AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

Faculty of Engineering

Department of EEE and CoE

Undergraduate Program

Course: ELECTRONIC DEVICES LAB **MID , Fall 2021**

Experiment Name: Study of Zener Diode

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Section: G

Submitted To: Dr. Mir Mohammad Nazmul Arefin

Title: Study of Study of Zener Diode

Abstract:

A Zener diode is a diode which allows current to flow in the forward direction in the same manner as an ideal diode, but also permits it to flow in the reverse direction when the voltage is above a certain value known as the “breakdown voltage”, "zener knee voltage", "zener voltage", "avalanche point", or "peak inverse voltage".

Introduction: The main objective of this experiment is to-

1. Study the voltage-current characteristics of Zener diode and
2. Observe the voltage regulation characteristics of a Zener Diode.

Theory and Methodology:

The basic function of Zener diode is to maintain a specific voltage across its terminals within given limits of line or load change. Typically it is used for providing a stable reference voltage for use in power supplies and other equipment.

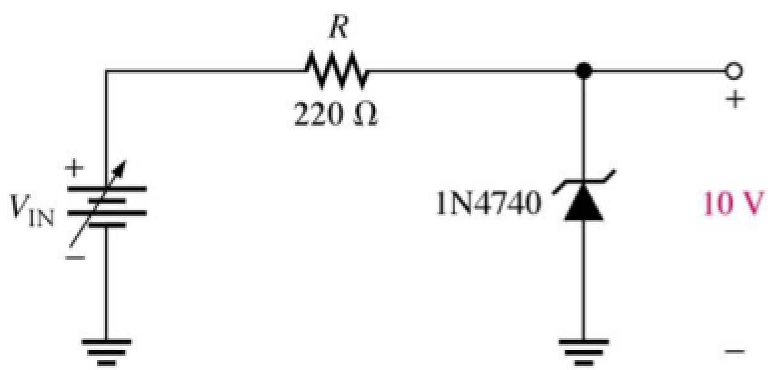


Figure 1: This particular Zener circuit will work to maintain 10 V across the load.

A Zener diode is much like a normal diode, the exception being is that it is placed in the circuit in reverse bias and operates in reverse breakdown. This typical characteristic curve illustrates the operating range for a Zener. Note that its forward characteristics are just like a normal diode.

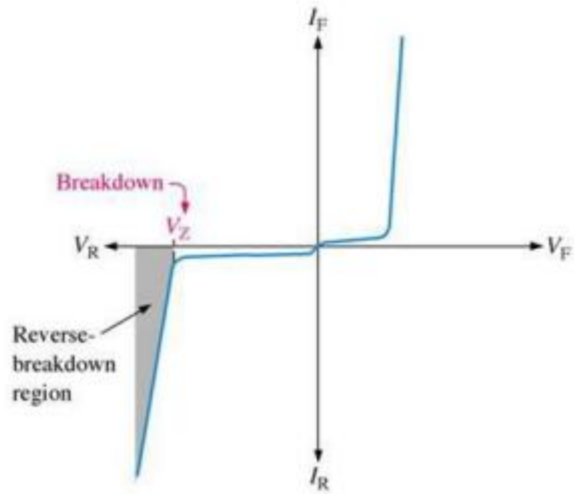


Figure 2: The normal operating region for a Zener diode is shaded

The doping process determines the Zener diode's breakdown characteristics. Low voltage Zeners less than 5V operate in the Zener breakdown range. Those designed to operate more than 5 V operate mostly in avalanche breakdown range. Zeners are available with voltage breakdowns of 1.8 V to 200 V.

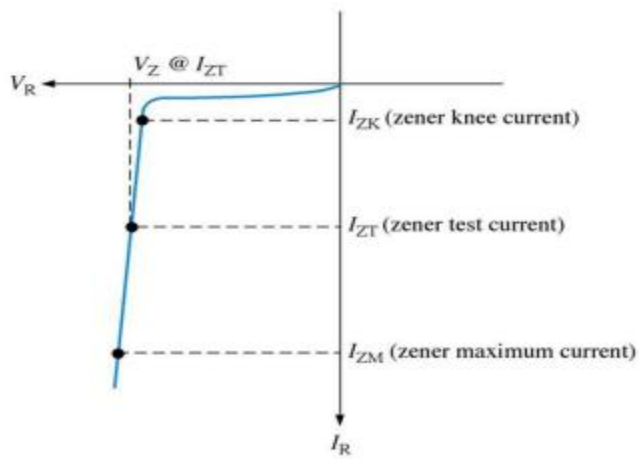


Figure 3: This curve illustrates the minimum and maximum ranges of current operation that the Zener can effectively maintain its voltage.

A voltage regulator is designed to keep the output voltage of a circuit at a constant value, independent of the input voltage and also independent of the load current. A Zener diode connected in parallel to the load is the simplest form of such a voltage regulator circuit shown in figure 1(right) in the Circuit Diagram part. If the voltage across the load tries to rise, then the Zener diode takes more current. The increase in current through the resistor causes an increase in voltage dropped across the resistor and the causes the voltage across the load to remain at its correct value. Similarly, if the voltage across the load tries to fall, then the Zener diode takes less current. The current through the resistor and the voltage across the resistor both fall down. The voltage across the load remains at its correct value.

Apparatus:

1) Zener Diode : [1 pc]
2) Trainer Board :
3) Resistors : 100Ω [1 pc]

   220Ω [1 pc]

   470Ω [1 pc]

4) Oscilloscope
5) Multimeter: [1pc]
6) Chord [2pcs]
7) POT: 100kΩ [1pc]
8) DC Power Supply

Circuit Diagram:

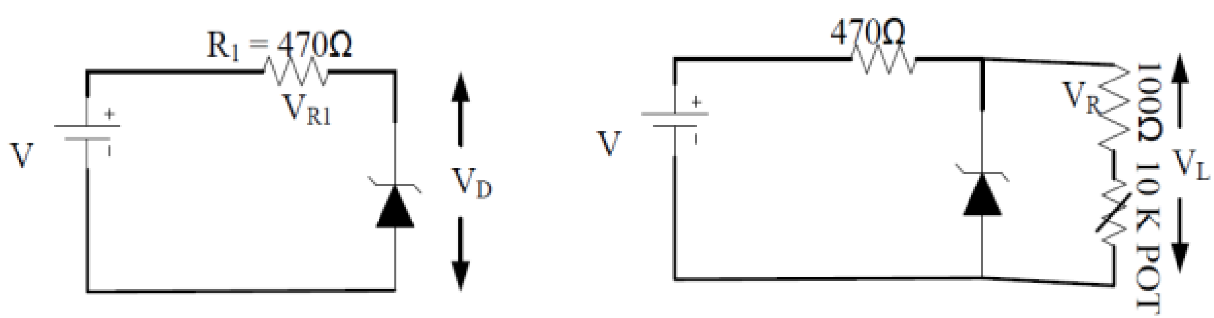


Figure 3: Zener circuit

Experimental Procedure:

Tabble-1: Data table for V – I characteristics using experimental values.

V (volt)	VR1 (volt)	VZ (volt)	I= (VR1/R1) (A)
0	0	0	0
0.5	5.4998e-5	0.499945	1.17017021e-7
1	0.00156	0.99844	0.00000331914
1.5	0.034999	0.001465	0.00007446595
2	0.243828	1.756	0.00051878297
2.5	0.607015	1.893	0.00129152127
3	1.028	1.972	0.00218723404
3.5	1.474	2.026	0.00313617021
4	1.933	2.067	0.00411276595
4.5	2.401	2.099	0.00510851063

Experimental Value:

1. V_R = 100 mV
   R = 470Ω V_L = 1.5299v
   $I_L = V_R / R$
   = 0.213 mA

2. V_R = 300 mV
   I_L = 0.64 mA V_L = 2.04 v

3. V_R = 500 mV
   I_L = 1.06 mA V_L = 2.34 v

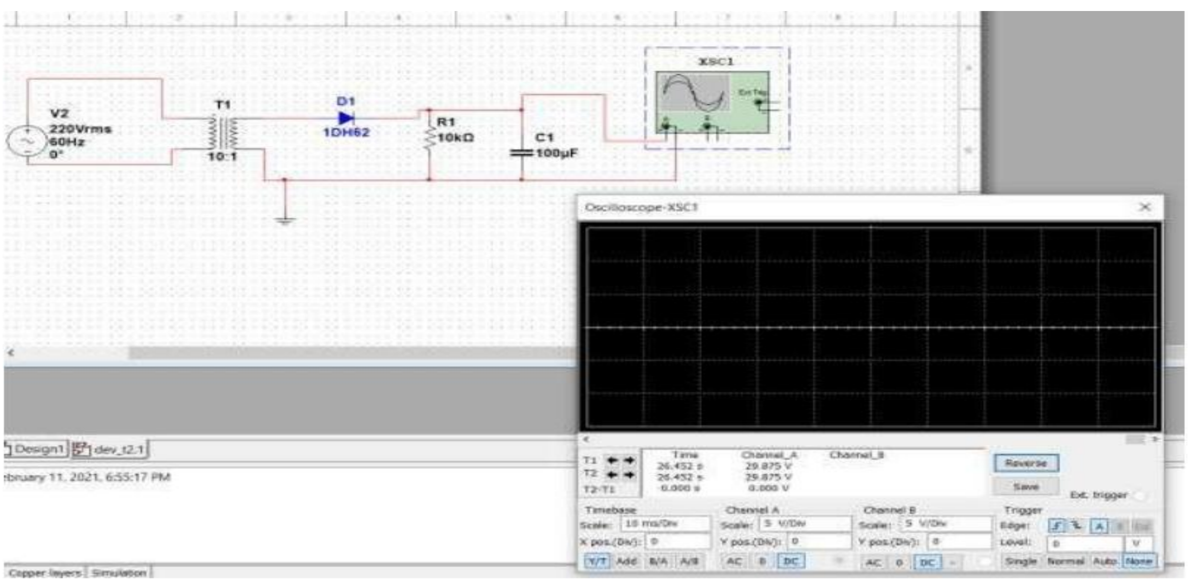
4. V_R = 700 mV
   I_L = 1.49 mA V_L = 2.6 v

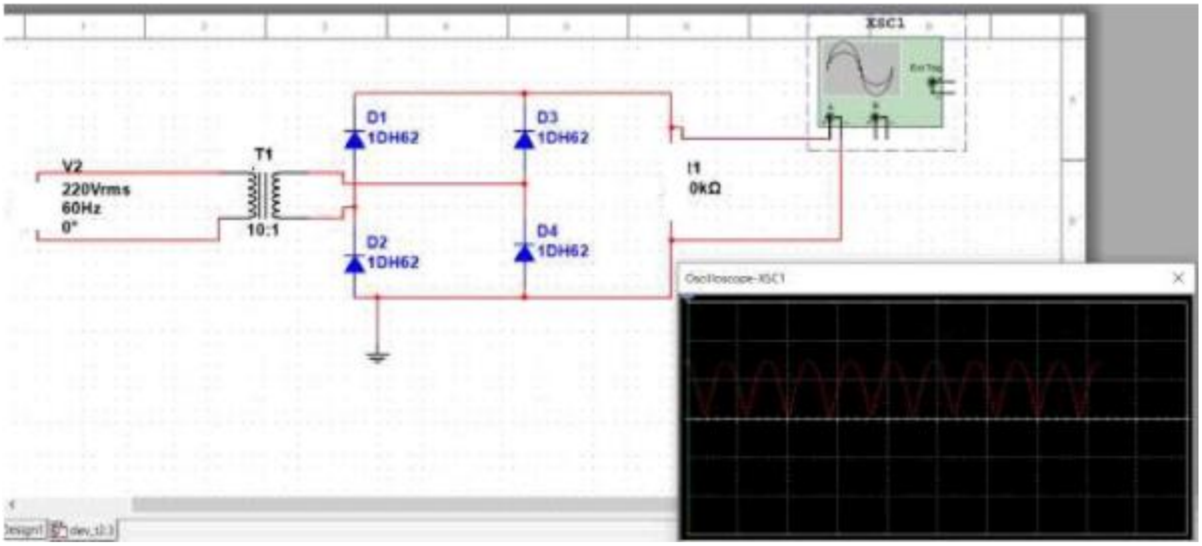
V_R	100	300	500	700
V_L	1.5299	2.04	2.34	2.6
I_L	0.213	0.64	1.06	1.49

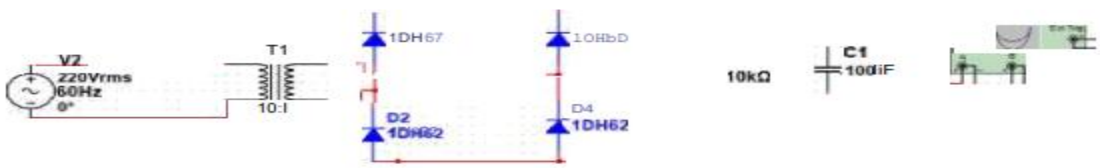
Table – 3: Table for regulation due to supply voltage variation using experimental values.

V	16	12	9	6
V_R	13.652	9.707	6.768	3.869
V_L	2.348	2.293	2.232	2.131

Simulation:

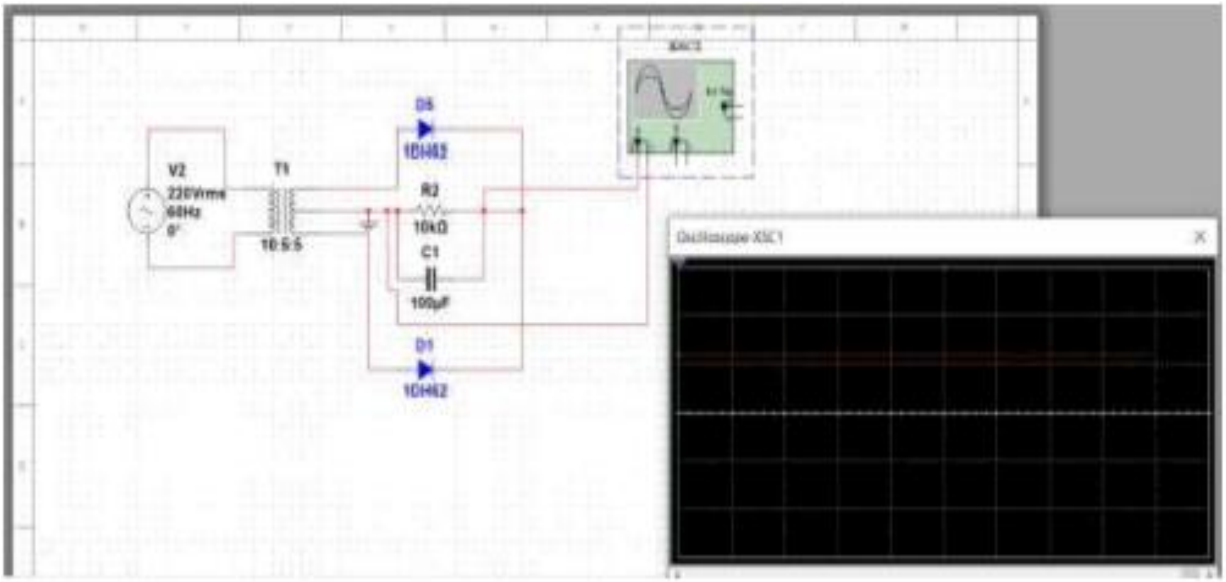


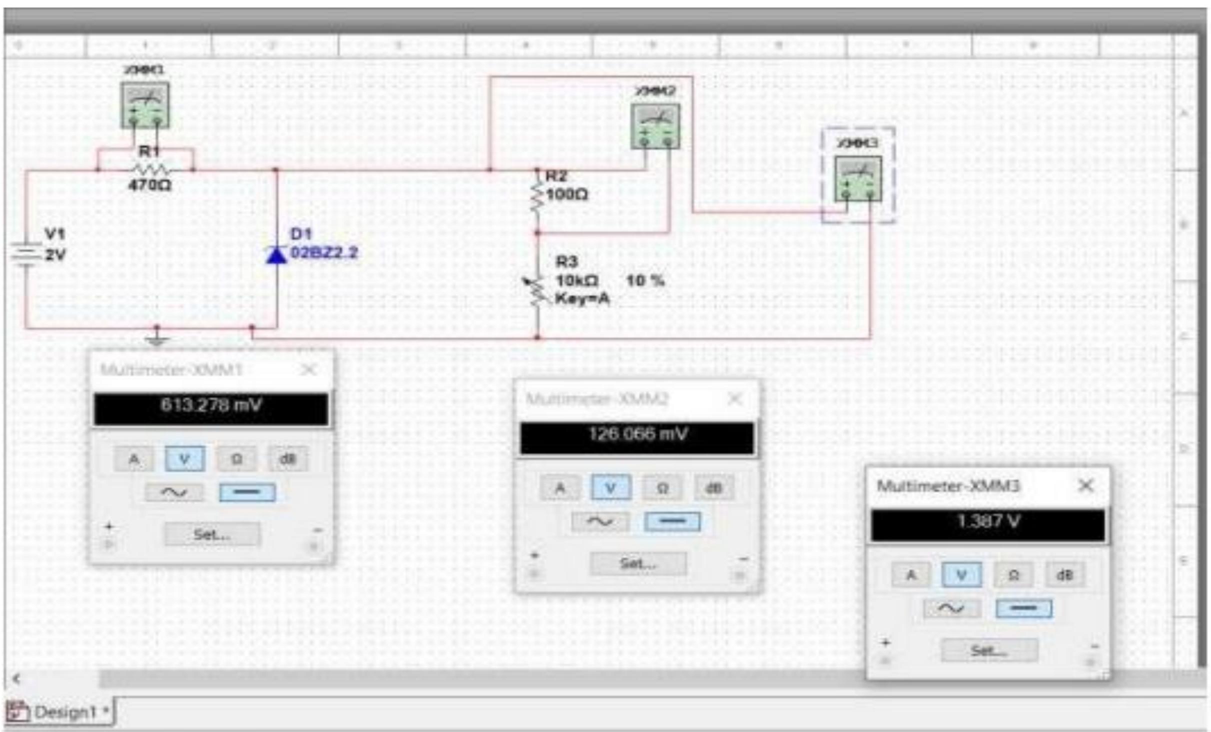

XSC1
D1
1DH62
D3
1DH62
T1
V2
220Vrms
60Hz
0°
10:1
I1
0kΩ
D2
1DH62
D4
1DH62
Oscilloscope-XSC1

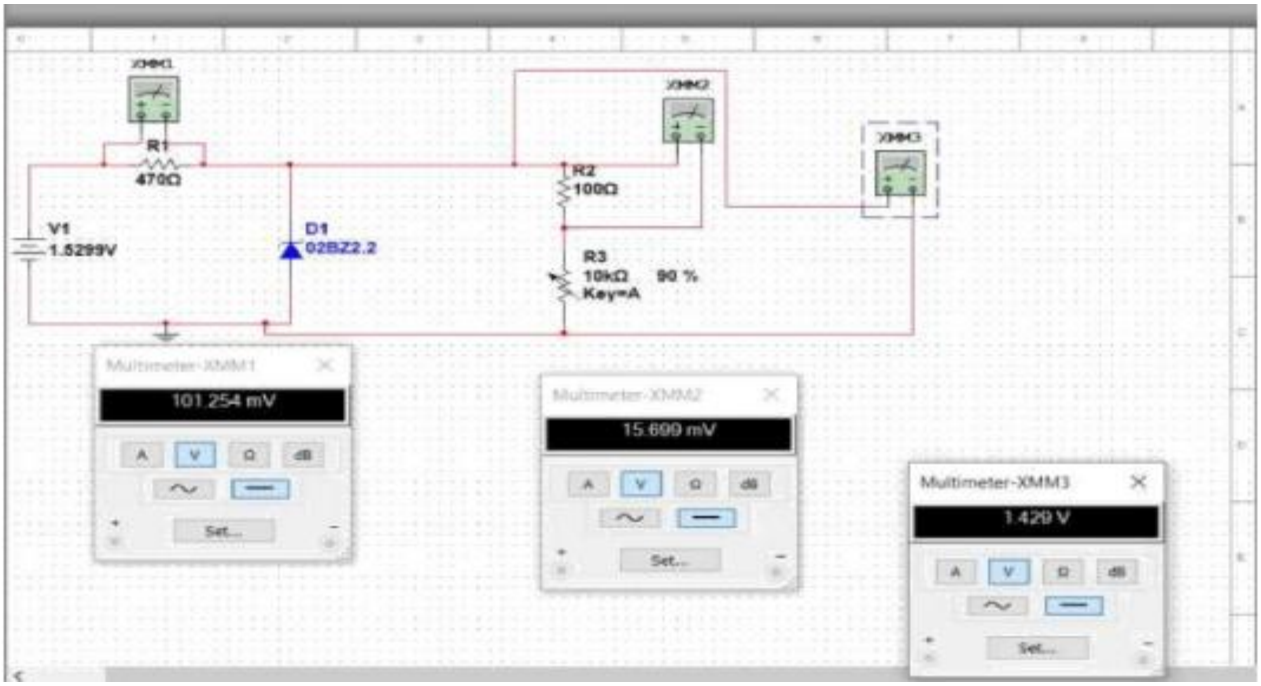

V2
220Vrms
60Hz
0°
T1
10:I
1DH67
1OHbD
D2
1DH62
D4
1DH62
10kΩ
C1
100iF

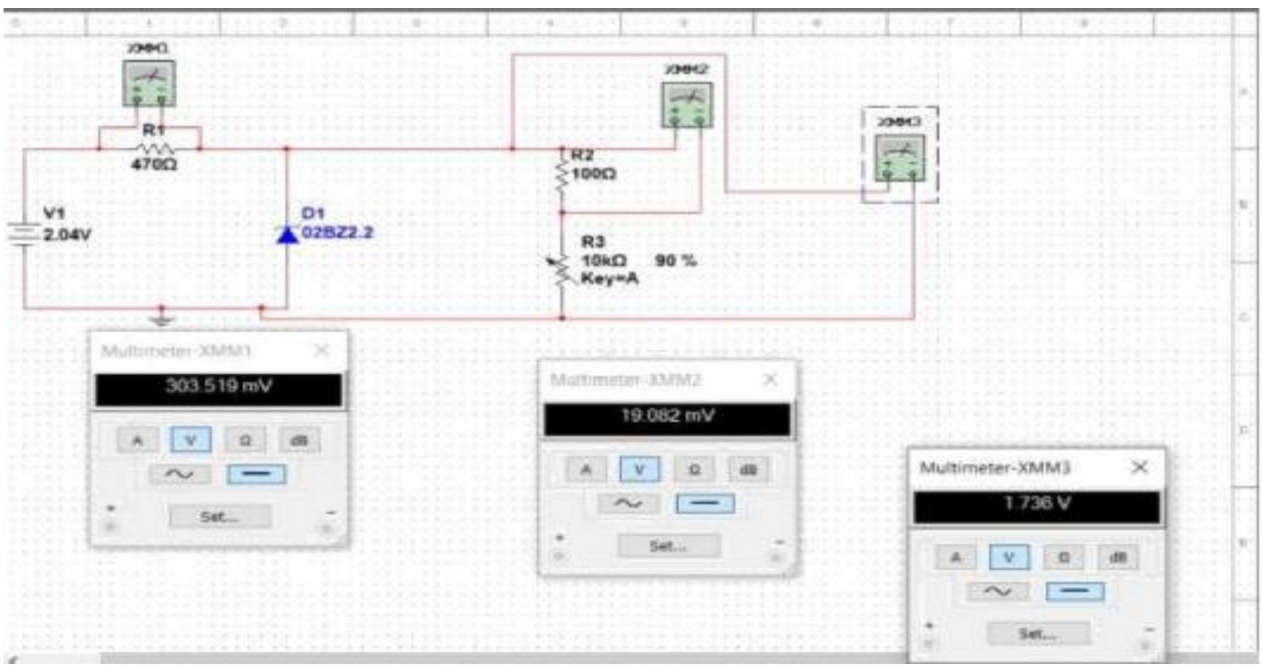

Copper layers
Simulation
Timebase
Channel A
Channel B
Trigger

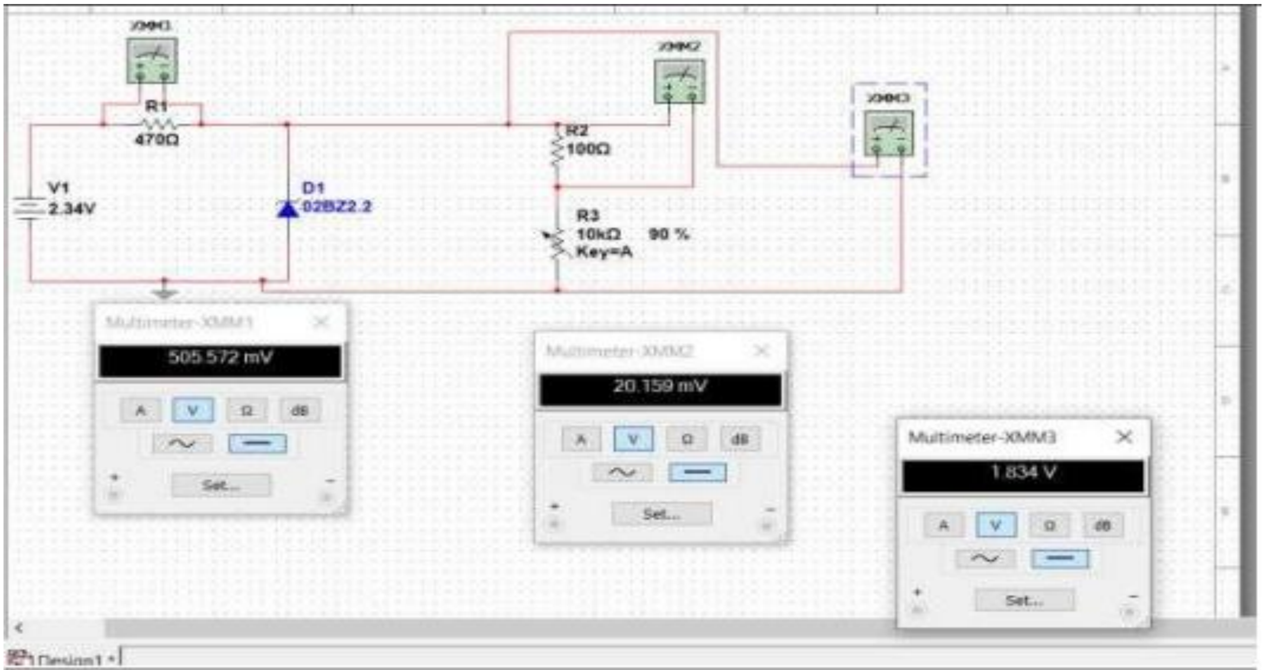

10kΩ

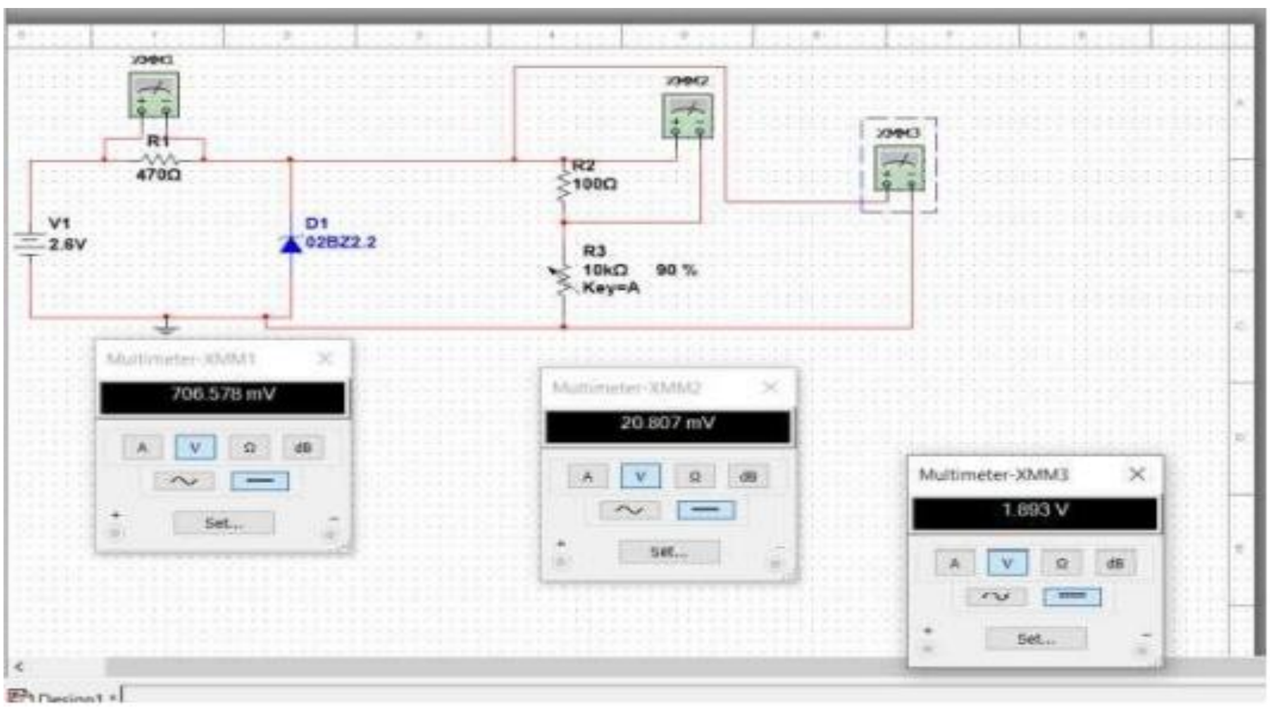

XSC1
D5
1DH62
V2
220Vrms
60Hz
0°
T1
10:5:5
R2
10kΩ
C1
100µF
D1
1DH62
Oscilloscope-XSC1

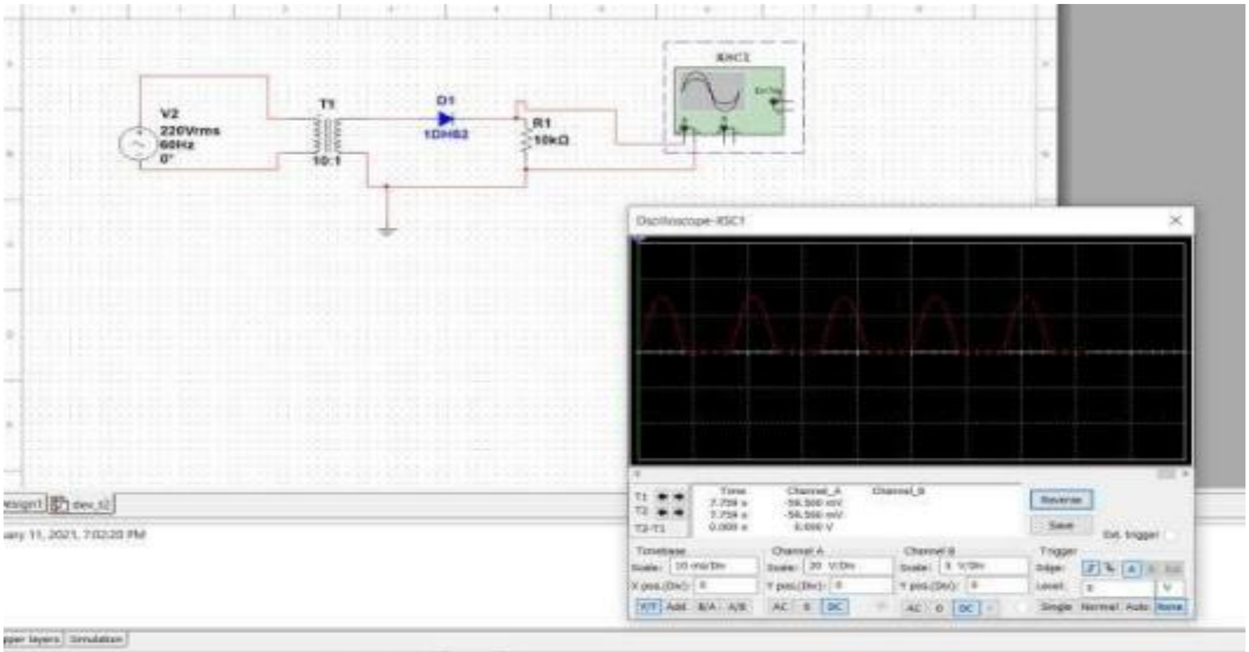

XMM1
R1
470Ω
V1
2V
D1
02BZ2.2
XMM2
R2
100Ω
R3
10kΩ 10 %
Key=A
XMM3
Multimeter-XMM1
613.278 mV
Multimeter-XMM2
126.066 mV
Multimeter-XMM3
1.387 V
Set...
Design1 *


XMM1
R1
470Ω
XMM2
R2
100Ω
XMM3
V1
1.5299V
D1
02BZ2.2
R3
10kΩ
90 %
Key=A
Multimeter-XMM1
101.254 mV
Multimeter-XMM2
15.699 mV
Multimeter-XMM3
1.429 V


XMM1
R1
470Ω
XMM2
R2
100Ω
XMM3
V1
2.04V
D1
02BZ2.2
R3
10kΩ
90 %
Key=A
Multimeter-XMM1
303.519 mV
Multimeter-XMM2
19.082 mV
Multimeter-XMM3
1.736 V

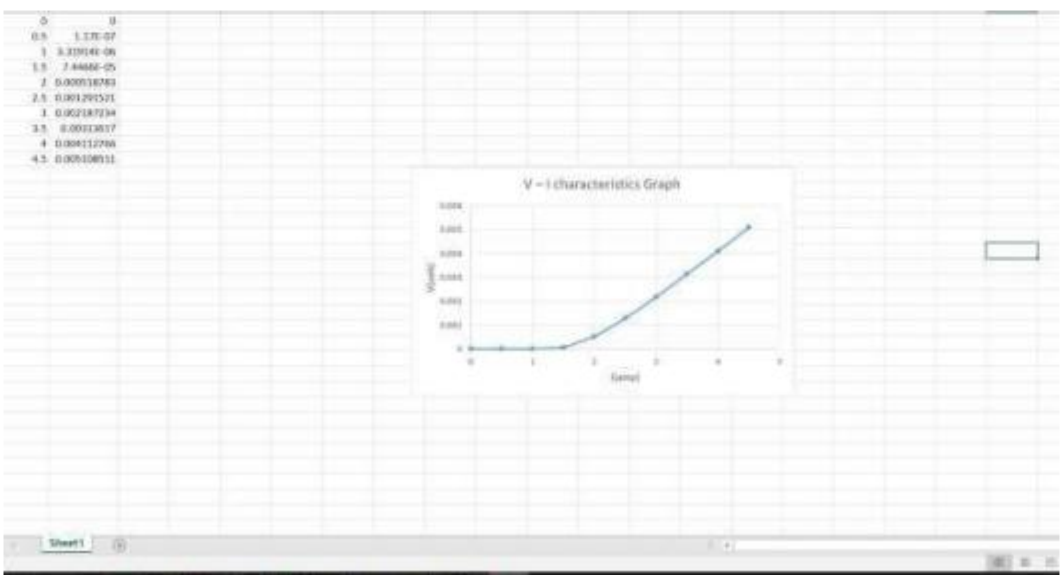

XMM1
R1
470Ω
XMM2
R2
100Ω
XMM3
V1
2.34V
D1
02BZ2.2
R3
10kΩ 90 %
Key=A
Multimeter-XMM1
505.572 mV
Multimeter-XMM2
20.159 mV
Multimeter-XMM3
1.834 V
Design1 *


XMM1
R1
470Ω
XMM2
R2
100Ω
XMM3
V1
2.6V
D1
02BZ2.2
R3
10kΩ 90 %
Key=A
Multimeter-XMM1
706.578 mV
Multimeter-XMM2
20.807 mV
Multimeter-XMM3
1.893 V
Design1 *



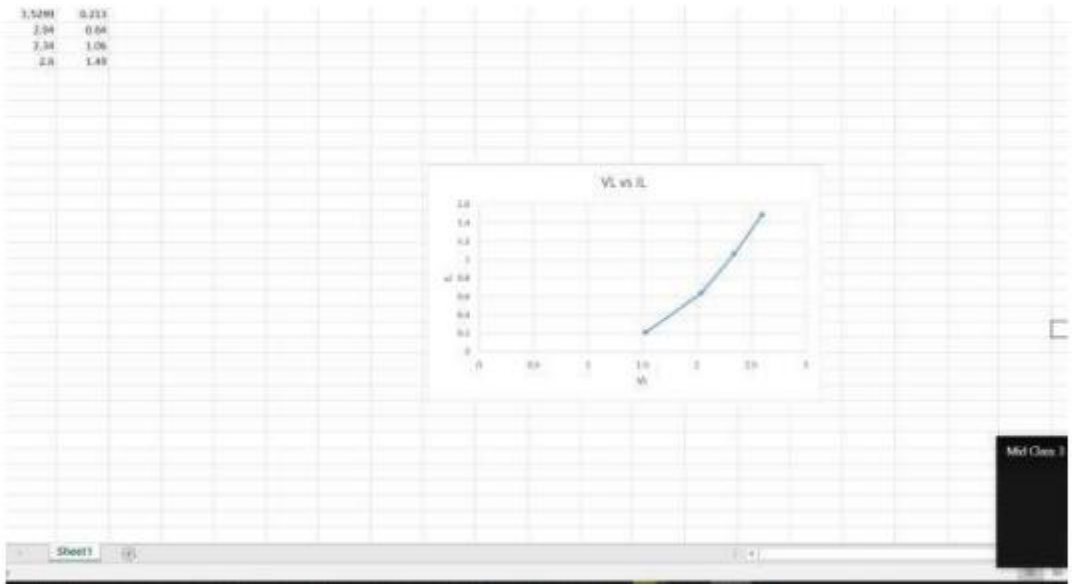
Questions Answers:

1. Plot the V – I characteristics of the Zener Diode. Determine the Zener Breakdown voltage from the plot.



the I-V characteristic intersects the horizontal axis. After reaching a certain voltage, called the breakdown voltage, the current increases widely even for a small change in voltage. However, there is no appreciable change in voltage. So, when we plot the graph, we should get a curve very near to x-axis and almost parallel to it for quite sometime. After the Zener potential Vz there will be a sudden change and the graph will become exponential.

2. Plot V_L vs I_L for the data of table?



Load Voltage is the voltage that a power source is able to supply when it is "loaded" at its rated "load value." It is dependent upon the internal resistance or impedance of the source. Load current is the current that the appliance is drawing at that instant. It should always be lower than the rated current of that item.

3. Discuss the experiment as a whole?

The main object of this lab is to observer zener diode practically. How the□ voltage and current changing with due to the increasing or decreasing of the load voltage. Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased. In the case of normal diodes the diode damages at the break down voltage. But zener diode is specially designed to operate in the reverse breakdown region. The basic principle of zener diode is the zener breakdown. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as zener breakdown. The breakdown voltage depends upon the amount of doping. For a heavily doped diode depletion layer will be thin and breakdown occurs at low reverse voltage and the breakdown voltage is sharp, whereas a lightly doped diode has a higher breakdown voltage. Thisexplains the zener diode characteristics in the reverse bias region. So a zener diode,in a forward biased condition acts as a normal diode. In reverse biased mode, after the break down of junction current through diode increases sharply. But the voltage across it remains constant. This principle is used in voltage regulator using zener diodes.

Conclusion:

Throughout this lab we observed the characteristics of I vs V graph. We have shown how the voltage changes significantly with a minimum amount of voltage and that has been done with reversed bias. The Zener diode, with its accurate and specific reverse breakdown voltage, allows for a simple, inexpensive voltage regulator. Combined with the right resistor, fine control over both the voltage and the supply current can be attained.

However, the low power ratings of standard Zener diodes and resistors make this solution impractical for high power devices.

Discussion:

The tough thing that we have faced that, the load Ir changes heavily with the changes of load voltage. To maintain 100mA or 300mA the given voltage has to be changed with a very small amount of DC voltage. So, that has been done very carefully.

References:

1. Adel S. Sedra, Kennth C. Smith, Microelectronic Circuits, Saunders College Publishing,3rd ed., ISBN: 0-03-051648-X, 1991.
2. David J. Comer, Donald T. Comer, Fundamentals of Electronic Circuit Design, John Wiley & fhim Sons Canada, Ltd.; ISBN: 0471410160, 2002