Lab 2

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***Abstract:* This lab was about diode circuits such as Zener and LED as well as bipolar circuits. We learned how to differ the waveform depending on factors such as resistance and capacitance as well as how to control the amount of current that flows through a diode circuit.**

***Keywords: Diode Circuits, Zener Diodes, Bipolar Circuits, Diode Current***

1. Introduction

A diode is the simplest semiconductor element which is built by a single PN semiconductor junction. There are many types of diodes like Rectifier, Zener, and Light Emitting Diode (LED). In this lab, we will focus on the above diodes and also experimenting with Bipolar Junction Transistor (BJT) circuits as well.

1. Simple Diode Circuit

A simple diode circuit consists of a power source, a resistor, and a diode. In this case, we will be having our Vcc (Voltage Common Collector) set to 5V and measure the output voltage (Vout). We will use LTSpice to show a simulation of this and will use Eq 1 to find the resistance required to ensure that we can meet the current limit of 1 mA, 10 mA, and 100 mA.

Eq 1 – Equation to find the current through the Diode (ID) and the Forward Current (IF)

|  |  |  |  |
| --- | --- | --- | --- |
| Vcc (V) | Id (mA) | Id (A) | Rd (Ohms) |
| 5 | 1 | 0.001 | 4300 |
| 5 | 10 | 0.01 | 430 |
| 5 | 100 | 0.1 | 43 |

Table 1 – Finding the resistance using Eq 1

Diagram, schematic

Description automatically generated

Figure 1 – Allowing only 10 mA to go through the diode

Graphical user interface, text, application

Description automatically generated

Figure 2 – Output for Vout, R = 4300 Ohms

As can be seen, the Vout is 500mV which is 0.5 V.

|  |  |  |
| --- | --- | --- |
| Vcc (V) | Resistance (Ohms) | Vout (V) |
| 5 | 4300 | 0.574 |
| 5 | 430 | 0.691 |
| 5 | 43 | 0.811 |

Table 2 – Vout for all different resistances

Now, we replaced our voltage with a sinusoid with frequency 100 Hz and Amplitude of +/- 10 V. Using this, we determined that a resistance of 1000 Ohms would yield a current less than 10 mA. The circuit is shown in Figure 3.

Diagram

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Figure 3 – Using a sinusoidal waveform instead of 5V

A picture containing diagram

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Figure 4 – Waveform for Figure 3, shows current less than 10mA

When adding a capacitor to the circuit shown in Figure 3, we want to get a ripple voltage less than 100 mV. After running some trials, it was found that the capacitance needs to be 7.4 Farads. Figure 5 shows the circuit.

Diagram

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Figure 5 – Circuit with Capacitor added in parallel

A picture containing graphical user interface

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Figure 6 – Waveform for the circuit in Figure 5

1. Zener

A Zener diode is a two terminal device where precise constant voltage can be obtained across its terminals. In our case, we built a Zener diode circuit with a resistance of 8.8 ohms since the voltage through the diode was 3.8 V, even though we were supposed to get 3.3 V.

Diagram

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Figure 6 – Zener Diode circuit

Graphical user interface

Description automatically generated with medium confidence

Figure 7 – Zener Diode Waveform

**EXPLAIN why 3.8 and not 3.3**

1. Light Emitting Diode

Diagram, schematic

Description automatically generated

Figure 8 – Light Emitting Diode Circuit

The resistance is set to 41 Ohms. This is because the diode’s max current rating is 225 mA. At this resistance, the current through the diode is 224.5 mA as shown in Figure 9.

Application

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Figure 9 – Current through Light Emitting Diode Circuit

1. Simple Bipolar Circuits
2. Diagram, schematic

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Figure 3 – Rb and Rc values such that Vout = 5V

Rb = 17 kOhms

Rc = 39 Ohms

Ib = 129 mA

Ic = 1.07 mA

Hfe = 129 / 1.07 = 120.56

1. Diagram

   Description automatically generatedFigure 4 – Rb and Rc values such that Vout = 0.2 V

Rb = 5 kOhms

Rc = 38 Ohms

Ib = 257.9 mA

Ic = 1.9 mA

Hfe = 257.9 / 1.9 = 135.74