Calculated using $R_Z = \frac{V_{CC}-V_Z}{I_Z}$. I_Z values found in the manufacturer's datasheet.

- Part 3:

R	V_{out}
167 Ω	5 V

Table 5. Calculated using $R_L = \frac{V_{CC}-V_L}{I_L}$. I_L values found in the manufacturer's datasheet (5 mA).

- Part 4:

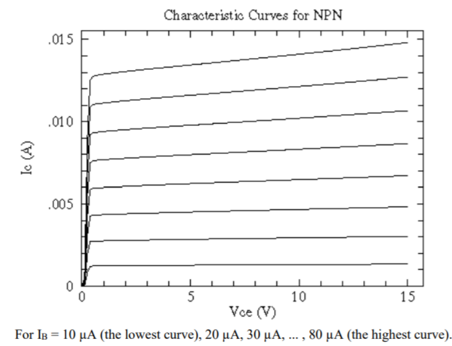

Figure 1. Characteristic curves.

V_{CEQ}	V_{BE}	R_B	R_C
5 V	0.7 V	485.5 $k\Omega$	833 Ω

Table 6. Calculated using $R_C = \frac{V_{CC}-V_{CEQ}}{I_C}$ and $R_B = \frac{V_{CC}-V_{BE}}{I_B}$. $I_C = 0.006\ A, I_B = 20\ \mu A$.

V_{CEQ}	V_{BE}	R_B	R_C
0.2 V	0.8 V	460 $K\Omega$	1.7 KΩ

Table 7. Calculated using $R_C = \frac{V_{CC}-V_{CEQ}}{I_C}$ and $R_B = \frac{V_{CC}-V_{BE}}{I_B}$. $I_C = 0.0058\ A, I_B = 20\ \mu A$.

A. Parts List

- 0-5 V and 0-10 V pulse generators. See **Figure 2** and **Figure 3**.
- 0-10 V sine wave generator. See **Figure 4**.
- Resistors.
- 1N4148 diodes.
- A capacitor (1.075 μF).
- A 1N750 Zener diode.
- A BZX84B6V2L Zener diode.
- A NSCW100 LED.
- 2N3904 transistors.
- Grounding components.
- LTspice software.

II. DESCRIPTION OF THE CIRCUITS' SCHEMATICS

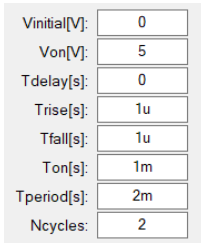

Figure 2. 0-5 V pulse generator's settings.

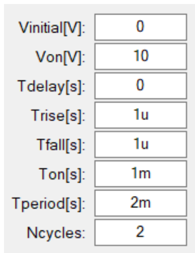

Figure 3. 0-10 V pulse generator's settings.

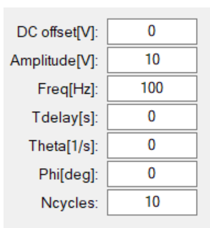

Figure 4. 10 V sine generator's settings.

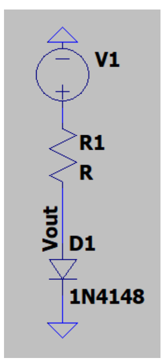

Figure 5. DC series circuit for Part 1.

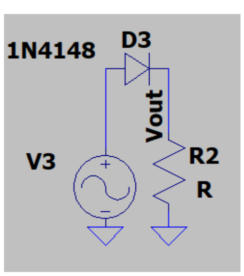

Figure 6. AC series circuit for Part 1.

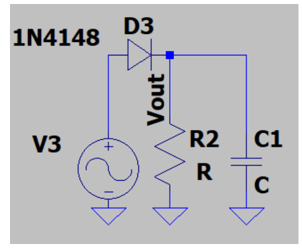

Figure 7. AC parallel circuit for Part 1.

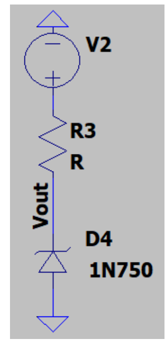

Figure 8. Circuit for Part 2, 4.7 V rating.

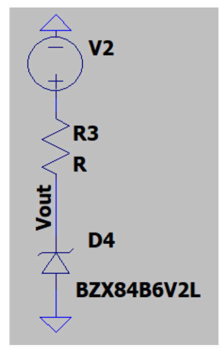

Figure 9. Circuit for Part 2, 6.2 V rating.

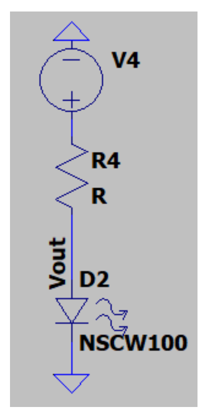

Figure 10. Circuit for Part 3.

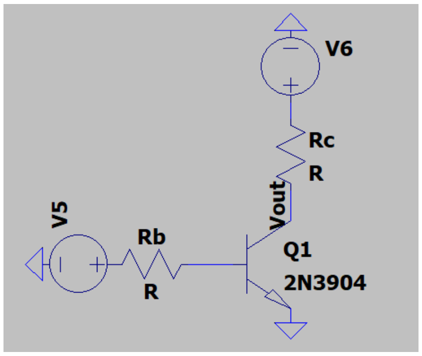

Figure 11. Circuit for Part 4.

III. Waveforms and Results

- Part 1:

I_{max}	$I_{measured}$	V_{out}
1 mA	981.36067μA	845.91807 mV
10 mA	9.5733851 mA	693.99683 mV
100 mA	92.405237 mA	585.67562 mV

Table 8. Table for the series DC circuit. Calculated using $I_D = \frac{V_{CC}-0.7V}{R_D}$.

I_{max}	$I_{measured}$
10 mA	9.995002mA

Table 9. Table for the series AC circuit. Calculated using $I_D = \frac{V_{CC}-0.7V}{R_D}$.

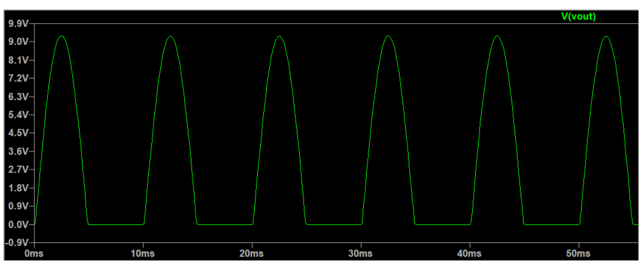

Figure 12. Waveform for the series AC circuit for Part 1.

$V_{r_{measured}}$	$V_{r_{max}}$
$45.490095mV$	$100\ mV$

Table 10. Table for the series AC circuit. Calculated using $V_r = \frac{V_{max}}{RCf}$.

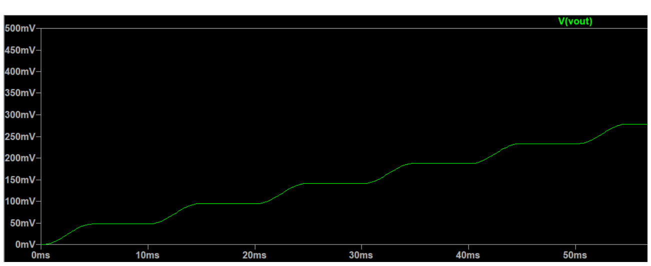

Figure 13. Waveform for the parallel circuit for Part 1.

- Part 2:

V rating	V_{out}
4.7 V	4.6107177V
6.2 V	6.1836987V

Table 9. Calculated using $R_Z = \frac{V_{CC}-V_Z}{I_Z}$. I_Z values found in the manufacturer's datasheet.

- Part 3:

V rating	V_{out}
5 V	3.927805V

Table 10. V_{out} for the Q = ACT circuit

- Part 4:

V_{CEQ}	V_{BE}	V_{out}	% error
$5\ V$	$0.7\ V$	$5.074288V$	1.49%
$0.2\ V$	$0.8\ V$	202.33443mV	1.17%

Table 11. V_{out} for the Q = SAT circuit.

IV. Discussion

For all parts of Part 1, we selected resistors and capacitor values that allowed us to stay within the given thresholds, I_{max} for the first and second parts of Part 1, and I_{ripple}, or I_r for Part 1's last part. Furthermore, our results confirm we accomplished Part 1's objectives.

For Part 2, we selected resistor values that would not allow V_{out} to go over 2 different voltage ratings, 4.7 and 6.2V. Additionally, our results confirm we accomplished Part 2's objectives.

For Part 3, we also chose a resistor value that would allow us to remain within the given voltage rating threshold, 5 V. Moreover, our results confirm we accomplished Part 3's objectives.

For Part 4, we chose resistor values that would allow us to obtain results close to the desired V_{out} values, 5 and 0.2 V. If we examine our % error, we notice that, in both cases, we acquired a % error between 1 and 2%. We believe this could be improved or even brought down to 0% if we became even more selective when choosing resistors' values. Nevertheless, with the learning purposes of this lab in mind, we believe we also accomplished Part 4's objectives.

V. Description of the Learning Experience

This lab, in my opinion, seemed harder than it was. At times, I thought we were prompted to ask particular values, like a specific value for our capacitor or for our resistors. After spending some time with the lab, nevertheless, I understood that we were actually given a range of options, rather than asked to find particular values, as long as they didn't cross the given threshold. Overall, I believe this improved my attention to detail and my circuits design skills.

VI. CONCLUSION

In conclusion, this lab experiment was a fruitful diode circuits experience. We learned not only how simple diode, Zener diode, LED, and simple bipolar transistor circuits work, but also learned to better analyze and understand circuits in general. This lab was helpful in conveying the idea of thresholds and possible components' values within circuits.