Faculty of Engineering & Technology
Department of Electrical & Computer Engineering
ENEE2103-Circuit And Electronics Laboratory
Report2
Exp#6: Diode Characteristic and Applications

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Abstract:
The purpose of this experiment is to delve into the functionality of a PN junction and explore the voltage-current (VI) characteristics of a silicon diode. Additionally, it aims to examine various applications of the PN junction, such as rectification, clamping, and clipping. The experiment involves collecting data pertaining to these aspects and subsequently analyzing and discussing the findings obtained.

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1. DIODE CHARACTERISTICS

1.1 Diode Definition:

A diode is a two-terminal electronic component that conducts current primarily in one direction (asymmetric conductance). It has low (ideally zero) resistance in one direction and high (ideally infinite) resistance in the other[1].

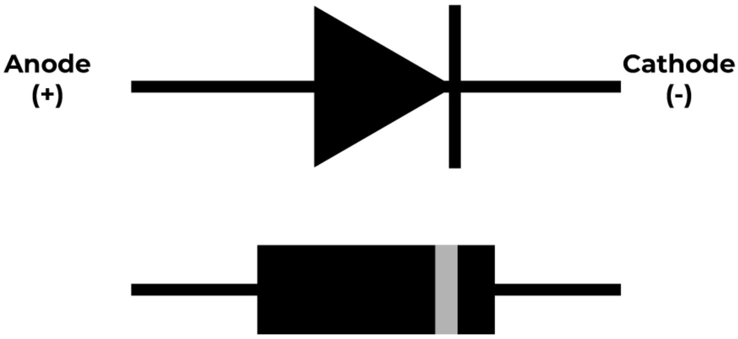

Figure1 :Diode shape and symbols [2]

1.2 PN Junction:

A P-N junction is an interface or a boundary between two semiconductor material types, namely the p-type and the n-type, inside a semiconductor which is created by the method of doping. The p-side or the positive side of the semiconductor has an excess of holes, and the n-side or the negative side has an excess of electrons.

In the N-type region, the majority of charge carriers are electrons and the minority of charge carriers are holes. Whereas, In the P-type region, the majority of charge carriers are holes and the minority of charge carriers are electrons. Because of the concentration difference, the diffusion takes place in majority charge carriers and they recombine with the minority charge carriers which are then collected near the junction and this region is known as the Depletion Region.

- When the anode or p-type terminal of the diode is connected with a negative terminal and the n-type or cathode is connected with the positive terminal of the voltage source, this type of connection is called a Reverse Bias condition.
- When the anode or p-type terminal of the diode is connected with a positive terminal and the n-type or cathode is connected with the negative terminal of the voltage source , this type of connection is called a Forward Bias condition.[3]

1.3 Diode Characteristics:

1.3.1 Forward-Biased Diode:

In forward biasing semiconductor is connected to an external source when the p-type semiconductor is connected to the positive terminal of the source or battery and the negative terminal to the n-type, then this type of junction is said to be forward-biased. In forward bias, the direction of the built-in electric field near the junction and the applied electric field are opposite in direction. This means that the resultant electric field has a magnitude lesser than the built-in electric field due to this there is less resistivity and therefore depletion region is thinner. In silicon, at the voltage of 0.7 V, the resistance of the depletion region becomes completely negligible.[3]

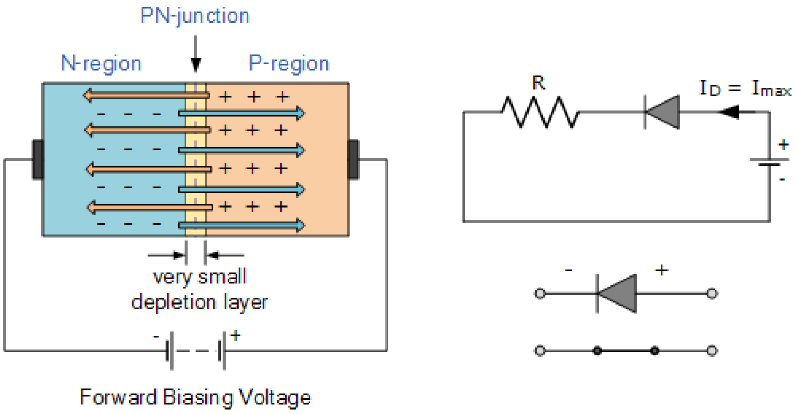

Figure2 :Forward-Biased Diode[4]

1.3.2 Reverse-Biased Diode:

In reverse biasing, the n-type is connected to the positive terminal and the p-type is connected to the negative terminal of the battery. In this case, the applied electric field and the built-in electric field are in the same direction and the resultant electric field has a higher magnitude than the built-in electric field creating a more resistive, therefore depletion region is thicker. if the applied voltage becomes larger, then the depletion region becomes more resistive and thicker.[3]

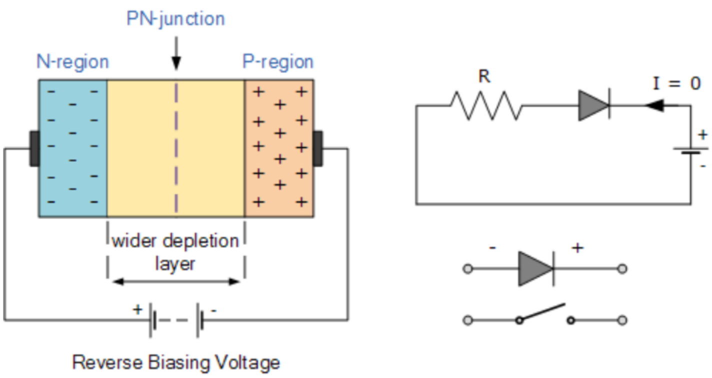

Figure3 :Reverse-Biased Diode[4]

1.4 V-I Characteristics of P-N Junction Diode:

VI characteristics of P-N junction diodes is a curve between the voltage and current through the circuit. Voltage is taken along the x-axis while the current is taken along the y-axis.

In the forward characteristics, the non-linear behavior reveals a gradual increase in current, followed by a sudden rise at the threshold voltage (knee voltage) due to low resistance. In reverse bias, current arises from minority carriers, and a sudden increase in reverse current occurs at the reverse breakdown voltage. These characteristics offer essential insights into the diode's behavior under distinct bias conditions.

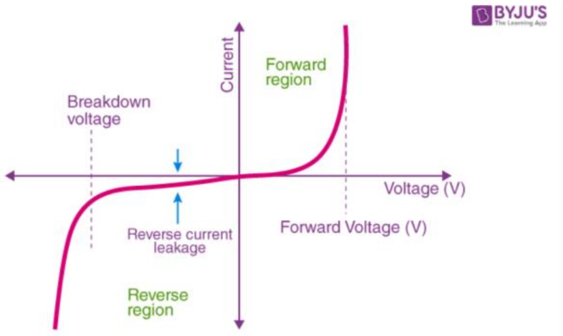

Figure 4:V-I Characteristics of P-N Junction Diode[5]

2.RECTIFICATION :

2.1 Definition of Rectifier:

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction.

Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power. As noted, rectifiers can serve as detectors of radio signals. In gas heating systems flame rectification is used to detect presence of a flame.

Depending on the type of alternating current supply and the arrangement of the rectifier circuit, the output voltage may require additional smoothing to produce a uniform steady voltage. Many applications of rectifiers, such as power supplies for radio, television and computer equipment, require a steady constant DC voltage (as would be produced by a battery). In these applications the output of the rectifier is smoothed by an electronic filter, which may be a capacitor, choke, or set of capacitors, chokes and resistors, possibly followed by a voltage regulator to produce a steady voltage [6].

2.2 Half-Wave Rectifier:

A half-wave rectifier converts an AC signal to DC by passing either the negative or positive half-cycle of the waveform and blocking the other. Half-wave rectifiers can be easily constructed using only one diode, but are less efficient than full-wave rectifiers.

Since diodes only carry current in one direction, they can serve as a simple half-wave rectifier. Only passing half of an AC current causes irregularities, so a capacitor is usually used to smooth out the rectified signal before it can be usable.

$$V_{\text{rms}} = \frac{V_{\text{peak}}}{2}$$

$$V_{\text{dc}} = \frac{V_{\text{peak}}}{\pi}$$

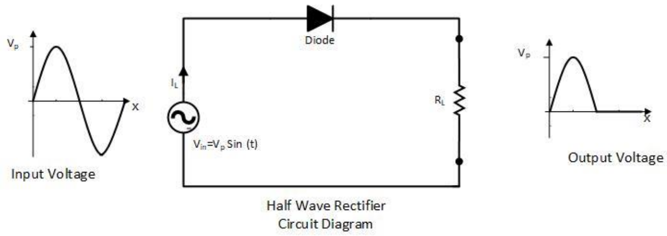

Figure5 :Half-Wave Rectifier circuit digram and output curve[7]

2.3 Full-Wave Rectifier:

A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC.

The circuit of the full wave rectifier can be constructed in two ways. The first method uses a center tapped transformer and two diodes. This arrangement is known as a center tapped full wave rectifier. The second method uses a standard transformer with four diodes arranged as a bridge.

2.3.1 Bridge Rectifier:

The bridge rectifier circuit is made of four diodes, and a load resistor. The four diodes are connected in a closed-loop configuration to efficiently convert the alternating current (AC) into Direct Current (DC). The main advantage of this configuration is the absence of the expensive center-tapped transformer. Therefore, the size and cost are reduced.

The four diodes are arranged in such a way that only two diodes conduct electricity during each half cycle[8].

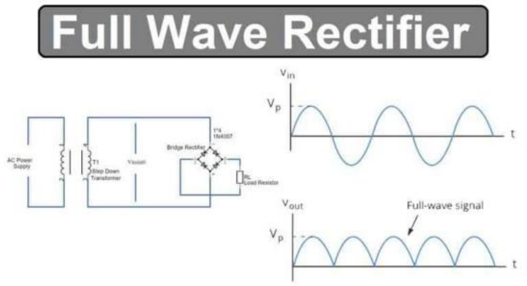

Figure 6:Full-Wave Rectifier Bridge circuit and output curve[9]

3. Other Applications:

3.1 Clipping:

are the circuits that clip off or removes a portion of an input signal, without causing any distortion to the remaining part of the waveform. These are also known as clippers, clipping circuits, limiters, slicers.

The basic operation of a diode clipping circuits is such that, in forward biased condition, the diode allows current to pass through it, clamping the voltage. But in reverse biased condition, no any current flows through the diode, and thus voltage remains unaffected across its terminals [10].

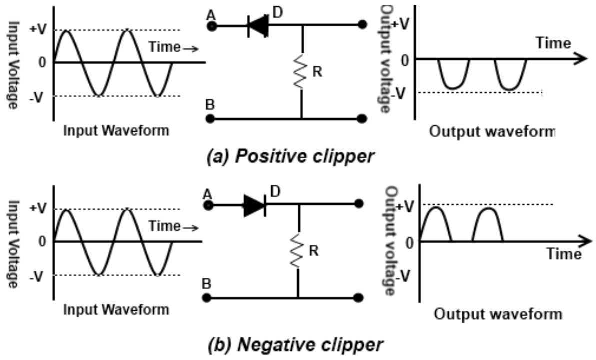

Figure 7:Positive and negative Clipper circuit [11]

3.2 Clamping:

A Clamper Circuit is a circuit that adds a DC level to an AC signal. Actually, the positive and negative peaks of the signals can be placed at desired levels using the clamping circuits. As the DC level gets shifted, a clamper circuit is called as a Level Shifter.

Clamper circuits consist of energy storage elements like capacitors. A simple clamper circuit comprises of a capacitor, a diode, a resistor and a dc battery if required[12].

3.2.1 Positive Clamper:

A Clamping circuit restores the DC level. When a negative peak of the signal is raised above to the zero level, then the signal is said to be positively clamped.

A Positive Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the positive portion of the input signal, Hence the signal is positively clamped and The output signal changes according to the changes in the input, but shifts the level according to the charge on the capacitor, as it adds the input voltage[12].

3.2.2 Negative Clamper:

A Negative Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the negative portion of the input signal, Hence the signal is negatively clamped and The output signal changes according to the changes in the input, but shifts the level according to the charge on the capacitor, as it adds the input voltage[12].

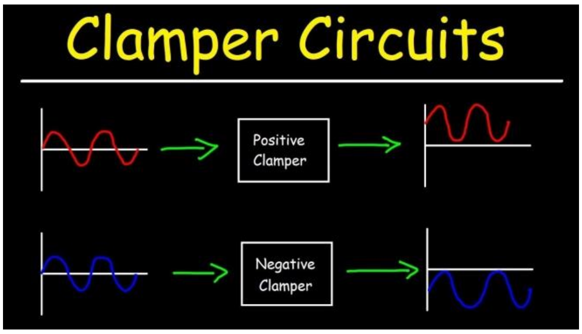

Figure 8:Positive and negative Clamper circuit [13]

Procedure And Data Analysis:

1. DIODE CHARACTERISTICS:

We connected the circuit below:

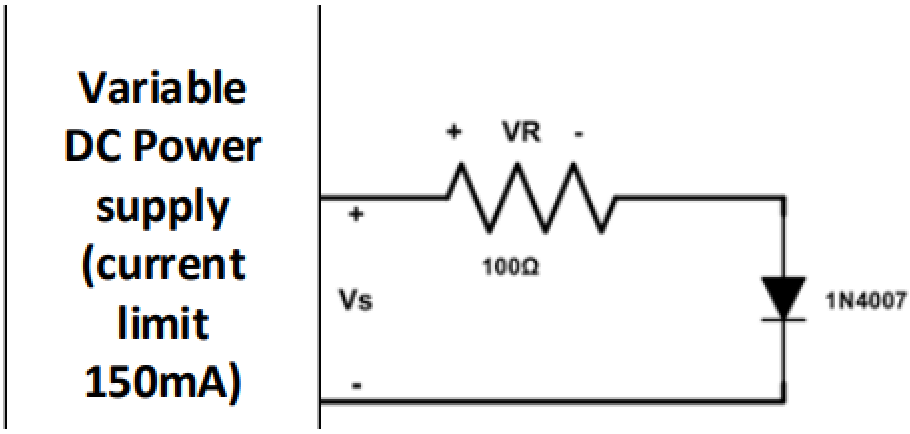

Figure9 :Diode Characteristic Lab Circuit[14]

Then we set the current limit of the DC power supply to 150mA. Also switched on the power supply and adjusted it from zero to 1 volt in 0.2V steps and in 0.5 steps from 1V to 3V. For each setting we measured the value of VR, Vs by DVM to calculate ID and VD by this equations:

VD=VS-VR

ID=VR/R

as shown in the table1 below.

Table 1:Diode Characteristic

SET		Measure	Calculate	
V_S (desired)	V_S (actual)	VR	V_D	I_D
0	-0.006	0.001	-0.007	0.01mA
0.1	0.130	0.001	0.129	0.01mA
0.2	0.204	0.001	0.203	0.01mA
0.3	0.365	0.001	0.364	0.01mA
0.4	0.471	0.008	0.463	0.08mA
0.5	0.532	0.022	0.510	0.22mA
0.6	0.598	0.045	0.553	0.45mA
0.7	0.699	0.111	0.588	1.11mA
0.8	0.795	0.182	0.613	1.82mA
0.9	0.929	0.293	0.636	2.93mA
1.0	1.043	0.394	0.649	3.94mA
1.5	1.542	0.856	0.686	8.56mA
2	1.994	1.291	0.703	12.91mA
2.5	2.537	1.817	0.720	18.17mA
3	3.045	2.315	0.730	23.15mA

Then I have drawn the forward characteristics of the diode by plotting ID versus VD on EXCEL.

VD	ID
0.007-	0.01
0.129	0.01
0.203	0.01
0.364	0.01
0.463	0.08
0.51	0.22
0.553	0.45
0.588	1.11
0.613	1.82
0.636	2.93
0.649	3.94
0.686	8.56
0.703	12.91
0.72	18.17
0.73	23.15

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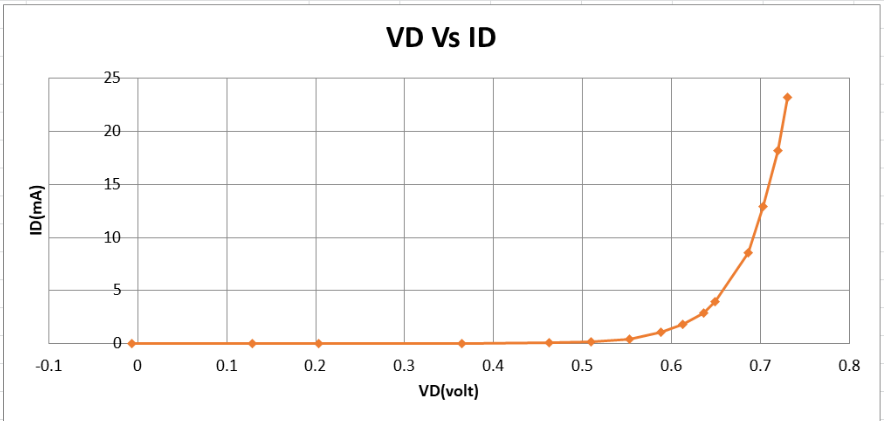


Figure 10:The forward characteristics(ID vs VD)

Questions:

1-At what approximate value of VD does the current ID begin to rise noticeably ? 0.588v

2-Does VD rise much above this value for larger values of ID ?No ,For large values of ID, VD remains constant.

3-What happens if the diode is reversed? If the diode is reversed it will act as an open circuit then there will be no current passing through the circuit, so VR will be equal to Vs.

2. Rectification:

2.1 Half-Wave Rectification:

First we connect the circuit below:

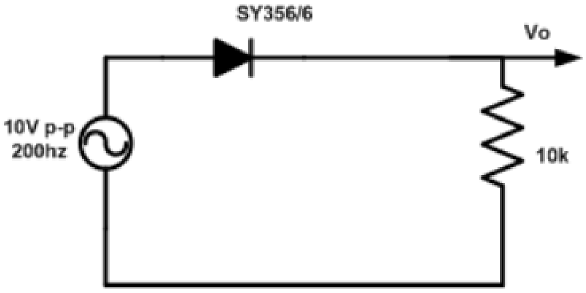


Figure 11:Half wave Rectification Lab Circuit[14]

Then we connect An oscilloscope to the terminals of the resistor And measured the period (T) and its value= 4.9ms. Also we measured the peak voltage Vpk for the output voltage which is equal 4.64volt.

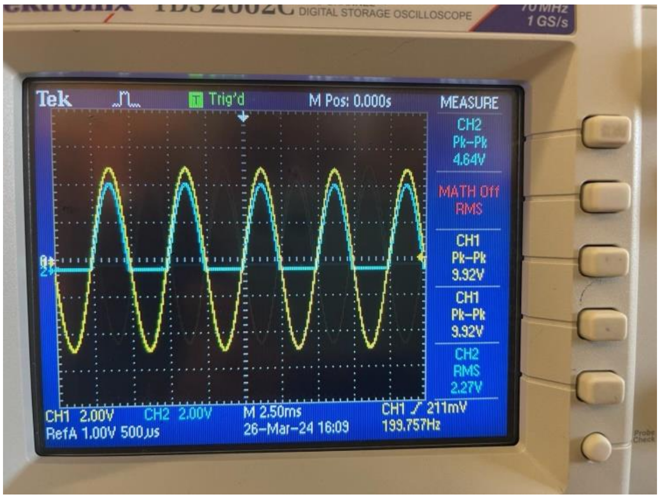


Figure 12:Half Wave Rectifier Waveform(with Vpk display in screan)

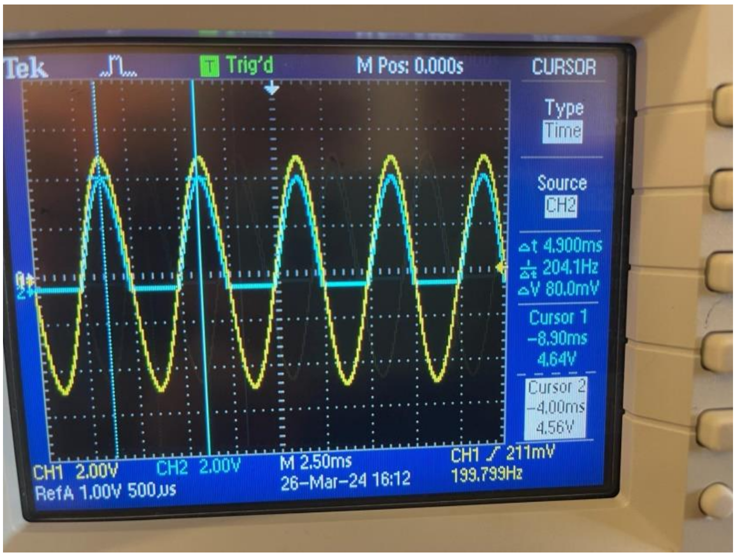


Figure 13:Half Wave Rectifier Waveform(with T display in screan)

The theoretical value of T=1/F=1/200=5ms. It is very close to 4.9ms(the particular value).

Also I measured the dc and ac components of the output voltage using DVM and found that the AC value =1.716volt, while the DC value equal 1.382volt.

The theoretical value of dc value = VPk/ π=5/ π=1.5915 volt.

Then we reversed the diode, the peak voltage =-4.40volt, AC value =1.611volt, while the DC value equal -1.257 volt.

The negative portion of the input signal is now allowed to pass through, while the positive portion is effectively reduced to zero. This behavior is reflected in the DC value of the output, which becomes negative.

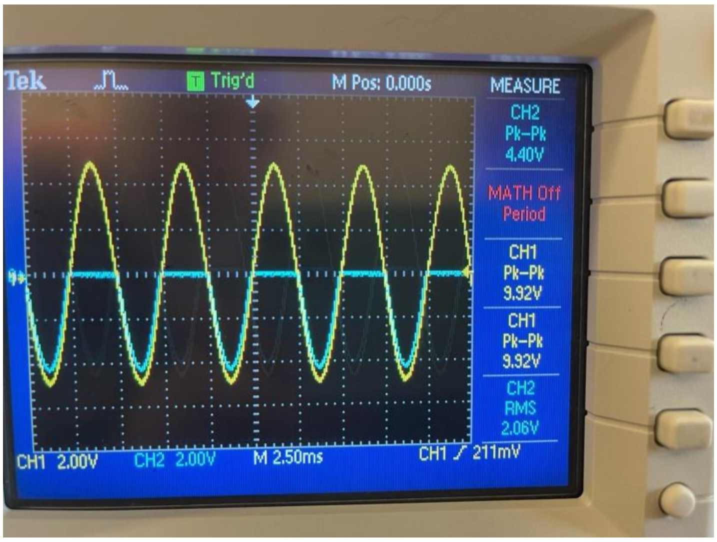


Figure 14:Half Wave Rectification with Reversed Diode

2.1.1 Questions:

1-Is V_{pk} nearly equal to the peak voltage of the supply? Yes the peak voltage =4.64volt is nearly equal to the peak voltage of the supply which equal 5 volt.

2-Why will V_{pk} not be exactly equal to the source peak voltage? Because, there is a small amount of voltage drop in the diode.

3- How much will it differ? By approximately 0.7V.

4-How could you obtain a negative voltage relative to zero? By reversing the diode.

Then , we add a capacitor of 2.2uF to our circuit , the circuit become as shown in Fig below:

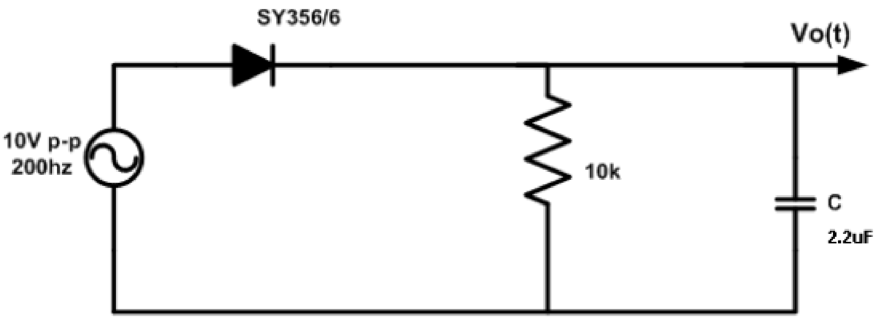


Figure 15:Half Wave Rectification with Capacitor[14]

Then we Observe the output waveform on the oscilloscope and measure peak-to-peak ripple which equal 760mV and RMS ripple voltage which equal 229mV (using ac coupling).

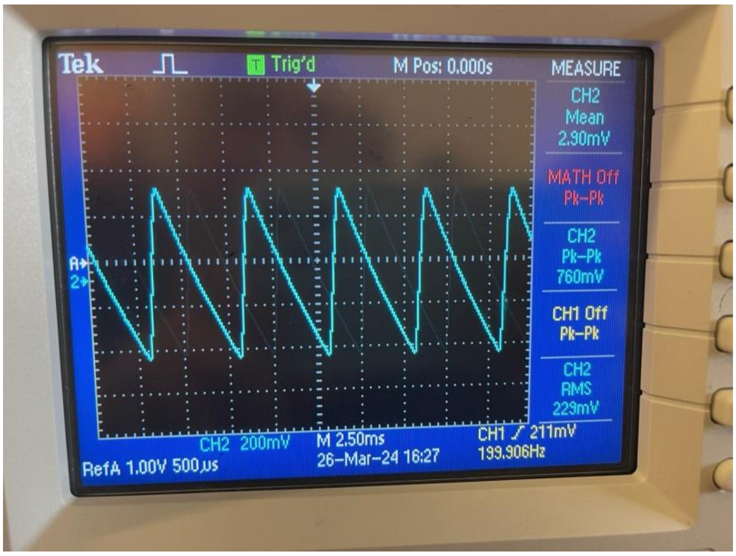


Figure 16:Half Wave Rectification Waveform with Capacitor 2.2uF using ac coupling

Then we Measure the mean value of Vo(t) using dc coupling which equal to 4.05v.
Peak to peak ripple = 760mv.
Rms ripple = 229mv.
The mean value of Vo (t) =4.05volt.
Ripple factor r%=Vrms/Vavg=229mv/4.05 *100%=5.65432%

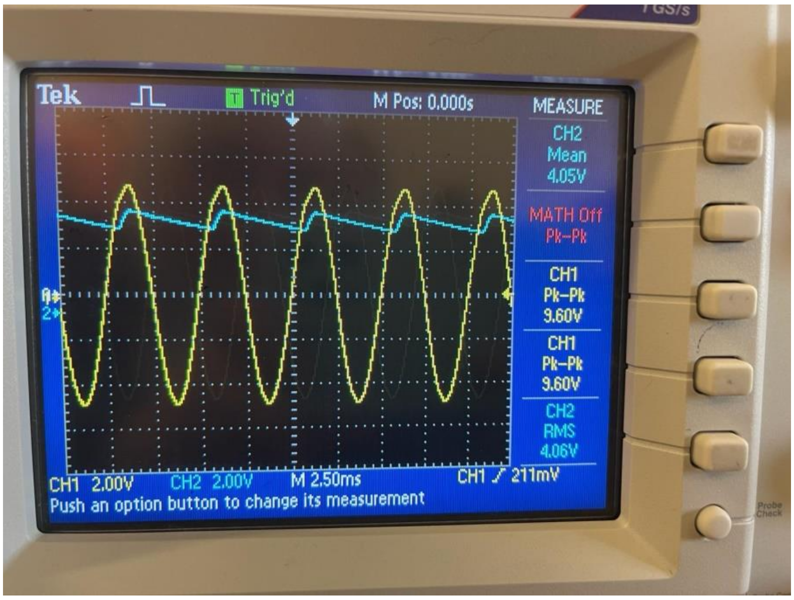


Figure 17:Half Wave Rectification Waveform with Capacitor 2.2uF using dc coupling

Then we use DVM to calculate the Ac voltage which equal to 0.226v and DC voltage which equal to 3.958v.

Then ,We replaced the 2.2uF capacitor by a much large value of 47uF(it not actually 47uF , we measured it and found that is 43uF).

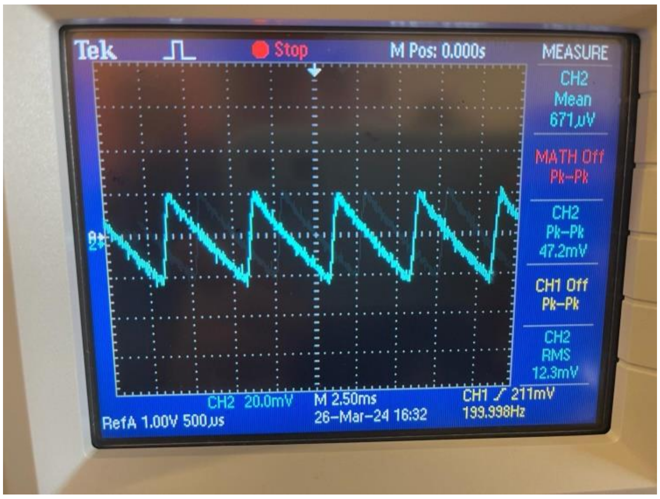


Figure 18:Half Wave Rectification Waveform with Capacitor 47uF using ac coupling

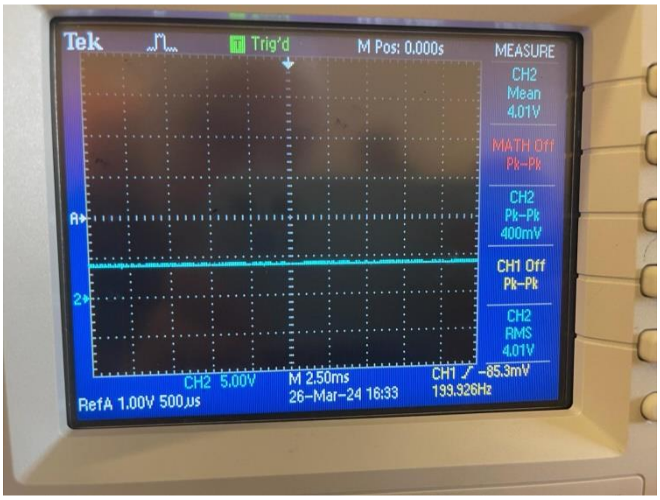


Figure 19:Half Wave Rectification Waveform with Capacitor 47uF using dc coupling

Peak to peak ripple = 47.2mv.

Rms ripple = 12.3mv.

The mean value of Vo (t) =4.01volt.

Ripple factor r%=Vrms/Vavg=12.3mv/4.01 *100%=0.3067%

2.1.2 Questions:

1- Is the ripple now less than or more than it was with the lower value of the capacitor?

Ripple factor r%=Vrms/Vavg=229mv/4.01 *100%=0.3067%

It is now less than it was with the lower value of the capacitor

2- Is the mean rectified voltage now greater or less?

The mean is increased while the ripple factor is decreased.

2.2 Full-Wave Rectification:

We constructed the circuit below:

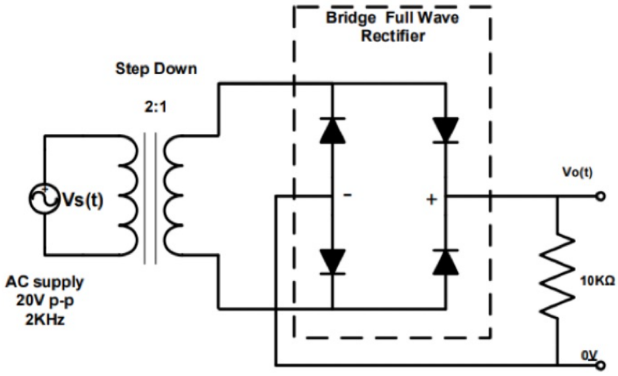


Figure 20:Diode Bridge Circuit as a Full-Wave Recticfer (lab circuit) [14]

Then ,We connected the oscilloscope to the output:

Figure 21:Full Wave Rectifier Waveform

Then we measure using DVM the dc component which equal to 2.791v and ac component which equal 1.691v.

Then We added a capacitor of 2.2uF to the circuit.

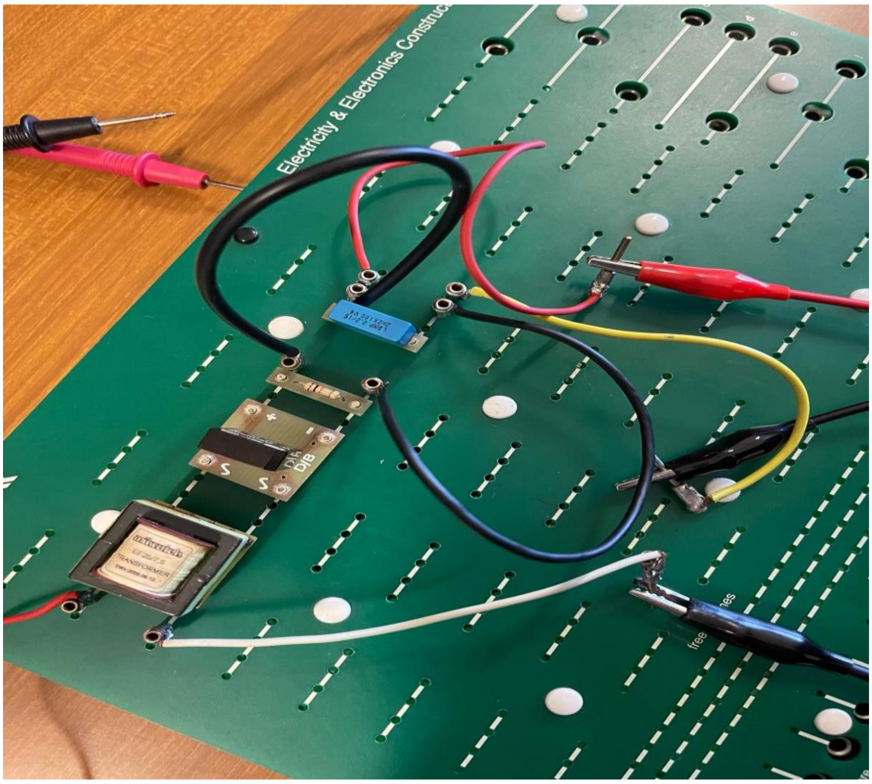


Figure 22:Diode Bridge Circuit as a Full-Wave Recticfer with 2.2uF capacitor (lab circuit)

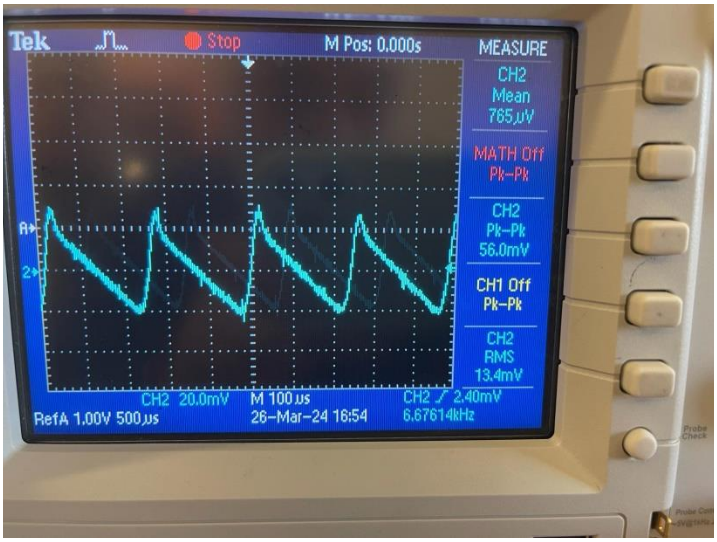


Figure 23:Full Wave Rectifier Waveform with c =2.2uF

Then we measure using DVM the dc component which equal to 4.523v and ac component which equal 13.22mv.

2.2.1 Questions:
1- When the capacitor connected, what is the change on the waveform, why?

The ripple becomes much less than the previous circuit, this is because the capacitor acts as a filter.

2- Does the ripple voltage change with frequency?

Yes, the ripple voltage changes with frequency according to this equation:

$r\% = 1/\sqrt{3} * (4f0RC - 1) * 100\%$

3- What is the effect of frequency on the ripple? When the input frequency is reduced, do you need a larger or a smaller capacitor to achieve the same ripple?

Increasing the frequency will reduce the ripple factor, when the frequency is reduced, we need a smaller capacitor to achieve the same ripple.

3. Other Applications:

3.1 Clipping:
We connected the circuit below:

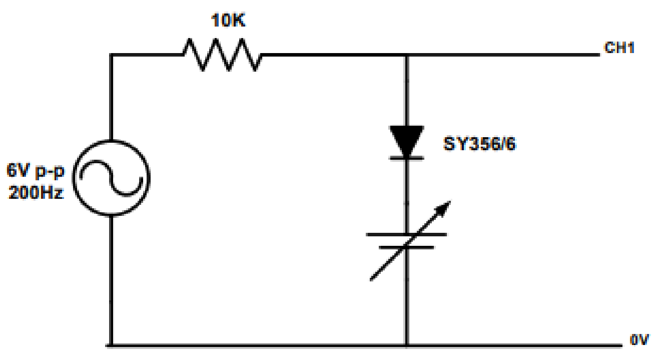


Figure 24:Clipping Circuit(lab circuit)[14]

Then we connected the oscilloscope to the output of the circuit and set the power supply variable control to zero (fully anti-clockwise) then increase it slightly to 1.5v then 4v.

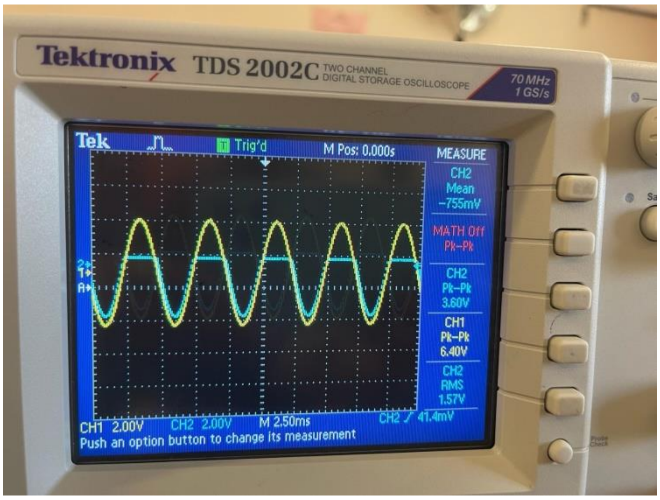


Figure 25:Clipping Circuit Waveform for 0 volt

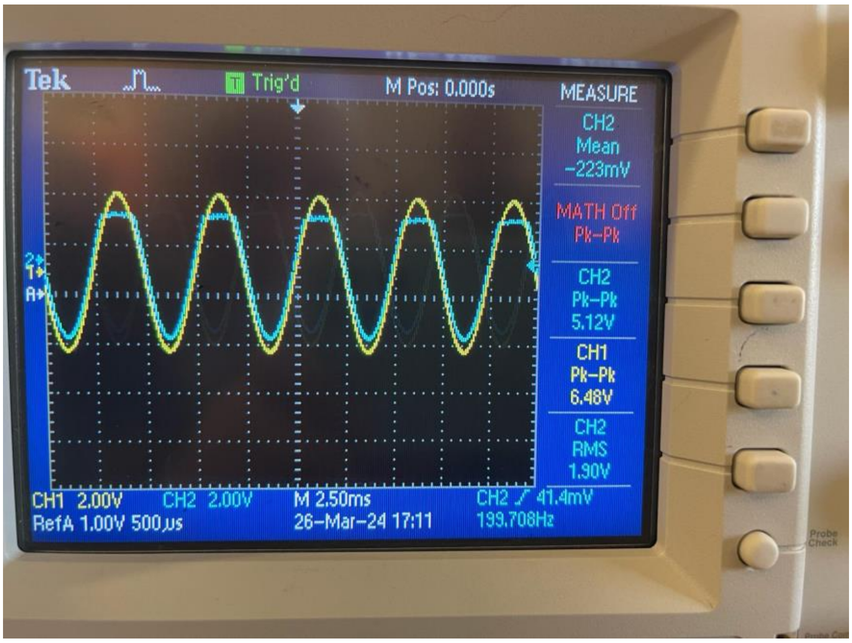


Figure 26:Clipping Circuit Waveform for 1.5 volt

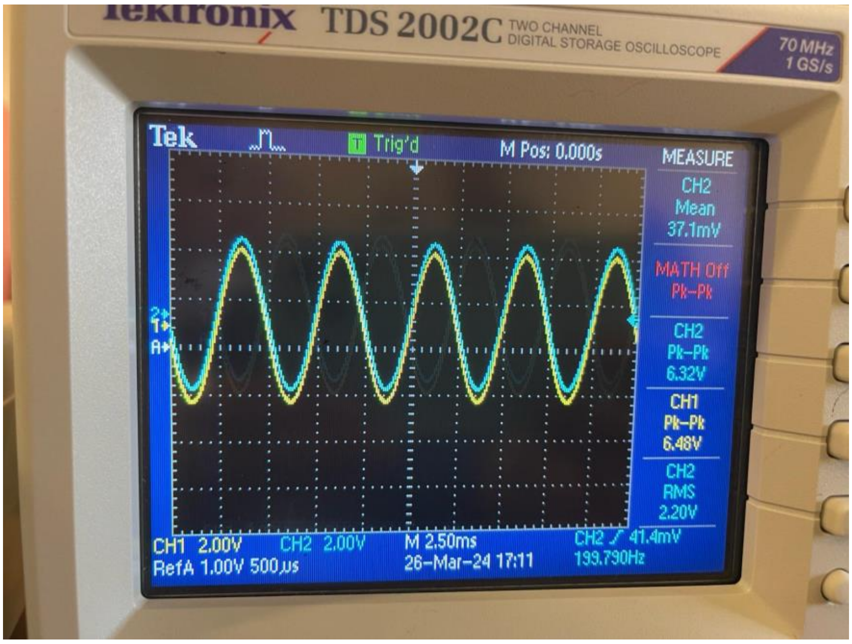


Figure 27:Clipping Circuit Waveform for 4 volt

3.1.1 Questions:

1-What difference is there between the input and output wave?

The difference is that the output wave is chopped off at certain voltage values.

2-At what voltage is the output wave form chopped off?

At approximately the same value of the variable dc source -the voltage drop on the diode (0.7Volts).

3-If the dc is 1.5V, at what voltage are the positive peaks chopped off?

When the dc is 1.5V, the output is chopped off at 1.5-0.7=0.8

4- If the ac is 10V p-p, does the clipping voltage change?

No.

5-What is the relationship between the clipped level and the dc voltage in the two cases?

Clipped level=Vdc-Vd.

3.2 Clamping:

we first connect the circuit below:

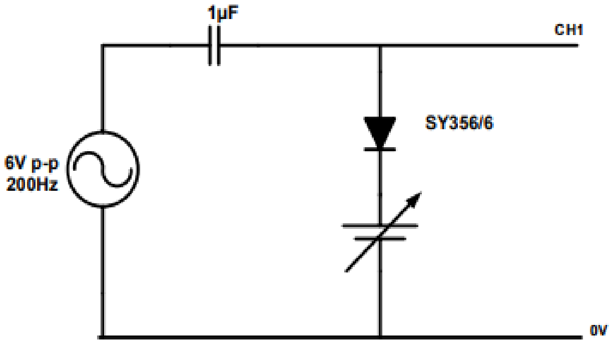


Figure 28:Clamping Circuit (lab circuit) [14]

Then we follow the same steps we had followed in part 3.1 (clipping).

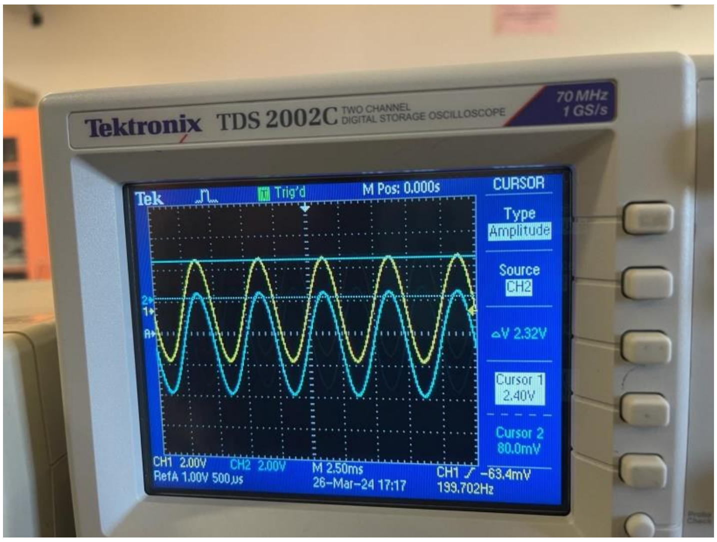


Figure29 :Clamping Circuit Waveform for 0 volt

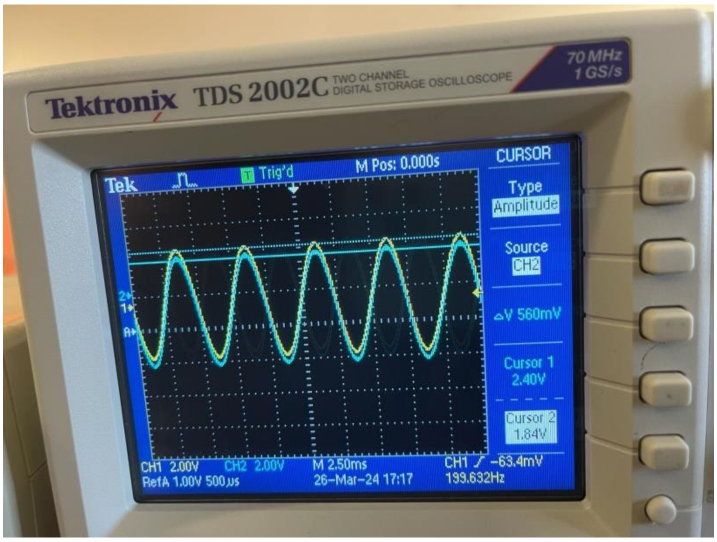


Figure 30:Clamping Circuit Waveform for 1.5 volt

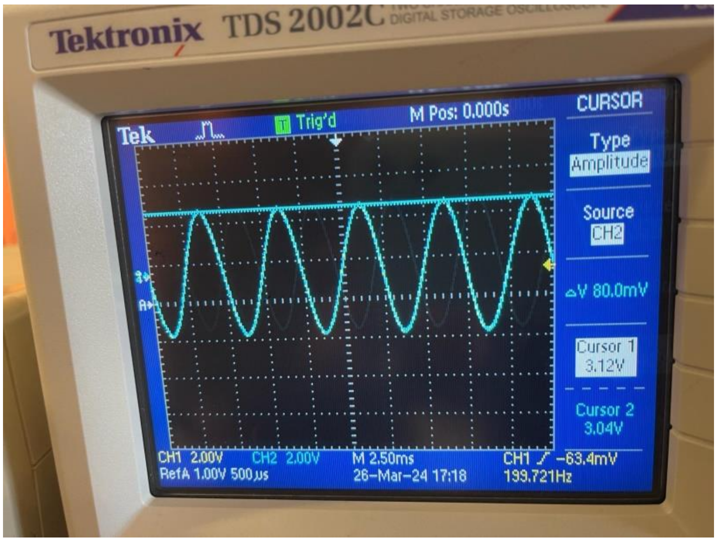


Figure 31:Clamping Circuit Waveform for 4 volt

3.2.1 Questions:

1- Does the output wave form alternate about the same dc level as the input waveform?

No, the output was shifted.

2-To what value the positive peak of the output waveform is clamped, if the ac input signal is 5VPK?

If dc = 0 then the peak Approximately 0.7 volts.

Else if dc=1.5 then the peak Approximately 5-2.8 =3.2volts.

Else if dc=4 then the peak Approximately 5-0.3 =4.7volts.

3- Does the positive peak still stay clamped to the same level?

Yes.

4-Can you see any relation between the reference voltage setting and the clamping level.

Clamping Level = Vi (+or-) Vc.

Conclusions:

In conclusion, we explored the I-V characteristics and behavior of diodes is discovered. IvsV characteristics highlighted role in forward and reverse bias, resembling a voltage source and an open circuit. We discovered that diodes are primarily used for rectification, allowing current flow in one direction while blocking it in the other. Additionally, we examined various applications of diodes, such as half and full wave rectifiers, clippers, and clampers. Through these applications, we saw how half-wave and full-wave rectifier circuits convert AC to DC in industrial contexts .control clipping and clamping levels and understanding positive and negative clipping and capacitor-based clamping.

References:

[1] https://en.wikipedia.org/wiki/Diode#:~:text=A%20diode%20is%20a%20two,infinite)%20resistance%20in%20the%20other [Accessed On 2024, March 27]

[2] https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.geeksforgeeks.org%2Fdiode%2F&psig=AOvVaw18X9pJOfPMaYVQCDzZzKct&ust=1711369190296000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCMj3y5fxjIUDFQAAAAAdAAAAABAJ [Accessed On 2024, March 27]

[3] https://www.geeksforgeeks.org/diode/ [Accessed On 2024, March 27]

[4] https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.electronics-tutorials.ws%2Fdiode%2Fdiode_3.html&psig=AOvVaw2l8ayzwW1M5suZFAP6X_Iq&ust=1711370358834000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCLCS68T1jIUDFQAAAAAdAAAAABBF [Accessed On 2024, March 27]

[5] https://cdn1.byjus.com/wp-content/uploads/2022/05/V-I-Characteristics-of-P-N-junction-Diode.png [Accessed On 2024, March 27]

[6] https://en.wikipedia.org/wiki/Rectifier [Accessed On 2024, March 27]

[7] https://electric-shocks.com/wp-content/uploads/2019/01/Half-Wave-Rectifier-Circuit-diagram.jpg [Accessed On 2024, March 27]

[8] https://byjus.com/physics/bridge-rectifier/ [Accessed On 2024, March 27]

[9] https://how2electronics.com/wp-content/uploads/2022/09/Full-Wave-Bridge-Rectifier-1000x562.jpg [Accessed On 2024, March 27]

[10] https://electronicscoach.com/clipper-circuits.html [Accessed On 2024, March 27]

[11] https://www.daenotes.com/sites/default/files/article-images/clipper-circuits-positive-and-negative.png [Accessed On 2024, March 27]

[12] https://www.tutorialspoint.com/electronic_circuits/electronic_clamper_circuits.htm [Accessed On 2024, March 28]

[13] https://i.ytimg.com/vi/PRzrS6NOyAY/maxresdefault.jpg [Accessed On 2024, March 28]

[14] lab manual https://ritaj.birzeit.edu/bzu-msgs/attach/2544741/ENEE2103+Lab+manual+second+semester+2023-2024.pdf [Accessed On 2024, March 28]

Appendix:

Experiment # 6 **ENEE2103**

Diode Characteristic and Applications.

Objectives:

1. To investigate the operation of PN junction, and the VI characteristics of the silicon diode
2. To investigate some applications of the P-N junction like Rectification, Clamping and Clipping.

Pre-lab Work:

1. Simulate the circuits in the procedure section and determine the required values (set the parameters that must be assigned by the instructor in the procedure to proper values).
2. Verify if Simulation Results match the expected results

Procedure:

I. DIODE CHARACTERISTICS

1. Connect the Circuit of Fig. (6.1).

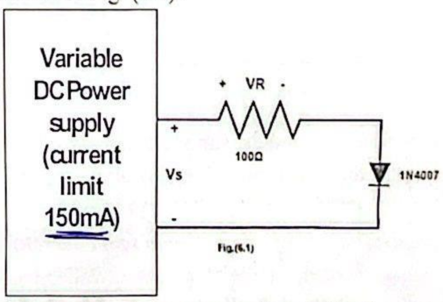


Fig.(6.1)

2. Set the current limit of the dc power supply to 150mA.
3. Switch on the power supply and adjust it from zero to 1 volt in 0.1V steps and in 0.5 steps from 1V to 3V.
4. For each setting measure the value of VR.

Table 6.1

SET		Measure	Calculate	
V_S (desired)	V_S (actual)	VR	V_D	I_D
0	-0.006	0.001		
0.1	0.130	0.001		
0.2	0.204	0.001		
0.3	0.365	0.001		
0.4	0.471	0.008		
0.5	0.532	0.022	Harem Awaysa	
0.6	0.589	0.045	26/3/24	
0.7	0.699	0.111		
0.8	0.795	0.182		
0.9	0.929	0.293		
1.0	1.043	0.394		
1.5	1.542	0.856		
2	1.994	1.291		
2.5	2.537	1.817		
3	3.045	2.315		

5. Calculate V_D and I_D and enter them in the table 6.1 .
6. Draw the forward characteristics of the diode by plotting I_D versus V_D.

Questions:

- At what approximate value of V_D does the current I_D begin to rise noticeably?
- Does V_D rise much above this value for larger values of I_D?
- What happens if the diode is reversed?

→ ID almost 0
open circuit

II. RECTIFICATION.

A. HALF - WAVE RECTIFICATION.

1. Connect the circuit as shown in Fig.(6-3).

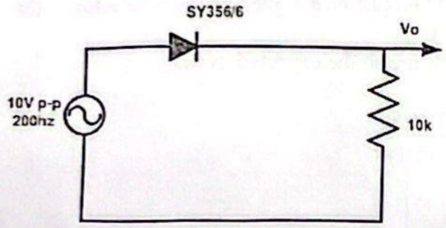


Fig.(6-3)

4.64

2. Switch on the oscilloscope and the sinusoidal supply.
3. Measure and record time T(the period) and peak voltage V_{pk} for the output voltage
→ 4.9ms

(also take pictures of the waveforms from scope screen)

1.382V → 1.716V

4. Measure the dc and ac components of the output voltage using DVM and compare your dc value with the theoretical value.
5. Reverse the Diode and observe the output voltage

$V_{pk} = -4.40V$ $V_{dc} = -1.257V$ $V_{Ac} = 1.611V$

Questions:

- Is V_{pk} nearly equal to the peak voltage of the supply.
- Why will V_{pk} not be exactly equal to the source peak voltage ?
- How much will it differ?
- How could you obtain a negative voltage relative to zero?

6. Now add a capacitor of 2.2uF to your circuit, the circuit becomes as shown in Fig.(6-4).

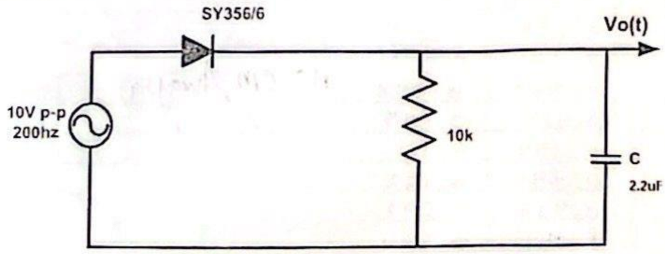


Fig.(6-4)

7. Observe the output waveform on the oscilloscope and measure peak-to-peak ripple and rms ripple voltage using ac coupling. → 760mV

2.2 μF

8. Measure the mean value of Vo(t) **using dc coupling**, then calculate the ripple factor. exactly 43μF 47μF

DWM

9. Now replace the 2.2 μF capacitor by a much larger value of 47μF, making sure to connect the + side of the capacitor to the diode cathode (the capacitor is electrolytic and MUST be connected in the correct polarity).

Ac → 0.276 V

Dc → 3.958 V

Dc avg = 4.093 V

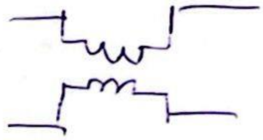
Ac 12 mV

** also take pictures of the waveforms from scope screen to show the waveforms and measured quantities*

Questions:

- Is the ripple now less than or more than it was with the lower value of the capacitor?
- Is the mean rectified voltage now greater or less?

B. FULL-WAVE RECTIFICATION



Diode bridge circuit as a full wave rectifier:

1. Construct the circuit of Fig.(6-5).

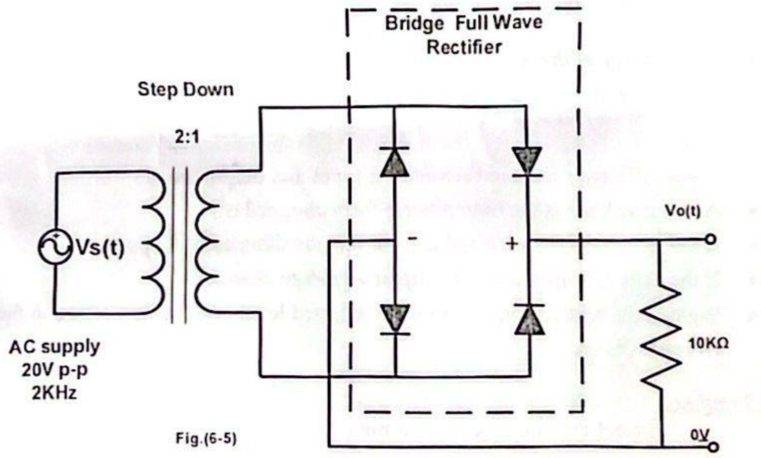


Fig.(6-5)

2. Connect the oscilloscope to the output.
3. Draw the output waveform as seen on the oscilloscope and take a picture showing key quantities.
4. Measure the dc and ac components of the voltage across the load using DVM.

2.791 V → 1.691 V

Questions:

- When the capacitor connected, what is the change on the waveform, why? Does the ripple voltage change with frequency?
- What is the effect of frequency on the ripple? When the input frequency is reduced, do you need a larger or a smaller capacitor to achieve the same ripple?

DVM 2.2μF

VAc = 13.22 mV

VDc = 4.523 V

III. other applications:

A. clipping:

1. Connect the circuit as shown in Fig.(6-6).

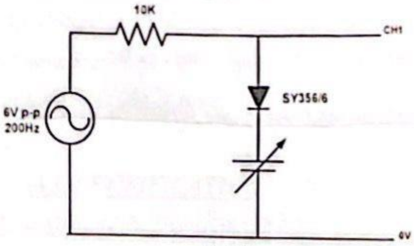


Fig (6-6)

2. Connect the oscilloscope to the output of the circuit.
3. Set the power supply variable control to zero (fully anti-clockwise) and sketch the output waveform.
4. Increase the dc source slightly and notice what happens to the output waveform (take photos of input and output for three different values of dc voltage: 0V, 1.5V and 4V)

Note: make sure to have dc coupling for oscilloscope channels

**** also take pictures of the waveforms from scope screen to show the waveforms and measured quantities***

Questions:

- What difference is there between the input and output wave?
- At what voltage is the output wave form chopped off?
- If the dc is 1.5V, at what voltage are the positive peaks chopped off?
- If the ac is 10V p-p, does the clipping voltage change?
- What is the relationship between the clipped level and the dc voltage in the two cases?

B. Clamping:

1. Connect the circuit shown in Fig.(6-7).

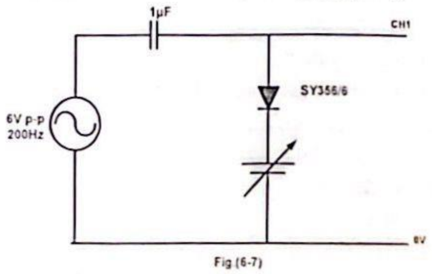


Fig (6-7)

2. Follow the same steps you had followed in the previous part A (clipping).
3. Take photos of both input and output for three different values of dc voltage: 0V, 1.5V and 4V

Note: make sure to have dc coupling for oscilloscope channels

Questions:

- Does the output wave form alternate about the same dc level as the input waveform?
- To what value the positive peak of the output waveform is clamped, if the ac input signal is $5V_{PK}$?
- Does the positive peak still stay clamped to the same level?
- Can you see any relation between the reference voltage setting and the clamping level.