AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF SCIENCE & TECHNOLOGY

Electronic Devices Lab

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Section: Q

Group : 3

LAB REPORT -3

Study of Diode Clipping and Clamping Circuits

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-Title: Study of Diode Clipping and Clamping Circuits

Abstract:

The purpose of this experiment is to study the behavior of different types of clipper and clamper circuits. The behavior of biased series positive and negative clipper circuits are studied in this experiment along with biased parallel positive and negative circuits. Moreover, behavior of clamper circuits are studied as well.

Introduction:

The purpose of this experiment is to observe the characteristics of different types of diode circuits:

1. clipper circuits
2. clamper circuits

Clippers:

In electronics, clipper circuits clip or cuts away part of the input ac signal such that the remaining part of the signal is not distorted or changed. Clipper circuits may seem similar to bridge rectifiers, at least the unbiased circuits, but the primary distinction is that clipper circuits are made up of a diode and a resistor while bridge rectifier is made up only one diode. In some cases, in biased circuits, a DC battery is also used. Clipper circuits can be divided into two main types: series clippers and parallel clippers. The parallel configuration places the diode in a branch parallel to the load, whereas the series configuration places the diode in series with the load.

Series Positive Clippers:

In reality, Series Positive Clippers eliminates the input voltage's positive half-cycles. A positive series clipper is shown in Figure 1. If the input is negative, the diode is forward biased and displays the input of the negative half cycle at the load. If the input is positive, the diode is in reverse biased condition, the output shown is zero.

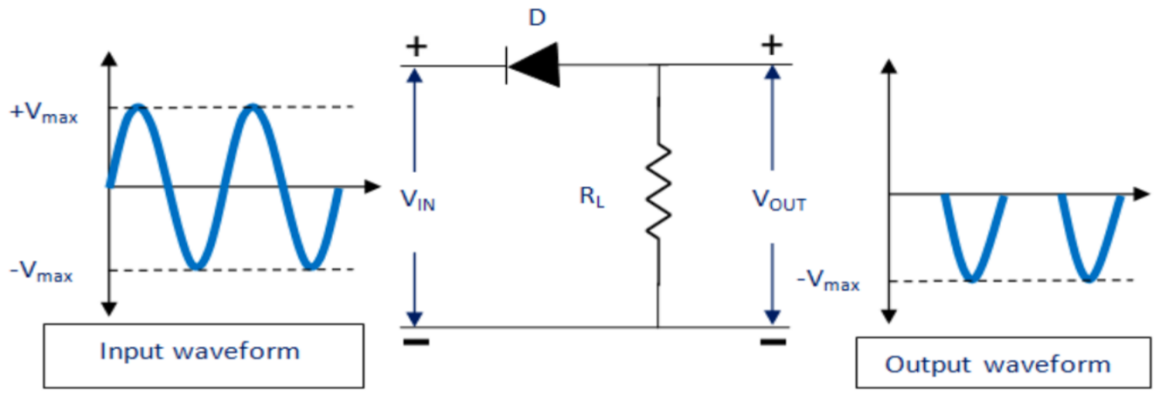


Figure 1: Series Positive Clipper

Parallel Negative Clippers:

It eliminates the input voltage's negative half-cycles. A parallel negative clipper is shown in Figure 2. The diode becomes reverse biased during the positive half cycle of the input. As a result, the resistor experiences no current flow. The output signal is attained for the positive half of the input signal as the output current is measured at the load. The diode becomes forward biased during the negative half of the input signal, therefore no-load current is produced. In the end, the output for the negative half of the input signal is not seen.

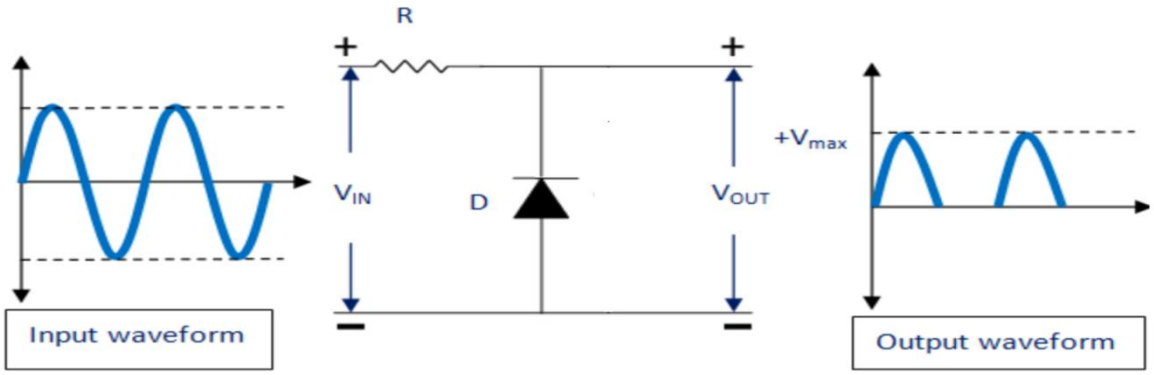


Figure 2: Parallel Negative Clipper

The circuits with the ideal diode are the clippers mentioned above in figures 1 and 2. However, if the knee voltage (VK) is taken into account, the output voltage of the positive and negative clippers is indicated in figure 3 (for Si = 0.7 V and Ge = 0.3 V, respectively).

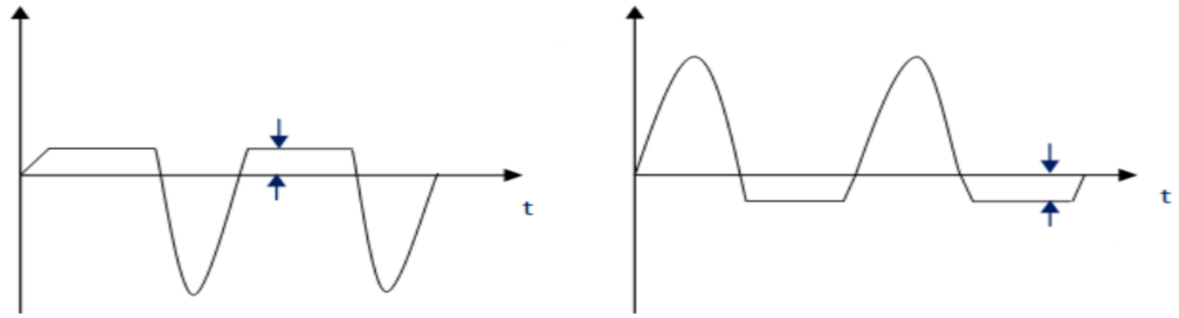


Figure 3: Output of the Circuit of Figure 1 and 2 With the value of V_k

Sometimes it's necessary to remove a very little amount of the input signal voltage's positive or negative half cycles. Biased clippers are utilized in these situations. Only when the input voltage is higher than the battery voltage does the clipping in Figure 4 occur during the positive cycle.

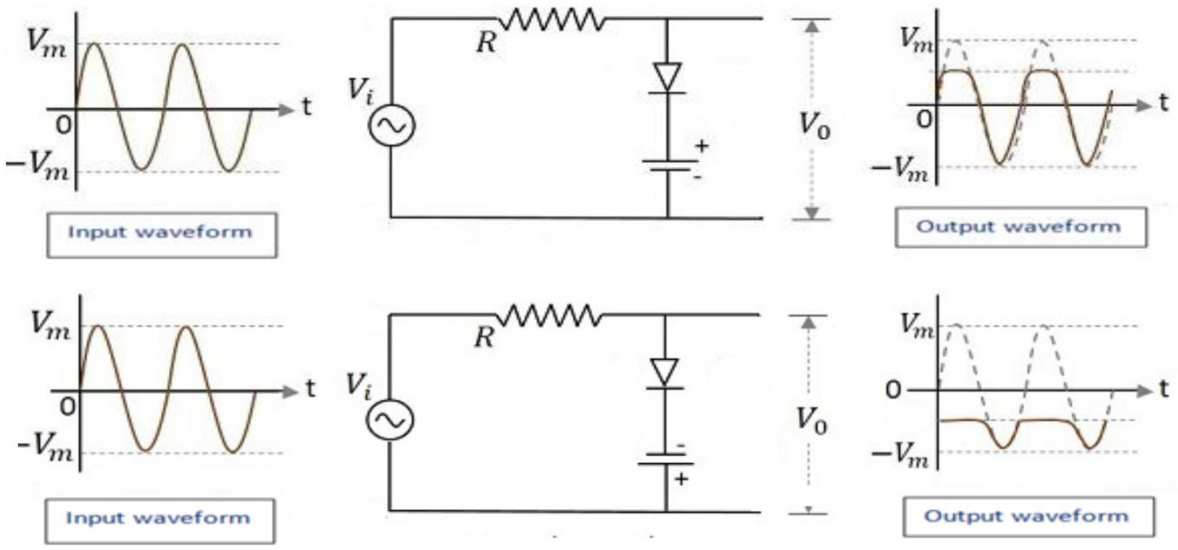


Figure 4: Parallel Positive Clipper with bias

Clampers:

A clamper circuit is a circuit that adds a DC level to an AC signal. Shift the signal to the positive or negative side as shown in Figure 5. In fact, the positive and negative peaks of the signal can be clamped to desired levels using a clamp circuit. If it shifts the DC level, the clamp circuit is called a level shifter.

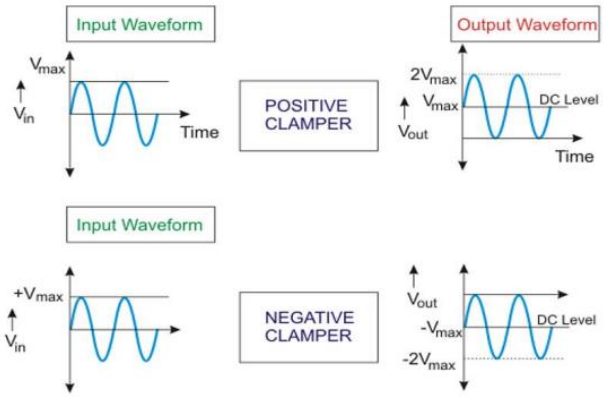


Figure 5: Input and Output wave Shapes of Basic Clamper Circuit

A clamper circuit consists of an energy storage element such as a capacitor. A simple clamp circuit consists of a capacitor, a diode, a resistor, and optionally a DC battery. Waveform type it remains the same, but the difference is in the shifted plane peak-to-peak value of the waveform never changes

The peak value and average value of the input waveform and the clamped output will be different. The time constant of the RC circuit should be ten times the time-period of the entering AC input voltage for better clamping action.

A negative clamper is shown figure 6. During the entire positive half-cycle of the input, the diode will conduct, and the output voltage will correspond to the diode barrier potential (V0). At this point, the capacitor charges to (V - V0) through the negative half cycle of the input, the diode will become negatively biased, and it has no effect role on the capacitor voltage. Due to the high value of R the capacitor cannot discharge as much. Therefore, output voltage will be - (2V - V0). Peak to peak voltage will be 2V, output waveform is original signal shifted in the downward direction.

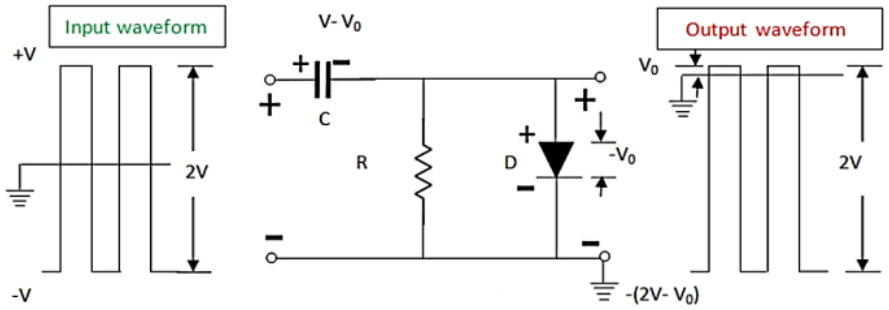


Figure 6: Negative Clamper Circuit

Apparatus:

No.	Apparatus	Quantity
1	Diode	1
2	Trainer Board	1
3	Resistors: 1kΩ	1
4	Oscilloscope	1
5	Multimerer	1
6	Chord	2
7	Capacitors: 10µF	1
8	DC Power Supply	1

Circuit Diagram:

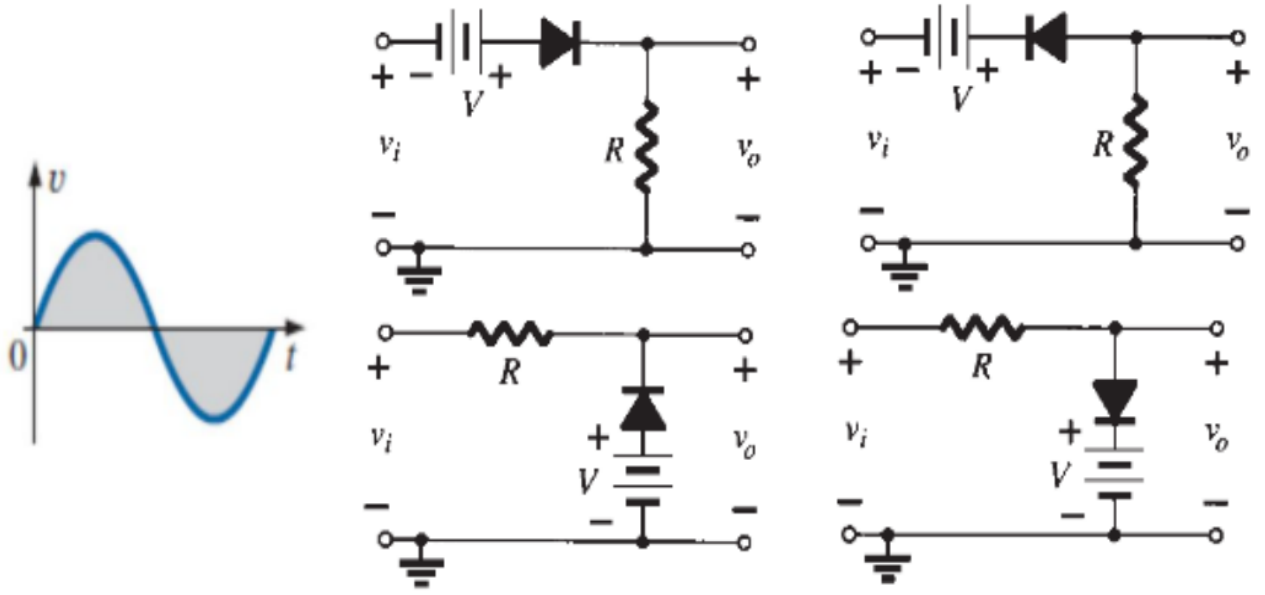


Figure 7: Clipper circuit

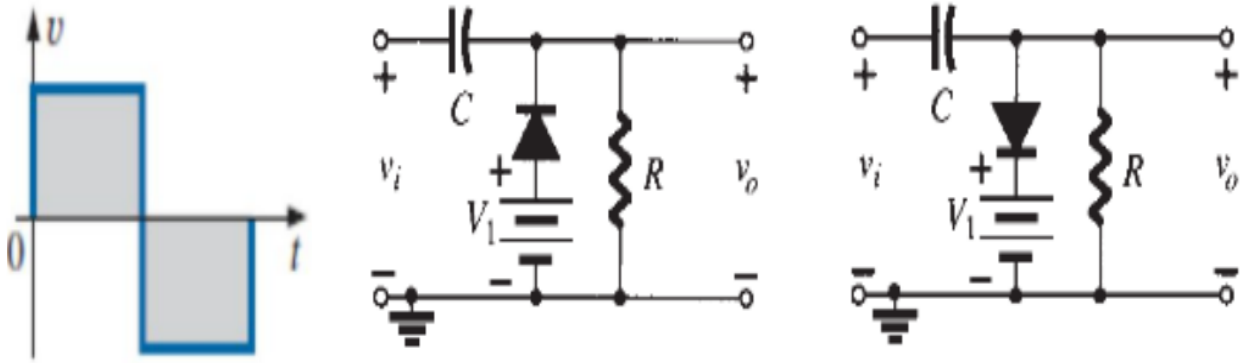
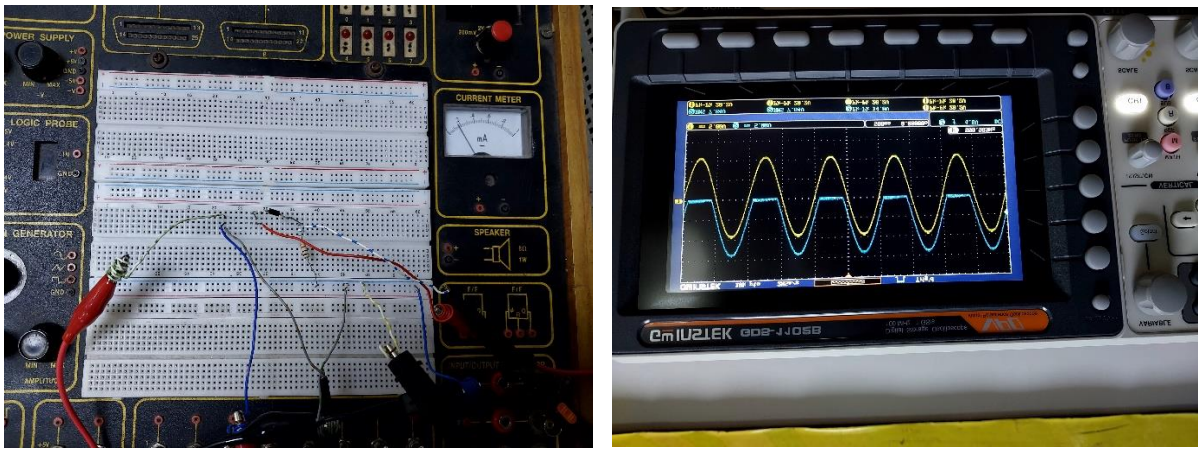


Figure 8: Clamper circuit

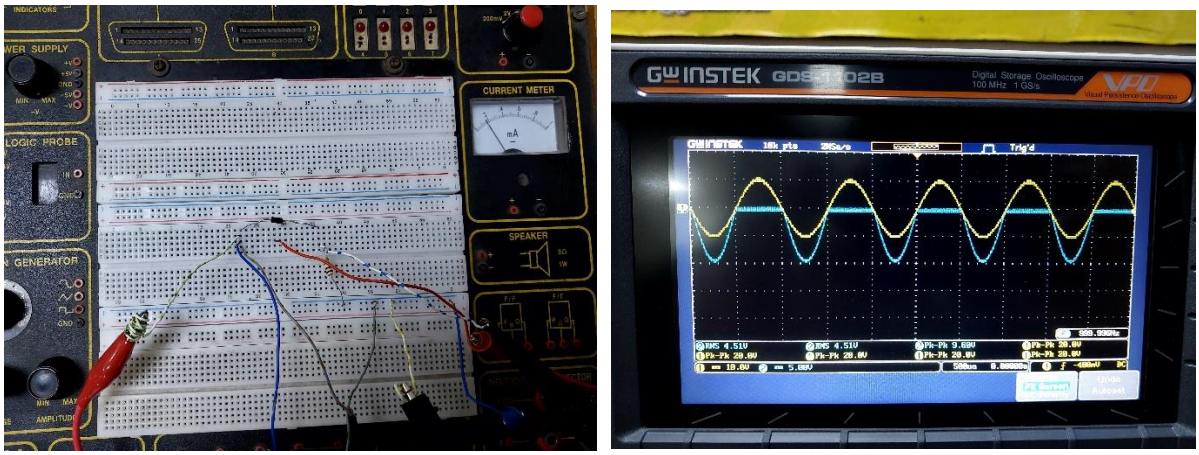
Hardware Implementation:

Figure 9:



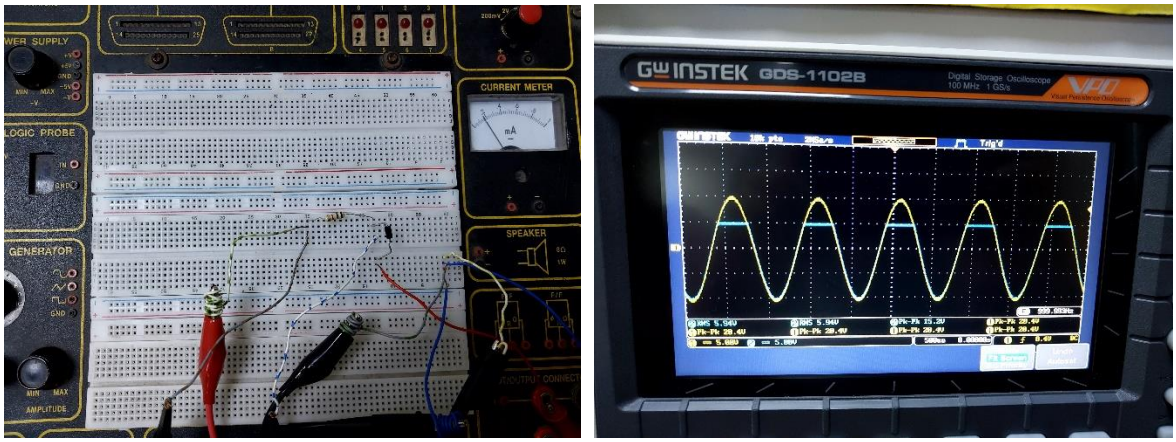
Implementation of Series Negative Clipper Circuit

Figure 10:



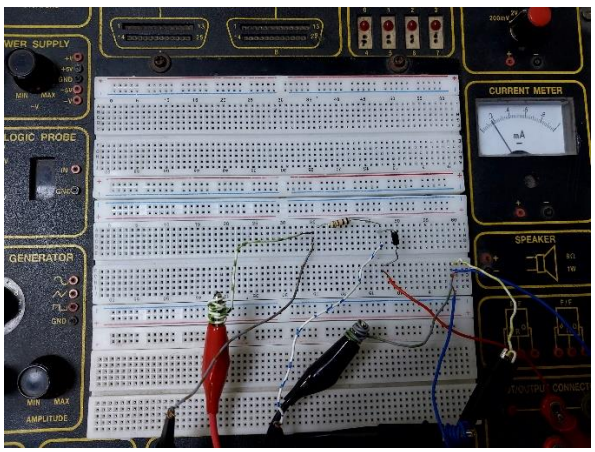
Implementation of Series Positive Clipper Circuit

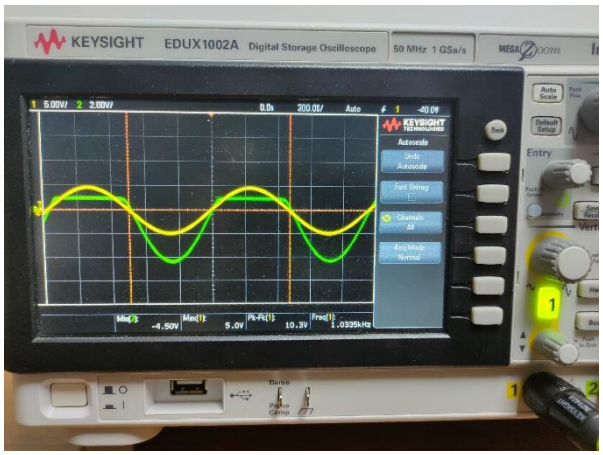
Figure 11:



Implementation of Parallel Negative Clipper Circuit

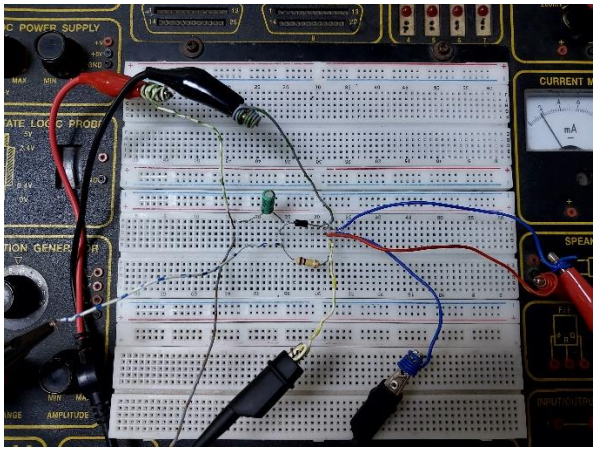
Figure 12:

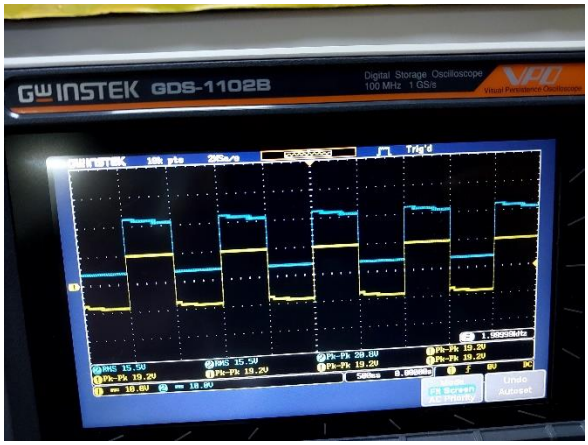




Implementation of Parallel Positive Clipper Circuit

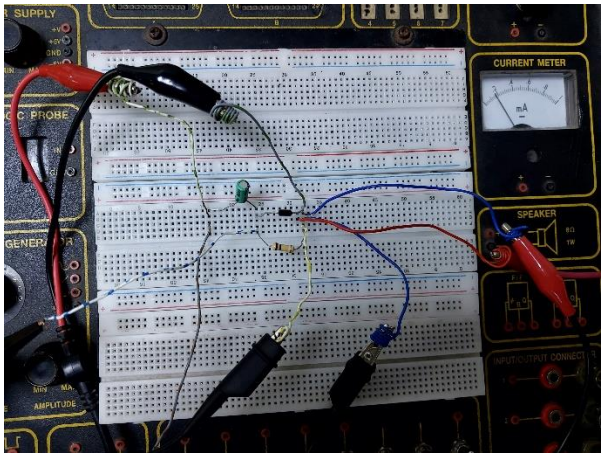
Figure 13:

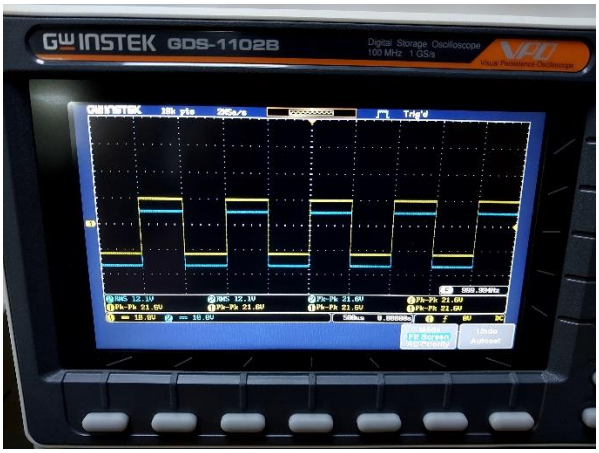




Implementation of Positive Clamper Circuit

Figure 14:





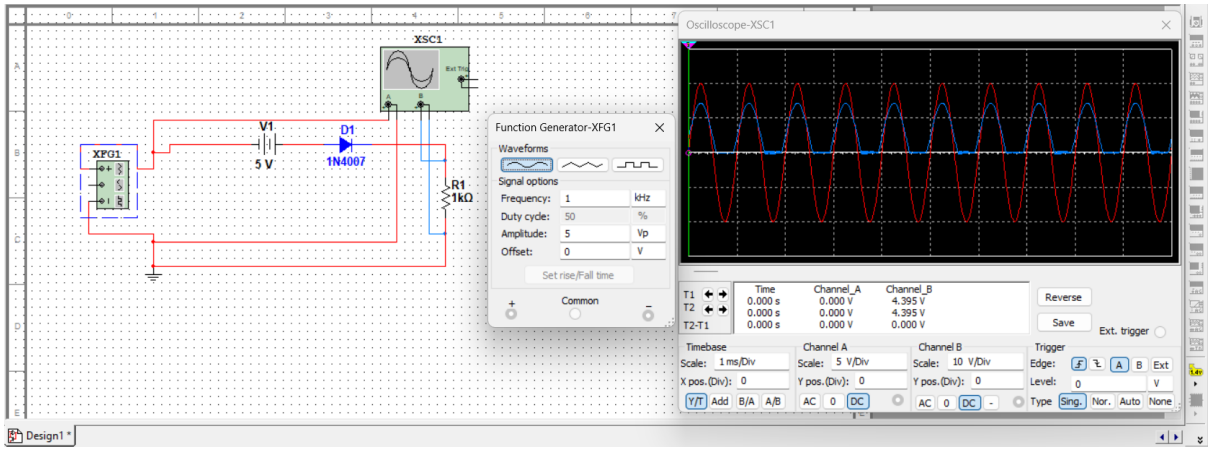
Implementation of Negative Clamper Circuit

Experimental Procedure:

1. The Clipper and Clamper circuits were implemented as shown in figure 7 and figure 8.
2. The input and the output waves shapes were observed simultaneously on the oscilloscope in dual mode and the waveforms were observed.
3. The same procedure was applied for the simulation and the input and the output waveforms were observed.

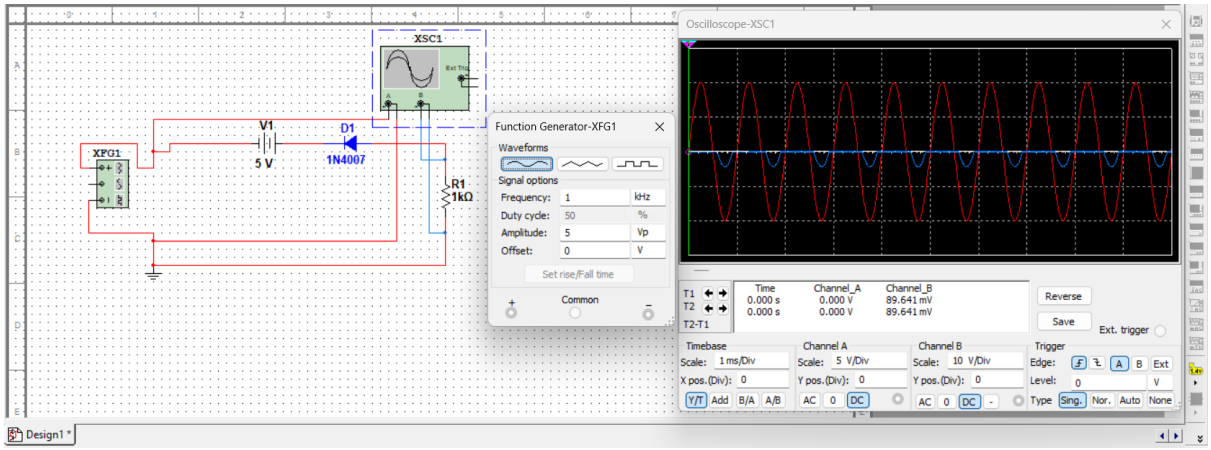
Simulation:

Figure 15:



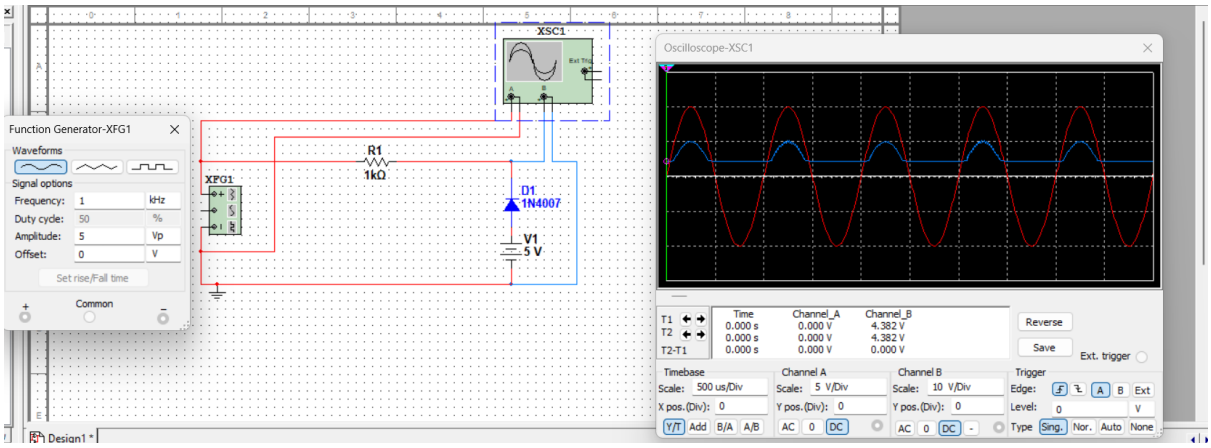
Simulation of Series Negative Clipper Circuit

Figure 16:



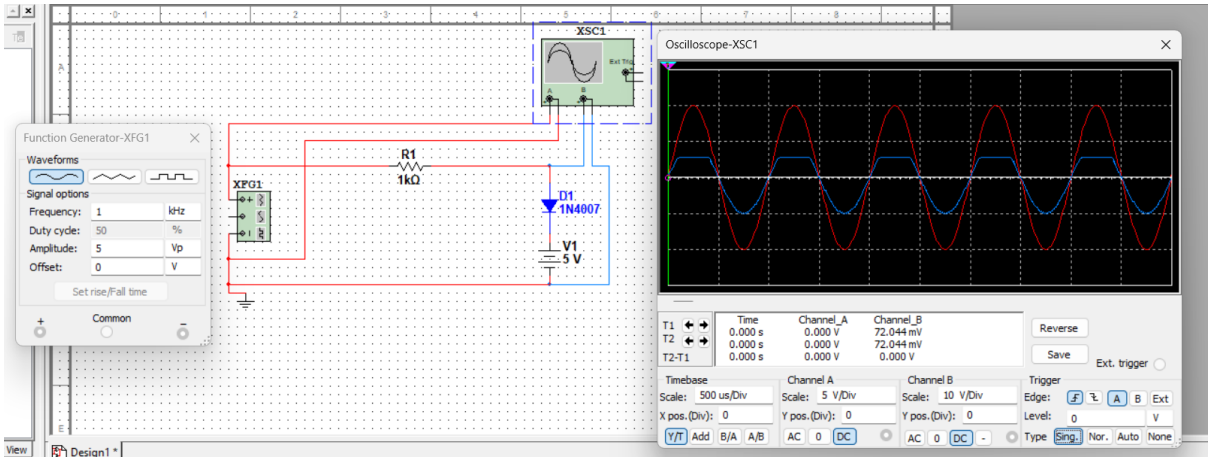
Simulation of Series Positive Clipper Circuit

Figure 17:



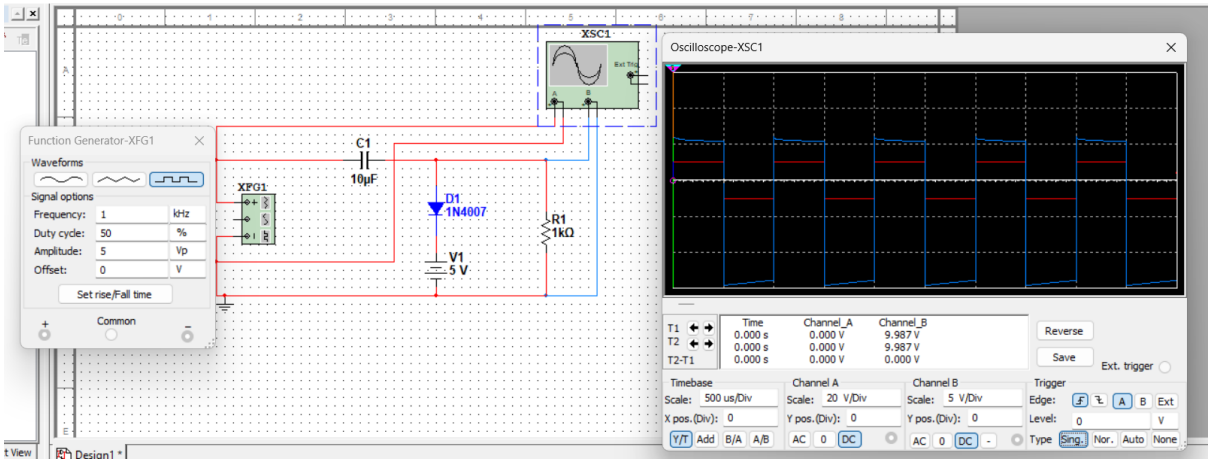
Simulation of Parallel Negative Clipper Circuit

Figure 18:



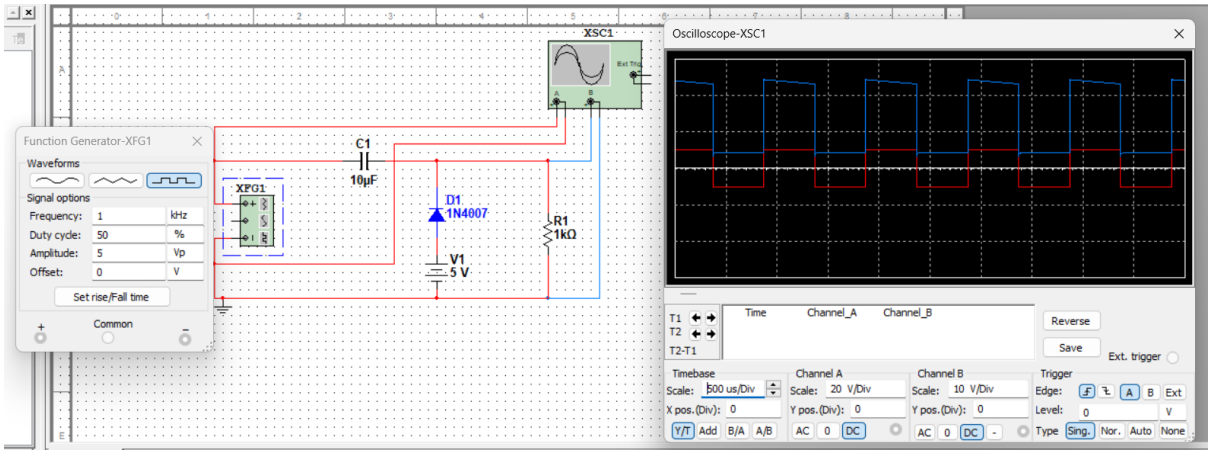
Simulation of Parallel Positive Clipper Circuit

Figure 19:



Simulation of Negative Clamper Circuit

Figure 20:



Simulation of Positive Clamper Circuit

Answers for report writing:

Operation of Clipper and Clamper Circuits:

Clipper Circuit: It limits signal amplitudes by using diodes to "clip" or remove voltage levels above or below a specified threshold. Positive clippers remove voltage levels above the threshold, while negative clippers remove levels below it. They are used for amplitude control and waveform shaping.

Clamper Circuit: Clamper circuits shift the DC level of a waveform without changing its shape. They use capacitors and diodes to add a DC offset (positive or negative) to the input signal. Positive clampers raise the waveform's DC level, while negative clampers lower it. They are used for DC restoration and biasing.

Difference Between Diode Clipping Circuit and Clamping Circuit:

Diode Clipping Circuit: It limits the amplitude of the signal by chopping off parts of the waveform that exceed a certain voltage level. It does not change the DC level of the signal.

Clamping Circuit: It shifts the entire waveform up or down by adding a DC bias. It does not cut off parts of the signal; instead, it changes the reference point of the waveform.

Differences from Ideal Diodes:

Real diodes have characteristics like forward voltage drop and reverse leakage current. Ideal diodes have zero voltage drop and no reverse current. This means real diodes will exhibit slight distortions in the clipped or clamped waveforms compared to ideal diodes.

Effect of Load on Clamper Circuit:

Lowering the load resistance in a clamper circuit affects the time constant of the RC network (R: load resistance, C: capacitor). A smaller load resistance results in faster charging and discharging of the capacitor, leading to quicker adjustment of the DC level of the output waveform. It may also affect the

amplitude of the clamped waveform if the load resistance interacts with the internal resistance of the diode.

Result and Discussion:

Clipping and Clamping are very widely used diode applications. In this experiment, the clipper & clamper circuits were constructed carefully. Observing the input and output voltage from the oscilloscope. It can be seen that the positive half cycle of the input voltage has been clipped off in the positive clipper circuit and the negative half cycle of input waveform has been cut off in the negative clipper circuit. During the experiment of clamper circuit, the characteristics were observed. In the Positive clamper circuit, the input signal has shifted upward and in the negative clamper circuit the input signal has shifted down. The same characteristic can be seen observing the input and the output signals from the simulation. As a result, Diode Clipping and Clamping Circuits were studied accurately.

Conclusion:

In this paper, positive and negative diode clipper, biased clipper, positive clamper, negative clamper is designed and simulated using Multisim software. Outputs of each designed circuit are calculated numerically, and simulation results have been displayed in oscilloscope through Multisim. The clipping functions and clamping functions of the circuits have been analysed through the resultant output waveforms. Observed values of limiting and clamping voltage levels are reasonably identical to the theoretical outputs.

Reference:

- American International University–Bangladesh (AIUB) Electronic Devices Lab Manual.
- Electronic Devices and Circuit Theory Book by Louis Nashelsky and Robert Boylestad.
- Adel S. Sedra, Kennth C. Smith, “Microelectronic Circuits”, Saunders College Publishing, 3rd ed., ISBN: 0-03-051648-X, 1991.