Al-Mustaqbal University
Department Prosthetics & Orthotics Engineering
Class 2nd
Subject: Electronic circuits Practical Part
Lecturer : Assist.Lect. Ali Imad &Eng. Noor Adnan

2nd term – Lec 3

Experiment No.3: Clippers, Clampers, and Voltage Multipliers

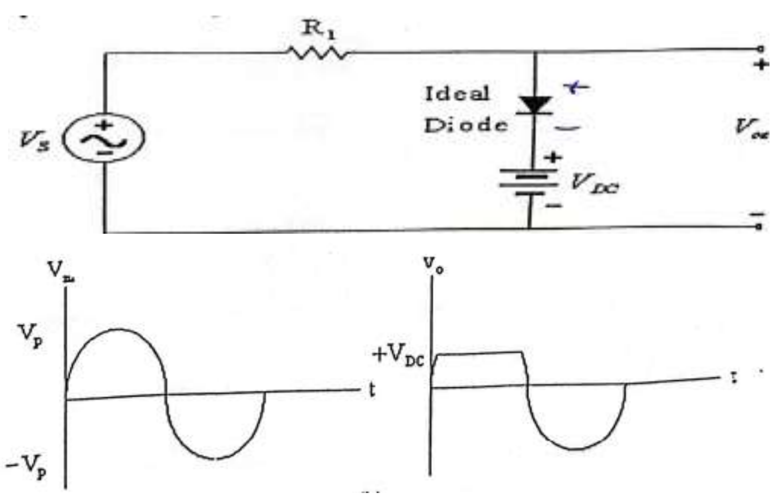
OBJECTIVES:

After performing this experiment, you should be able to:

- Demonstrate the operation of the shunt clipper circuit.
- Demonstrate the operation of the diode clamper circuit.
- Demonstrate the operation of a half-wave voltage multiplier.

SUMMARY OF THEORY:

The primary function of clippers is to "clip" away a portion of an applied alternating signal. The process is typically performed by a resistor-diode combination. DC batteries are also used to provide additional shifts or "cuts" of the applied voltage. The half-wave rectifier is a simple series clipper. It "clips" either the positive or the negative alternation of its input waveform, depending on the polarity of the diode. Since we examined series clipper operation in the rectifier experiment.



(b)

Fig.1: (a) Clipping Circuit (b) Input and Output Waveforins.

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A typical clipper circuit is shown in Figure 1(a). In this circuit the output voltage can never be greater than the value of V_{oc}. The ideal diode becomes forward biased at V_s DO S equal to V_{oc} and this ties the output directly to the V_{oc} supply as shown in DC Figural(b). Often in the development of electronic circuits it is required that voltages be limited in some manner to avoid circuit damage. Furthermore, the limiting or clipping of voltages can be very useful in the development of wave-shaping circuits.

The clamper is a diode circuit used to change the DC reference of a waveform without significantly altering the shape of that waveform. The positive clamper shifts its input waveform in the positive direction; the negative clamper shifts it in the negative directions The negative clamper is identical to the positive clamper except for the polarity of the diode and capacitor. Clampers are easily distinguished from clippers in that they include a capacitive element. A typical clamper as shown in Figure 2(a) includes a capacitor, diode, and resistor with some also having a DC battery. This circuit works by allowing the capacitor to charge up and act like a battery. This is the voltage across the capacitor depends on the input waveform, the output maximum (or the minimum depending on the orientation of the diode) will be clamped to a fixed reference point. The only design constraint is that 2n RC be five times larger than the period of the input waveform.

Observe that the output voltage is simply the input voltage shifted by the value of steady state offset (V_{oc}) as shown in Figure 2(b).

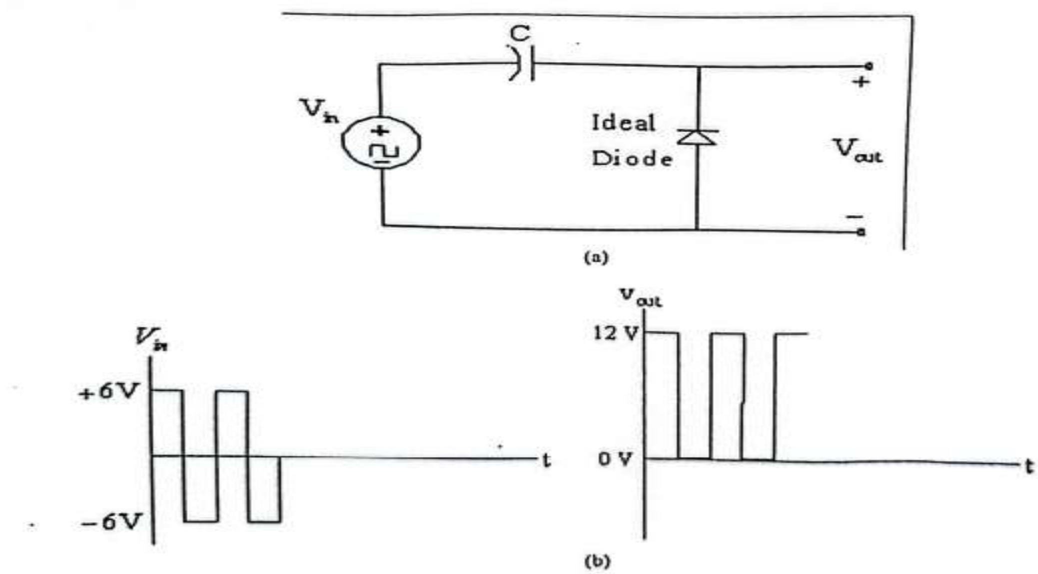

Fig.2: (a) Clamping Circuit (b) Input and Output Waveforms

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A voltage multiplier is a diode circuit used to provide a DC output that is a specified multiple of the peak value of its input signal voltage. For example, the DC output from a voltage doubler is approximately two times its peak input voltage. The voltage tripler provides a DC output that is approximately three times its peak input voltage, and so on. There is a slight voltage across each diode in the multiplier circuit, so the output voltage cannot truly reach the design multiple of the peak input voltage. In this experiment, we will investigate a simple half-wave voltage doubler as shown in Figure 3.

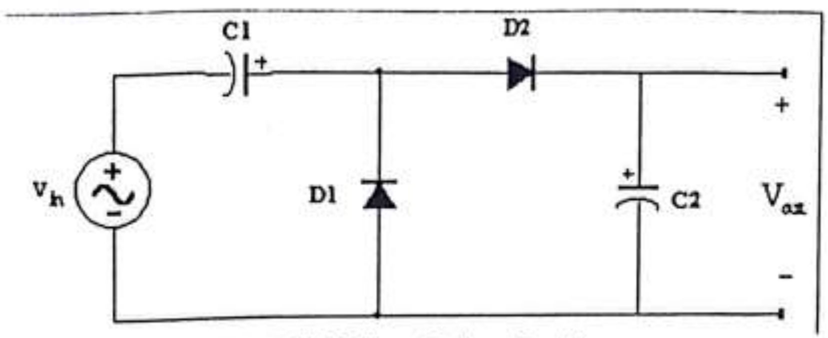

Fig.3: Half-Wave Voltage Doubler

Procedure

Clipper Circuit in Multisim

Required Components in Multisim:

1. **Function Generator** – Found in *Sources → AC Voltage*
2. **Oscilloscope** – Found in *Indicators → Oscilloscope*
3. **Resistor** – Found in *Basic → Resistor*
4. **Diode** – Example: *1N4148 or 1N4007*, found in *Diodes*
5. **Ground** – Found in *Sources → Ground*

1. Insert the Function Generator

- Drag the function generator into the workspace.
- Set the frequency to **1kHz** and amplitude to **5Vpp**.

2. Insert the Resistor

- Go to **Basic → Resistor**.
- Choose a **1kΩ resistor** and place it in the workspace.
- Connect **one terminal** to the **output of the function generator**.

3. Insert the Diode

- Go to **Diodes → 1N4148 (or any suitable diode)**.
- Drag it into the workspace.
- Connect:
  - **Cathode (–)** to the **common node** between the resistor and the diode.
  - **Anode (+)** to **ground**.

4. Insert the Ground

- Go to **Sources → Ground**.
- Place the **ground symbol** and connect it to the **lower end of the diode**.

5. Insert the Oscilloscope

- Go to **Indicators → Oscilloscope**.
- Place the oscilloscope in the workspace and connect it as follows:
  - **Channel A (CH1):** Connect it to the input signal (before the resistor).
  - **Channel B (CH2):** Connect it to the output signal (after the diode).
  - Make sure the **oscilloscope ground** is connected to the **circuit ground**.

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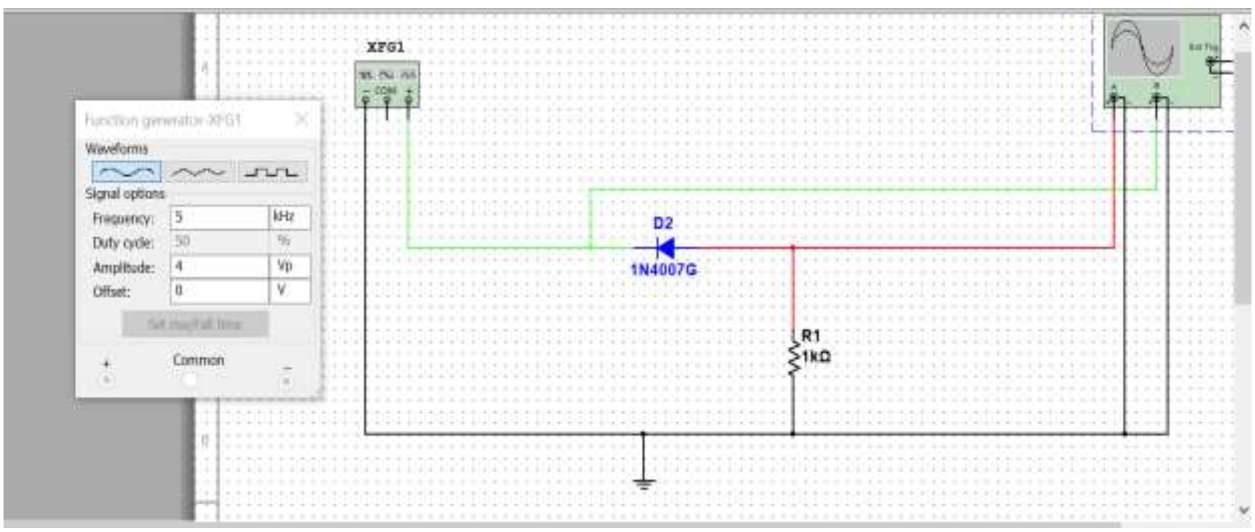
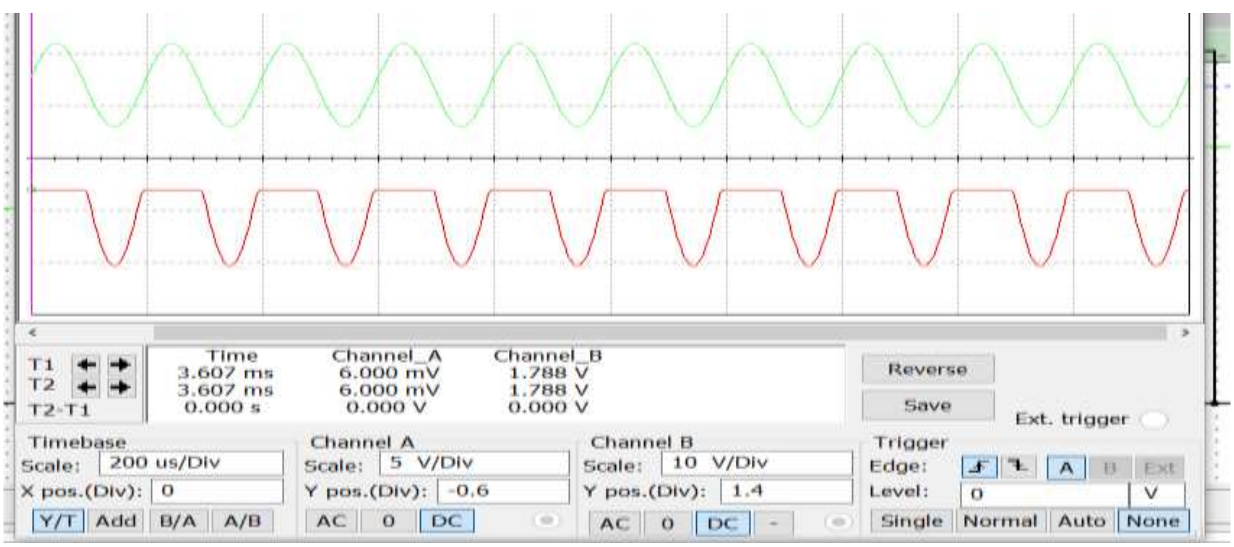
❖ Adjust Settings and Run Simulation

1. Ensure the function generator is set to **1kHz** frequency.
2. Start the simulation by clicking the **Run Simulation** button in the top toolbar.
3. Open the oscilloscope and observe the waveform:
   - **If it is a Positive Clipper:** The positive part of the waveform will be clipped.
   - **If it is a Negative Clipper:** The negative part of the waveform will be clipped.
4. Try modifying the frequency or amplitude to see how it affects the circuit's output.

Positive Clipper





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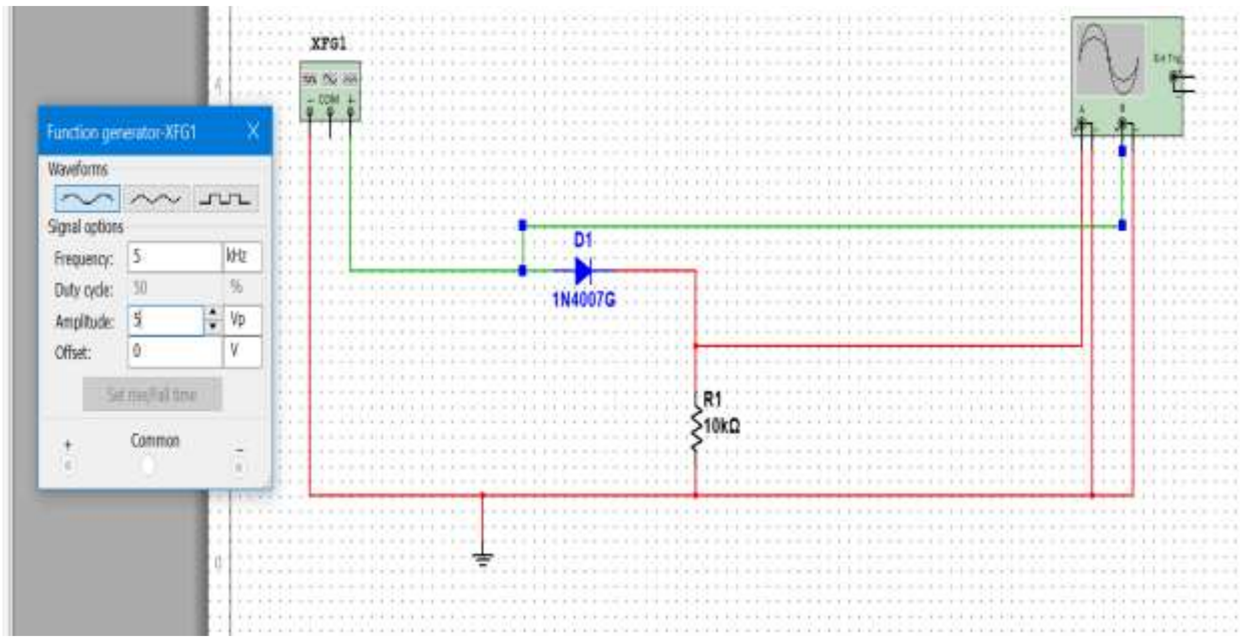
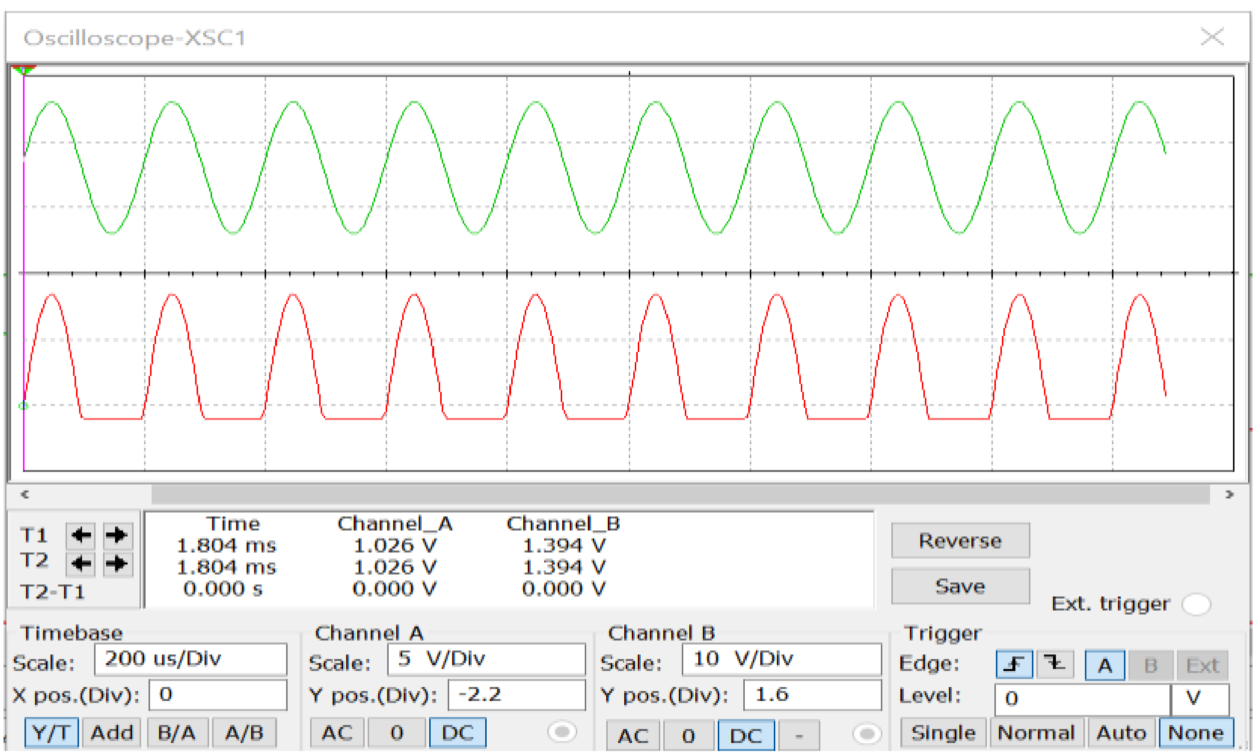
Negative Clipper





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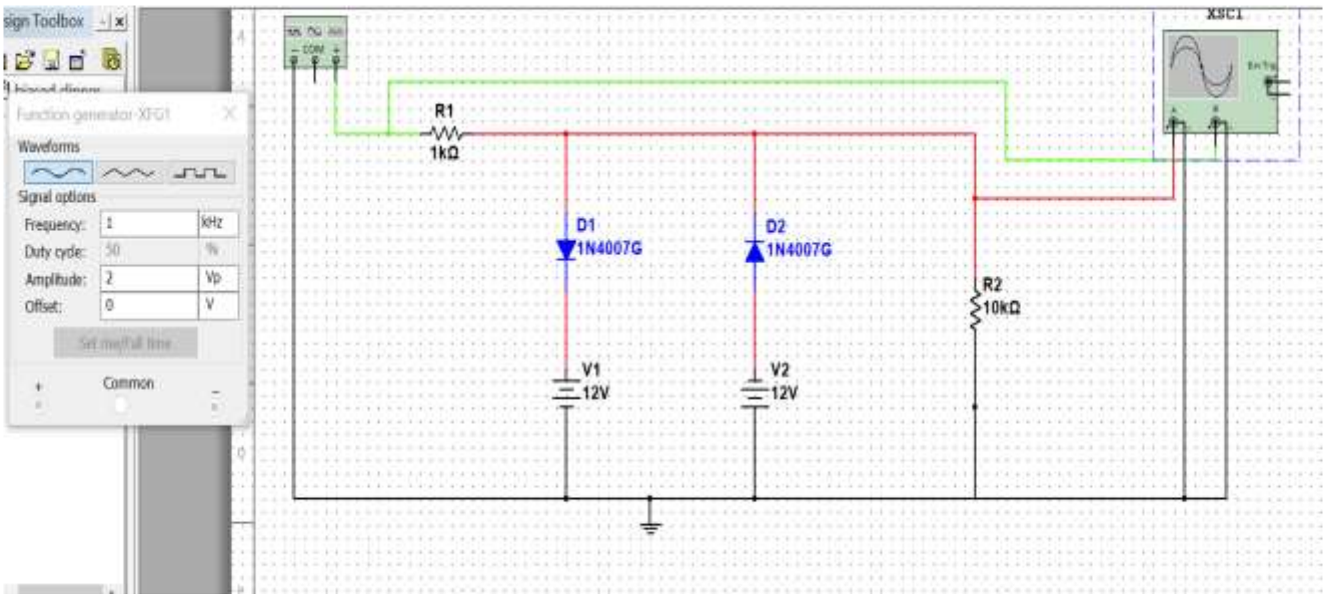
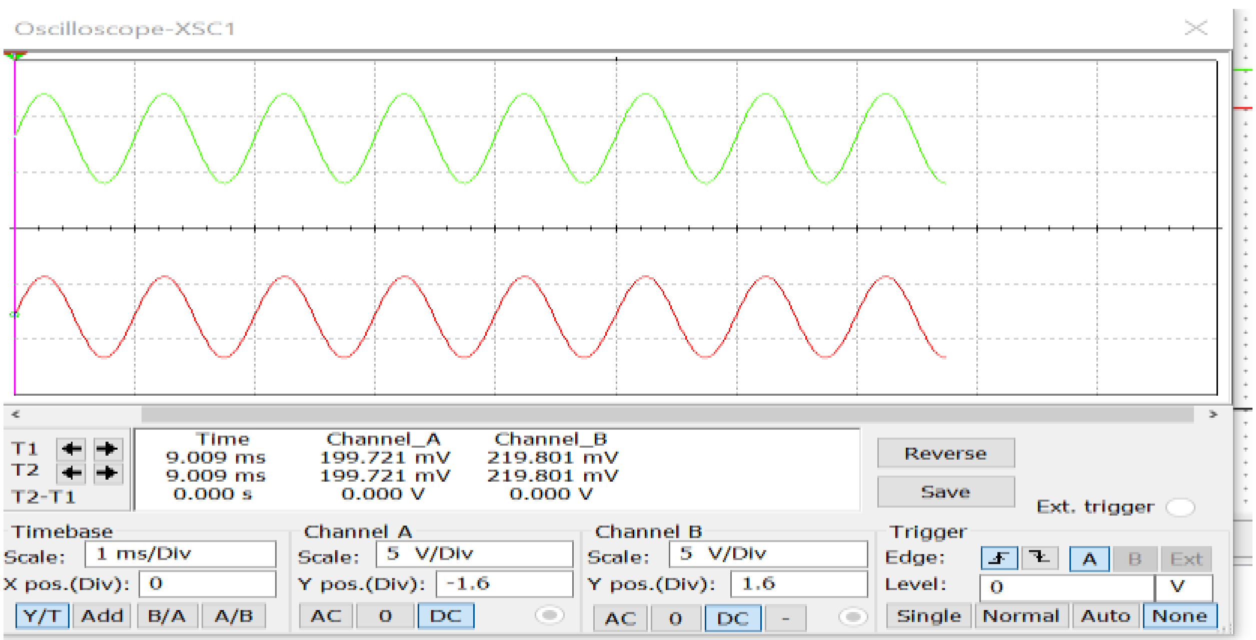
Biased Clipper





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Clamper Circuit in Multisim

Required Components in Multisim:

1. **Function Generator** – Found in *Sources → AC Voltage*
2. **Oscilloscope** – Found in *Indicators → Oscilloscope*
3. **Resistor** – Found in *Basic → Resistor* (1kΩ)
4. **Diode** – Example: *1N4148 or 1N4007*, found in *Diodes*
5. **Capacitor** – **100µF**, found in *Basic → Capacitor*
6. **Ground** – Found in *Sources → Ground*

1. Insert the Function Generator

- Drag the function generator into the workspace.
- Set the frequency to **1kHz** and amplitude to **5Vpp**.

2. Insert the Capacitor

- Go to **Basic → Capacitor**.
- Choose a **100µF capacitor** and place it in the workspace.
- Connect **one terminal** to the **output of the function generator**.

3. Insert the Diode

- Go to **Diodes → 1N4007 (or any suitable diode)**.
- Drag it into the workspace.
- Connect:
  - **Cathode (−):** Connect it to the **free terminal of the capacitor**.
  - **Anode (+):** Connect it to **ground**.

4. Insert the Resistor

- Go to **Basic → Resistor**.
- Choose a **1kΩ resistor** and place it in the workspace.
- Connect **one terminal** to the **common node between the capacitor and diode**.
- Connect the **other terminal** to **ground**.

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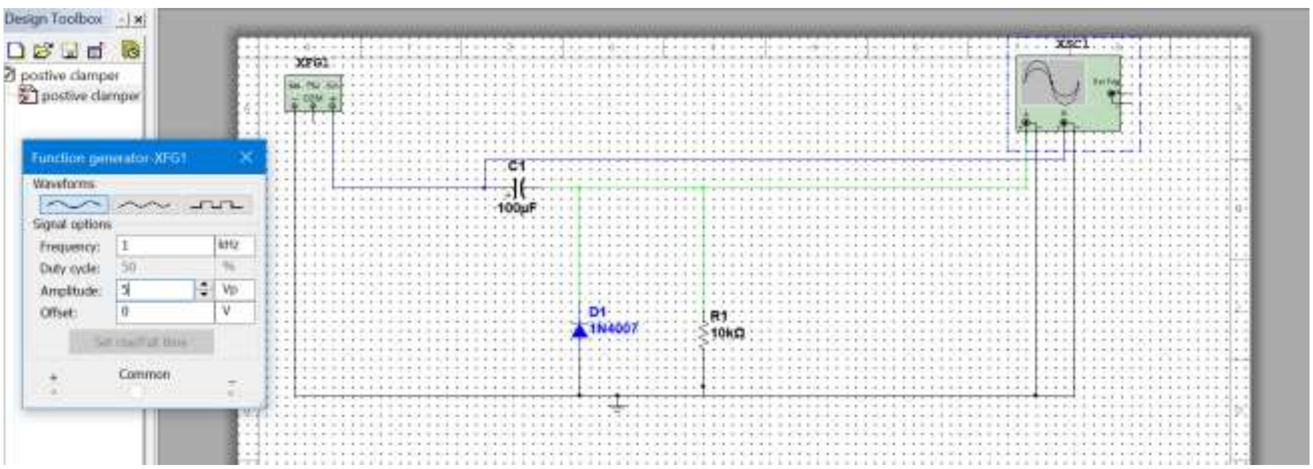
5. Insert the Ground

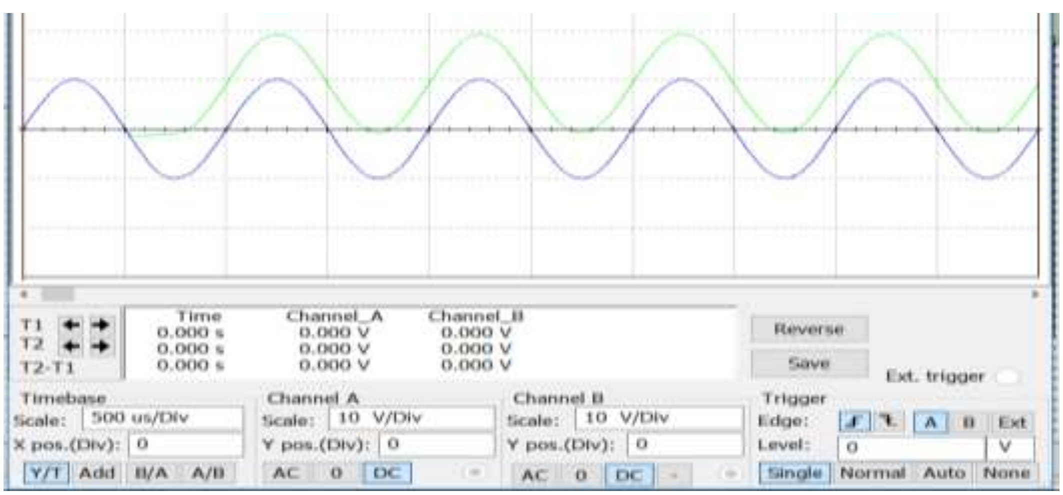
- Go to **Sources → Ground**.
- Place the **ground symbol** and connect it to the **lower end of the diode and resistor**.

6. Insert the Oscilloscope

- Go to **Indicators → Oscilloscope**.
- Place the oscilloscope in the workspace and connect it as follows:
  - **Channel A (CH1):** Connect it to the input signal (before the capacitor).
  - **Channel B (CH2):** Connect it to the output signal (after the capacitor).
  - Make sure the **oscilloscope ground** is connected to the **circuit ground**.

Positive Clamper





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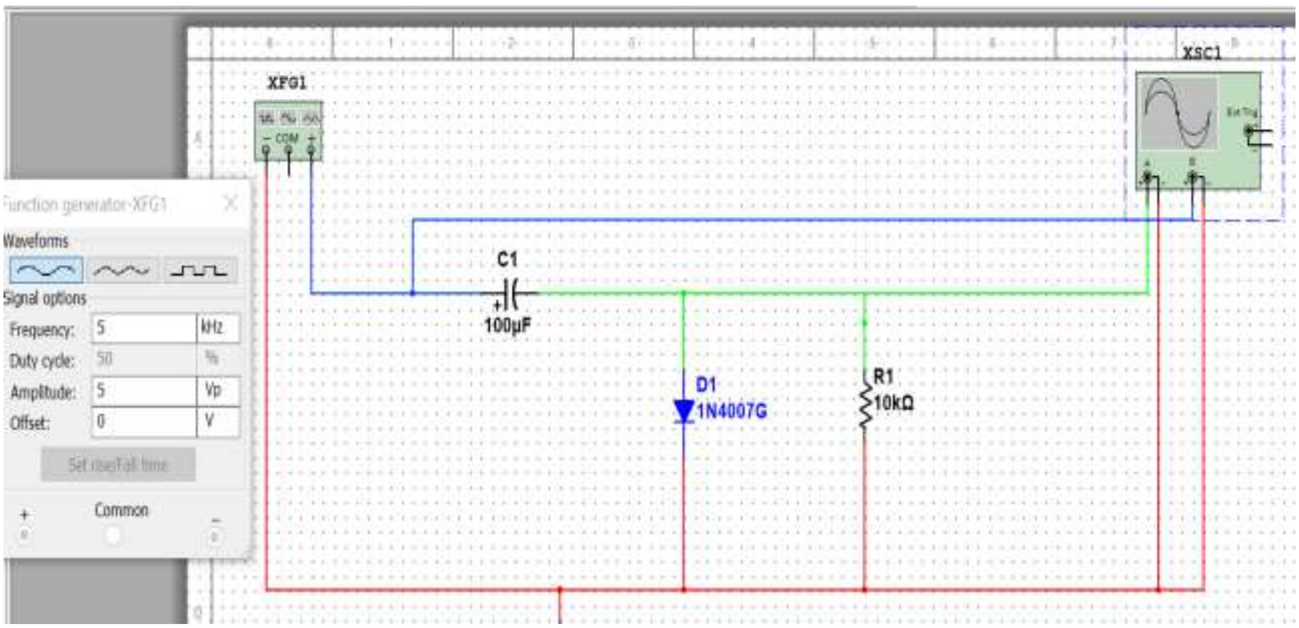
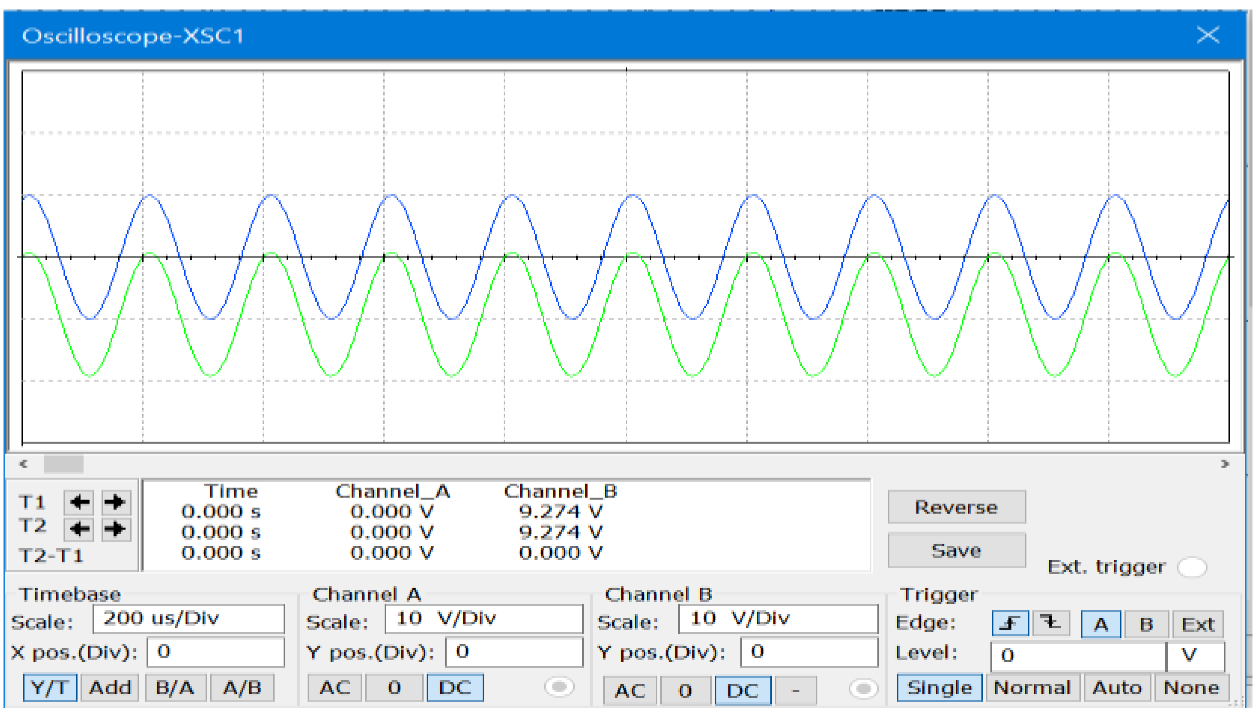
Negative Clamper





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Questions

1. **How does changing the value of the capacitor in a clamper circuit affect the waveform shift, and why does this happen?**

2. **What would happen if we replaced the diode in a clipper circuit with a Zener diode, and how would this impact voltage regulation?**

3. **Why do clamper circuits require a capacitor while clipper circuits do not, and how does this difference influence their applications?**

4. **How would the output waveform change if the resistor value in a clipper circuit is increased significantly, and what does this imply about the circuit's behavior?**

5. **In practical applications, why might we prefer a biased clipper over a simple clipper circuit, and how does the DC bias affect the clipping level?**

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