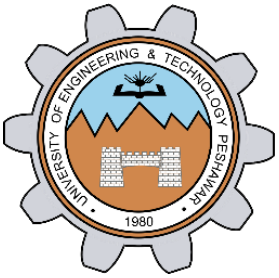
Lab Report : 07



Spring 2020

Electronic Devices and Circuit Theory

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Clampers

Objectives:

To become familiar with the function and operation of clampers

Equipment:

- Analogue Graph
- Probe Mode (Works as DMM)

Components

- Diode: Silicon (Generic)
- Resistors: 10kΩ
- Capacitor: 1 µF (Electrolyte)

Theory:

Diode:

A diode is a two-terminal electronic component that conducts current primarily in one direction; it has low resistance in one direction, and high resistance in the other.

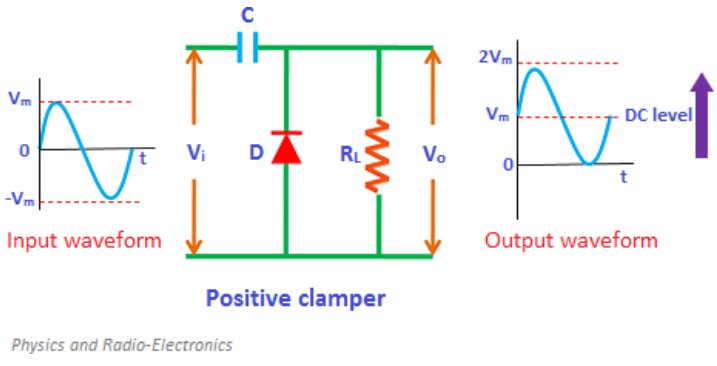
Clamper

A clamper is an electronic circuit that changes the DC level of a signal to the desired level without changing the shape of the applied signal. In other words, the clamper circuit moves the whole signal up or down to set either the positive peak or negative peak of the signal at the desired level.

The dc component is simply added to the input signal or subtracted from the input signal. A clamper circuit adds the positive dc component to the input signal to push it to the positive side. Similarly, a clamper circuit adds the negative dc component to the input signal to push it to the negative side.

Positive clamper

The positive clamper is made up of a voltage source Vi, capacitor C, diode D, and load resistor RL. In the below circuit diagram, the diode is connected in parallel with the output load. So the positive clamper passes the input signal to the output load when the diode is reverse biased and blocks the input signal when the diode is forward biased.



During negative half cycle:

During the negative half cycle of the input AC signal, the diode is forward biased and hence no signal appears at the output. In forward biased condition, the diode allows electric current through it. This current will flows to the capacitor and charges it to the peak value of input voltage V_m. The capacitor charged in inverse polarity (positive) with the input voltage. As input current or voltage decreases after attaining its maximum value $-V_m$, the capacitor holds the charge until the diode remains forward biased.

During positive half cycle:

During the positive half cycle of the input AC signal, the diode is reverse biased and hence the signal appears at the output. In reverse biased condition, the diode does not allow electric current through it. So the input current directly flows towards the output.

When the positive half cycle begins, the diode is in the non-conducting state and the charge stored in the capacitor is discharged (released). Therefore, the voltage appeared at the output is equal to the sum of the voltage stored in the capacitor (V_m) and the input voltage (V_m) { I.e. $V_o = V_m + V_m = 2V_m$} which have the same polarity with each other. As a result, the signal shifted upwards.

The peak to peak amplitude of the input signal is $2V_m$, similarly the peak to peak amplitude of the output signal is also $2V_m$. Therefore, the total swing of the output is same as the total swing of the input.

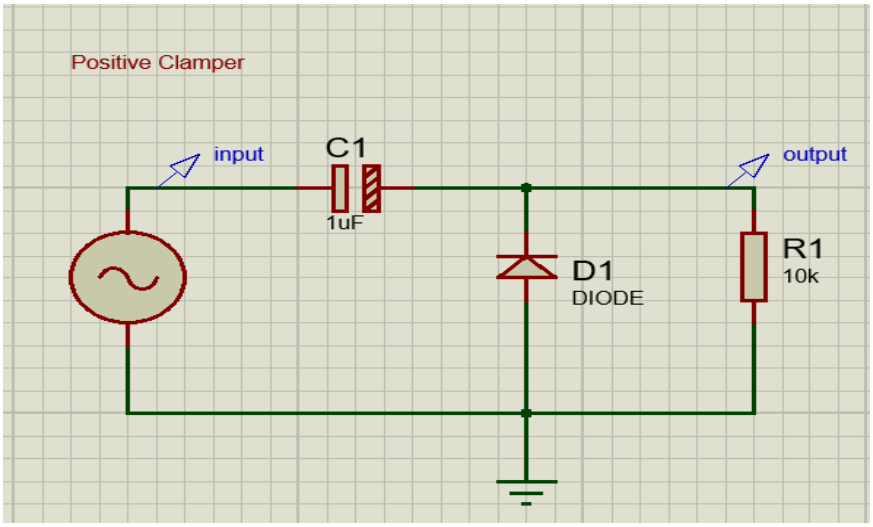
The basic difference between the clipper and clamper is that the clipper removes the unwanted portion of the input signal whereas the clamper moves the input signal upwards or downwards.

Procedure:

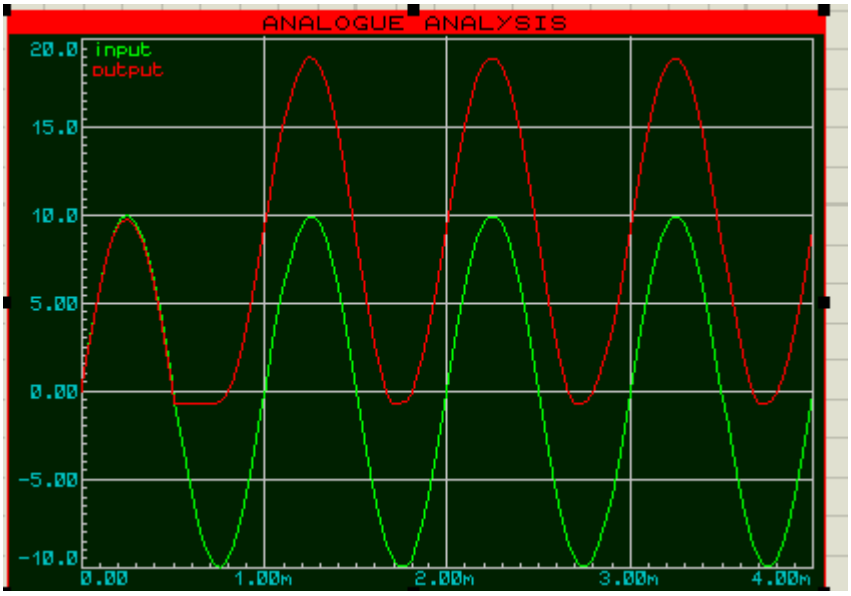
Construct the circuit in *Fig.1*. The input signal is an 10 V p-p Sinusoidal wave at frequency of 1000 Hz.

Set the Probes at Voltage source and load resistor as shown in fig-1.

Circuit Diagram:



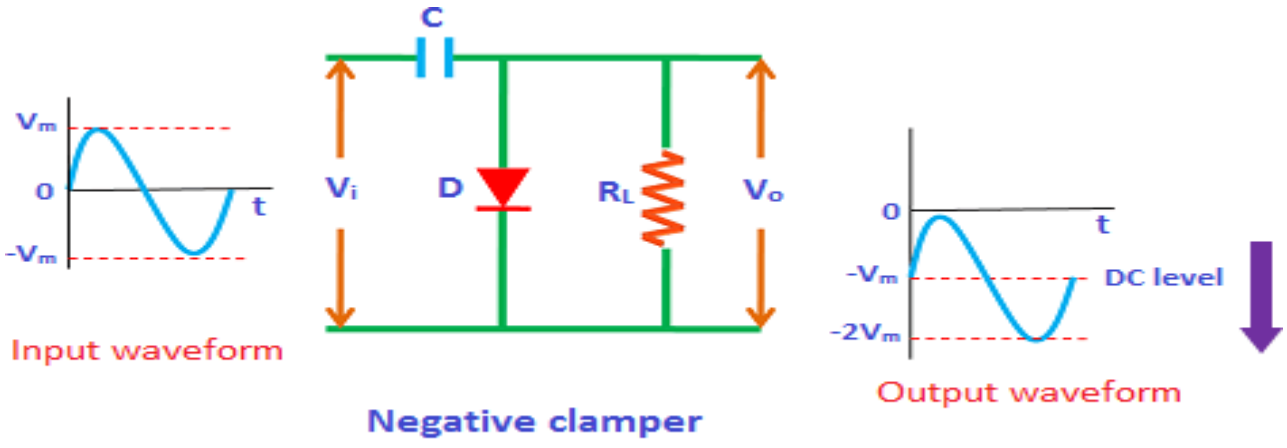
Analogue Output:



Negative clamper

During positive half cycle:

During the positive half cycle of the input AC signal, the diode is forward biased and hence no signal appears at the output. In forward biased condition, the diode allows electric current through it. This current will flows to the capacitor and charges it to the peak value of input voltage in inverse polarity $-V_m$. As input current or voltage decreases after attaining its maximum value V_m, the capacitor holds the charge until the diode remains forward biased.



During negative half cycle:

During the negative half cycle of the input AC signal, the diode is reverse biased and hence the signal appears at the output. In reverse biased condition, the diode does not allow electric current through it. So the input current directly flows towards the output.

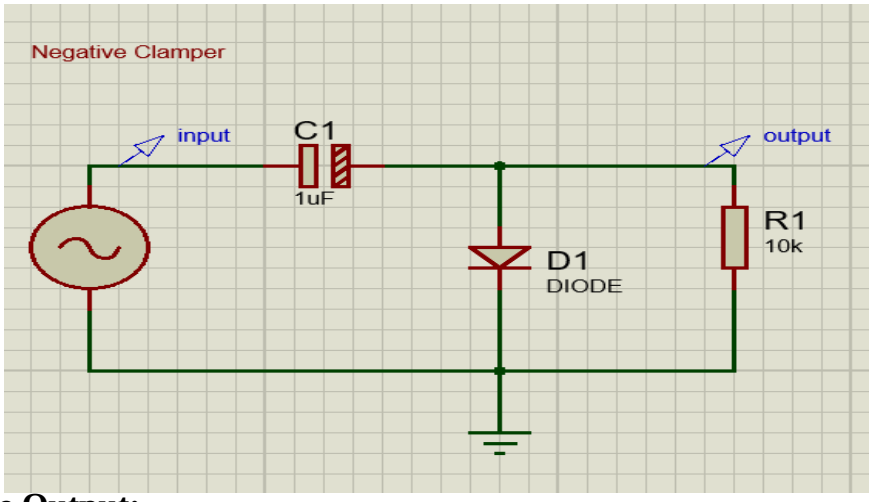
When the negative half cycle begins, the diode is in the non-conducting state and the charge stored in the capacitor is discharged (released). Therefore, the voltage appeared at the output is equal to the sum of the voltage stored in the capacitor ($-V_m$) and the input voltage ($-V_m$) {I.e. $V_o = -V_m - V_m = -2V_m$} which have the same polarity with each other. As a result, the signal shifted downwards.

Procedure:

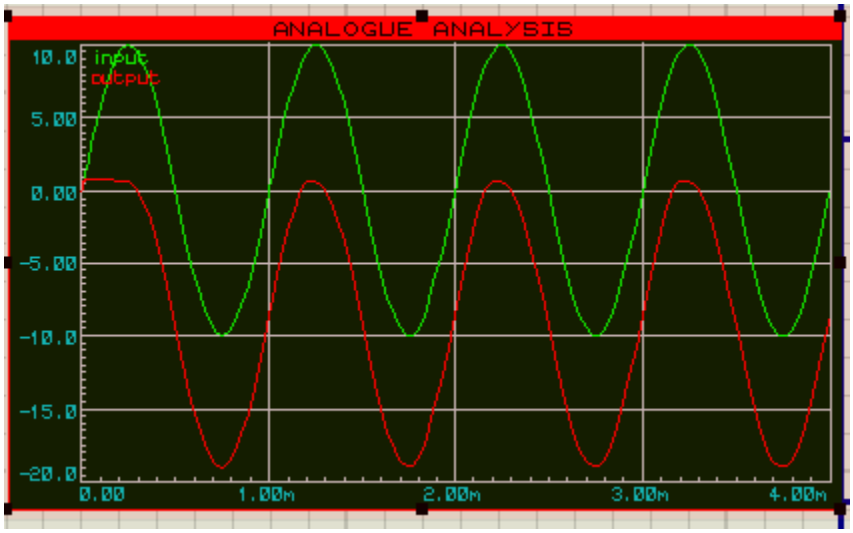
Construct the circuit in *Fig.1*. The input signal is 10 V p-p Sinusoidal wave at frequency of 1000 Hz.

Set the Probes at Voltage source and load resistor as shown in fig-1.

Circuit Diagram:



Analogue Output:



Biased clampers

Sometimes an additional shift of DC level is needed. In such cases, biased clampers are used. The working principle of the biased clampers is almost similar to the unbiased clampers. The only difference is an extra element called DC battery is introduced in biased clampers.

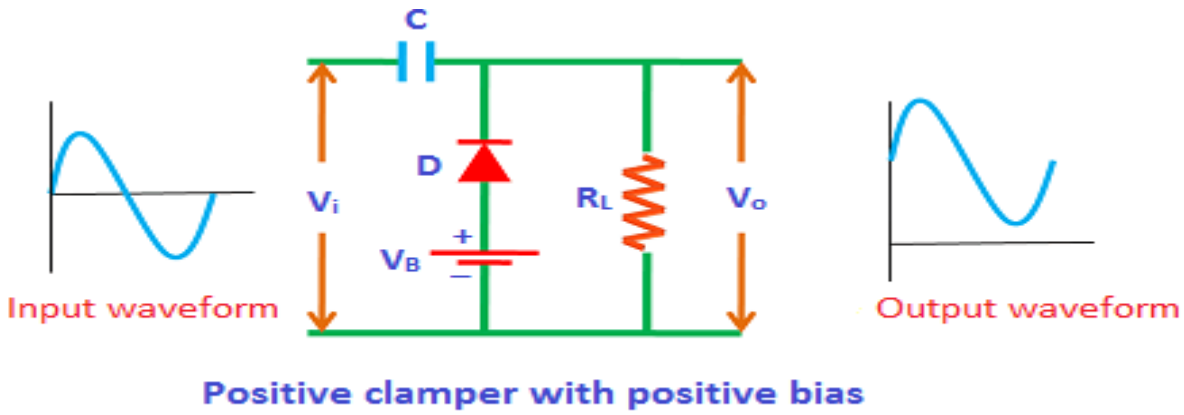
Positive clamper with positive bias:

If positive biasing is applied to the clamper then it is said to be a positive clamper with positive bias. The positive clamper with positive bias is made up of an AC voltage source, capacitor, diode, resistor, and dc battery.

During positive half cycle:

During the positive half cycle, the battery voltage forward biases the diode when the input supply voltage is less than the battery voltage. This current or voltage will flows to the capacitor and charges it.

When the input supply voltage becomes greater than the battery voltage then the diode stops allowing electric current through it because the diode becomes reverse biased.



Positive clamper with positive bias

Physics and Radio-Electronics

During negative half cycle:

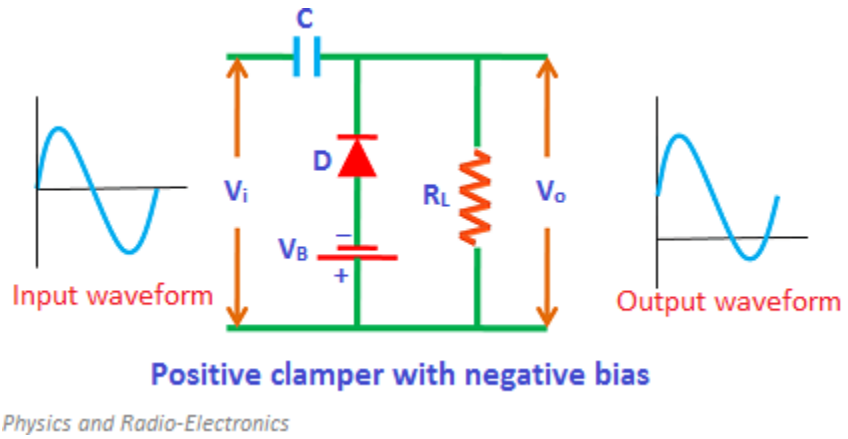
During the negative half cycle, the diode is forward biased by both input supply voltage and battery voltage. So the diode allows electric current. This current will flows to the capacitor and charges it.

Positive clamper with negative bias

During negative half cycle:

During the negative half cycle, the battery voltage reverse biases the diode when the input supply voltage is less than the battery voltage. As a result, the signal appears at the output.

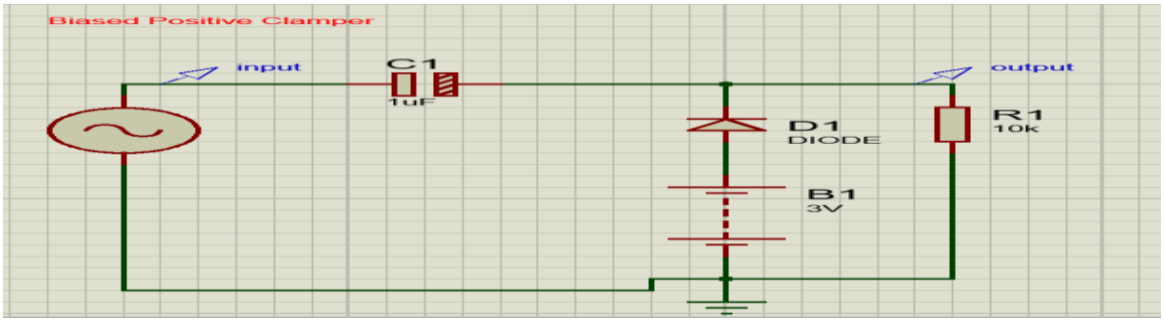
When the input supply voltage becomes greater than the battery voltage, the diode is forward biased by the input supply voltage and hence allows electric current through it. This current will flows to the capacitor and charges it.



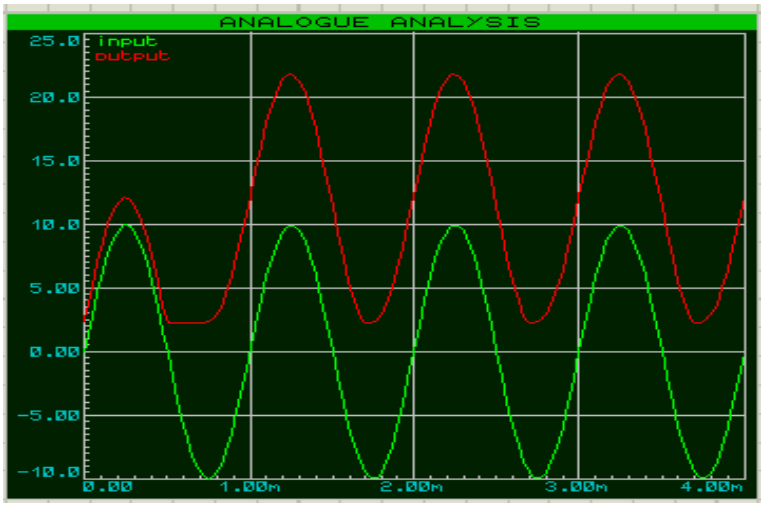
During positive half cycle:

During the positive half cycle, the diode is reverse biased by both input supply voltage and the battery voltage. As a result, the signal appears at the output. The signal appeared at the output is equal to the sum of the input voltage and capacitor voltage.

Circuit Diagram:



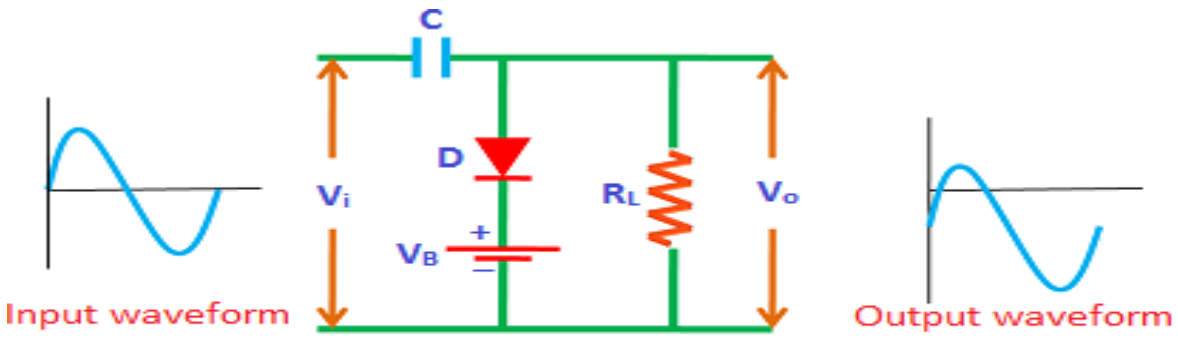
Analogue Output:



Negative clamper with positive bias

During positive half cycle:

During the positive half cycle, the battery voltage reverse biases the diode when the input supply voltage is less than the battery voltage. When the input supply voltage becomes greater than the battery voltage, the diode is forward biased by the input supply voltage and hence allows electric current through it. This current will flows to the capacitor and charges it.



Negative clamper with positive bias

Physics and Radio-Electronics

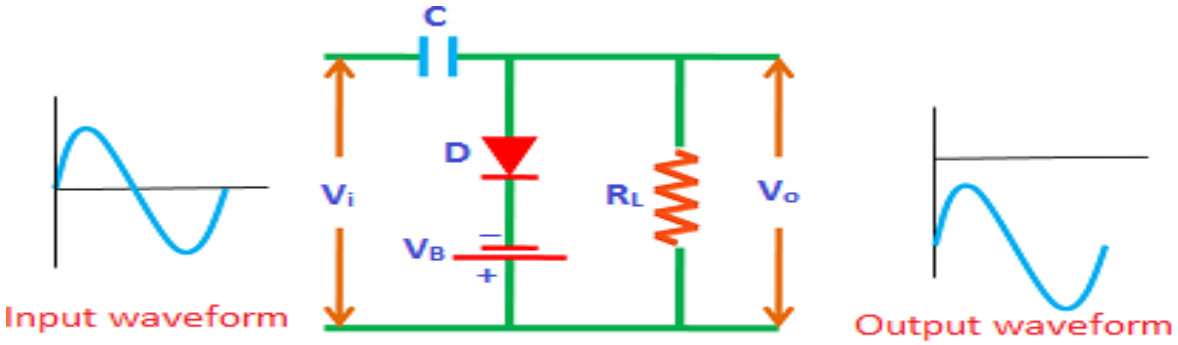
During negative half cycle:

During the negative half cycle, the diode is reverse biased by both input supply voltage and battery voltage. As a result, the signal appears at the output.

Negative clamper with negative bias

During positive half cycle:

During the positive half cycle, the diode is forward biased by both input supply voltage and battery voltage. As a result, current flows through the capacitor and charges it.



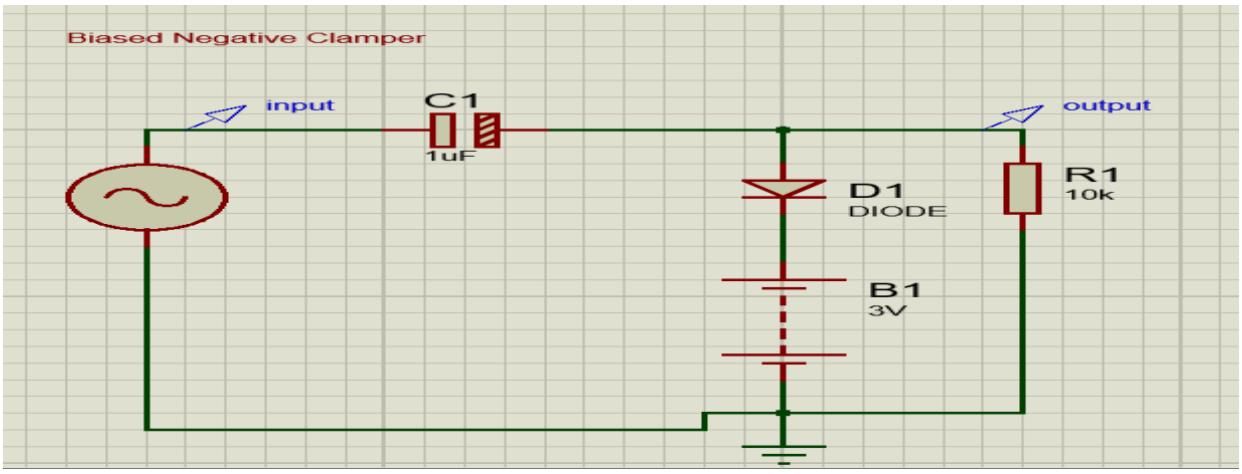
Negative clamper with negative bias

Physics and Radio-Electronics

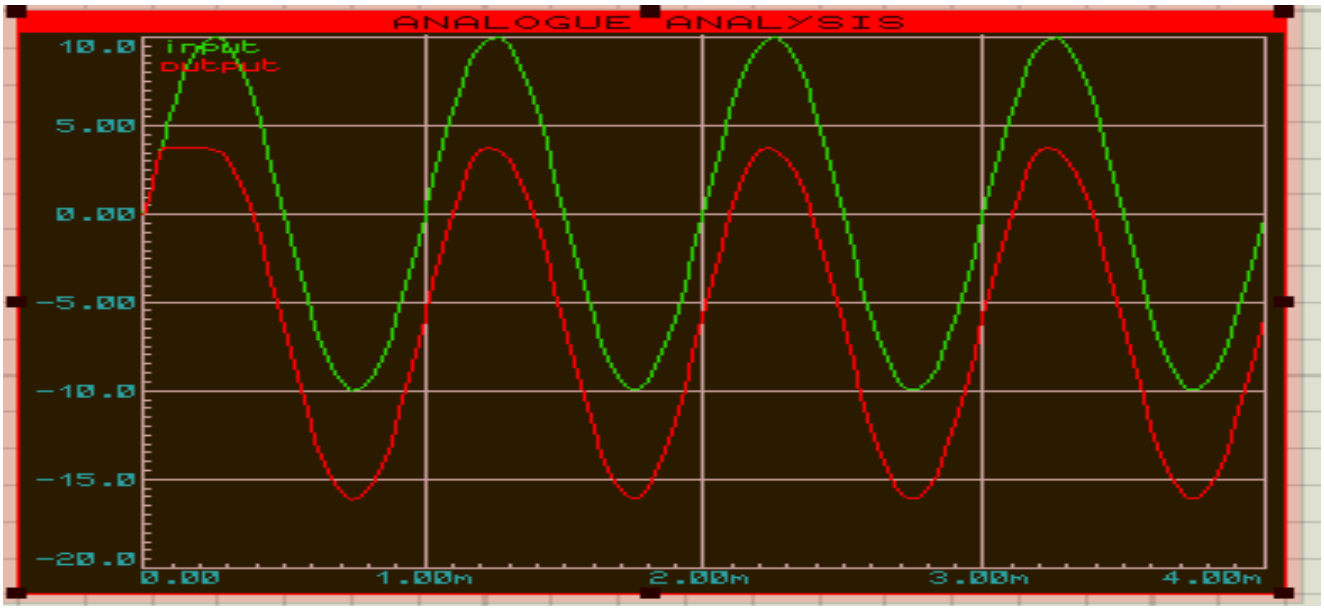
During negative half cycle:

During the negative half cycle, the battery voltage forward biases the diode when the input supply voltage is less than the battery voltage. When the input supply voltage becomes greater than the battery voltage, the diode is reverse biased by the input supply voltage and hence signal appears at the output.

Circuit Diagram:



Analogue Output:



Conclusion:

- Clampers can be used to increase the dc-value of the signal.
- We connect a high value resistance in parallel with the diode to eliminate the distortion in the output signal.
- A dc source can be connected in the clamper network to change the dc-level.