ME 411 Mechatronics @ UIC

LEDs, Diodes, Zener Diodes, Rectification

This lab is to be done in a group of two during lab hours

1 Prelab (not graded)

1.1 Motivation

The goals of the lab are to introduce you to non-linear elements such as LEDs, Diodes, and Zener Diodes and build simple rectifier circuits.

1.2 Assigned Reading

This part of the Lab needs to be done before you come to the lab. Assigned reading from the textbook is listed below

1. 3.2 Semiconductor physics (Lecture 6/7)
2. 3.3 Junction Diode including 3.3.1 Zener diode, 3.3.2 Voltage regulator, and 3.3.3 Optoelectronic diodes (Lecture 6/7)
3. Half wave and full wave rectifier. Search on the internet.

1.3 Questions based on reading (not graded)

Answering the following questions will help assess your comprehension of the assigned reading. Since the labs are short, only 2 hours, it is important that you come prepared for the lab before hand. Note that there is a 20 point penalty for not completing the lab on time.

1. Which of the following are semiconductor elements.
   (a) Iron and Copper
   (b) Boron and Gallium
   (c) Silicon and Germanium
   (d) Arsenic and Phosphorous
2. The contact potential for a small signal p-n junction diode is about
   (a) 0 V
   (b) 0.7 V
   (c) 1.4 V
   (d) 5 V

3. A Light Emitting Diode can be forward biased by

   (a) connecting the p junction to the positive terminal of the battery
   (b) connecting the n junction to the positive terminal of the battery
   (c) connecting the shorter lead to the positive terminal of the battery
   (d) connecting the shorter lead to the negative terminal of the battery

4. For an LED to light brightly it is recommended to have about 10 mA of current flowing through it. For a circuit consisting of a 12V DC, a resistor R, and properly biased LED, the value of R should be. (Assume a voltage drop of 2 V across the diode)

   (a) 0.01 $K\Omega$
   (b) 0.1 $K\Omega$
   (c) 1 $K\Omega$
   (d) 10 $K\Omega$.

5. Which of the following element is used as a voltage regulator.

   (a) Light Emitting Diode
   (b) Silicon Diode
   (c) Zener Diode
   (d) Photo Diode

Answers 1 c; 2 b; 3 a,d; 4 c; 5 c

2 Labwork (graded)

Equipment list

1. 1 Light Emitting Diode.
2. 2 p-n Junction Diode.
3. 1 Zener Diode
4. Resistors: 1 each of $470, 1000, 2000\Omega$ and $100k\Omega$, 2 resistors of $10k\Omega$.
5. Breadboard.
6. Hantek2D72 Oscilloscope/Digital Multimeter/Function Generator
7. DC voltage supply (please return this back after the lab is done)

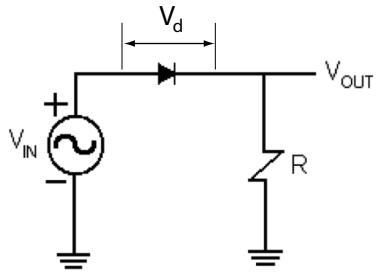
2.1 (10 pts) Identification of Diode/LED/Zener

Identify the diode, the LED and the Zener diode from your kit. Identify the cathode (+) and the anode (−) on these elements. The anode lead on a LED is longer. Use the diode test function on the multimeter to find the forward bias voltage drop across the Zener and the diode.

V_{diode} = ----------. V_{zener} = ----------.
Show any one measurement to the teaching assistant.

2.2 (20 pts) Simplest diode/LED circuit & Half wave rectification (Hardware)

Build the circuit shown below. Use $R \approx 470\ \Omega$. You will use (i) diode and (ii) LED for each V_{in} and fill in the table below.

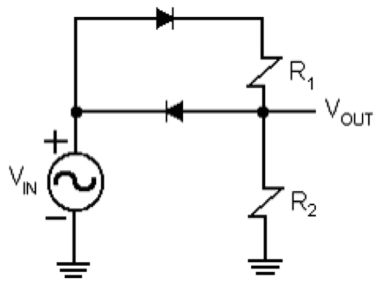


V_{in}	V_d (diode)	V_{out} (diode)	V_d (LED)	$V_{\text{out}}(LED)$
5 V				
-5 V				
$5\sin(6\pi t)$ V				

Show the following to the teaching assistant:
(1) Your circuit and measurements for the diode in line 3 in the above table.
(2) Rough sketch of V_{in}, V_d (diode) and V_{out} (diode) as a function of time t.

Now double the resistor to $\sim 1000\Omega$ and to $\sim 2000\Omega$. Note that the LED gets dimmer as you increase the resistance. Discuss why this happens with your group members.

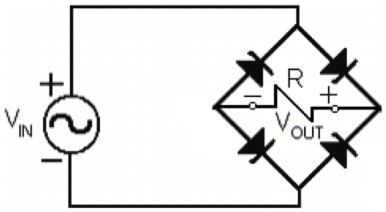
2.3 (25 pts) Half wave rectification using two diodes (Hardware)



1. Build the circuit shown above. Use $R_1 = R_2 = 10k\Omega$. Using the function generator to apply a sinusoidal wave of 10 V peak-to-peak at 100 Hz. Set up the oscilloscope to measure and plot V_{in} and V_{out} as function of time. Show the circuit and the plot to the teaching assistant.

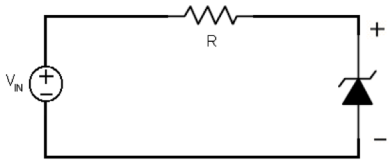
2. Build the circuit shown above. Use $R_1 = 10k\Omega$ and $R_2 = 1k\Omega$. Using the function generator to apply a sinusoidal wave of 10 V peak-to-peak at 100 Hz. Set up the oscilloscope to measure and plot V_{in} and V_{out} as function of time. Show the circuit and the plot to the teaching assistant.

2.4 (25 pts) Full wave rectification using four diodes, Bridge Rectification (TinkerCAD)



Build the circuit shown above in TinkerCAD. Use $R = 100k\Omega$. Using the function generator to apply a sinusoidal wave of 10 V peak-to-peak at 100 Hz. Set up the oscilloscope to measure and plot V_{in} and V_{out} as function of time. Show the circuit and the plot to the teaching assistant.

2.5 (20 pts) Zener diode (Hardware)



Build the circuit shown in the figure above. Use $R = 1k\Omega$. Using the function generator to vary the input voltage V_{in} between 1V and 25V, and us the oscilloscope to measure the voltage across the Zener diode V_{zener}. Make a plot of V_{zener} as a function of time and show it to the teaching assistant.