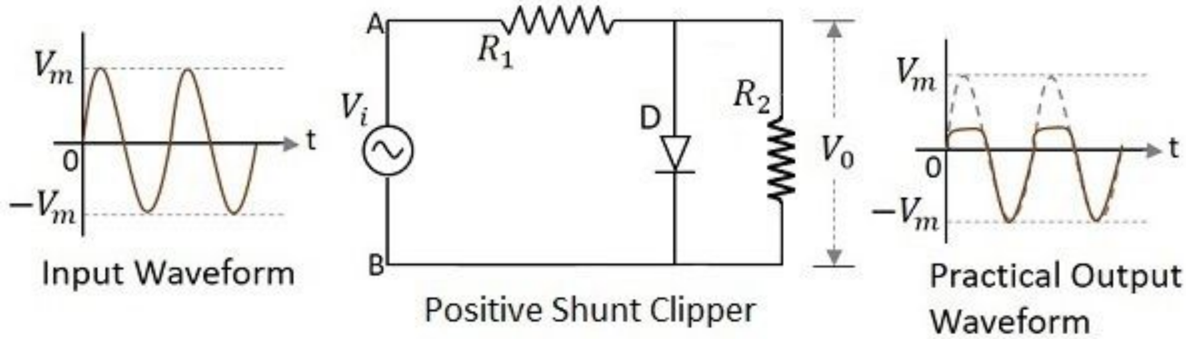
CLIPPING CIRCUITS

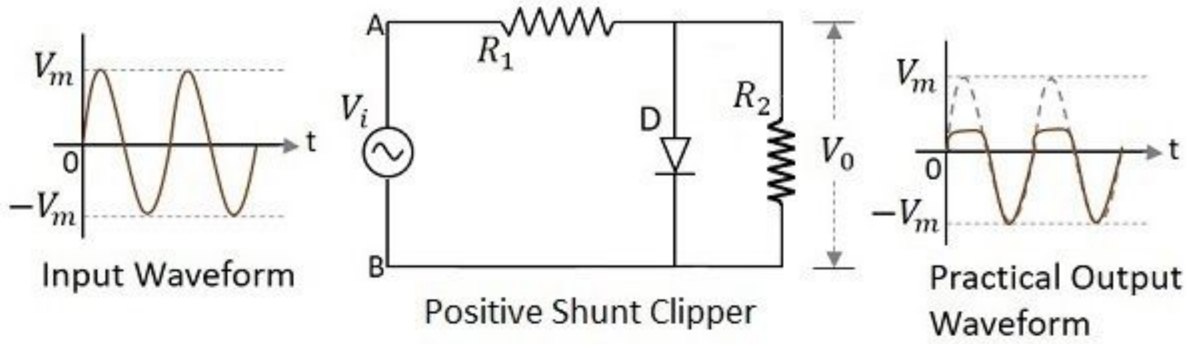
- A clipper is a device which limits, remove or prevents some portion of the wave form (input signal voltage) above or below a certain level
- In other words the circuit which limits positive or negative amplitude ,or both is called chipping circuit.
  - Shunt or parallel clippers
    - Positive
    - Negative
    - Biased
  - Series clippers
    - Positive
    - Negative
    - Biased
  - Combinational Clippers

- # Shunt positive clipper

A Clipper circuit in which the diode is connected in shunt to the input signal and that attenuates the positive portions of the waveform, is termed as **Positive Shunt Clipper**



- **Positive Cycle of the Input**
  - positive cycle of the input makes the point A in the circuit positive with respect to the point B.
  - This makes the diode forward biased when the input voltage magnitude greater than +0.7 volts (0.3 volts for a germanium diode) and hence it conducts like a closed switch.
  - When this happens the diodes begins to conduct and holds the voltage across itself constant at 0.7V until the sinusoidal waveform falls below this value.
  - Thus the voltage across the load resistor becomes zero as no current flows through it and hence V_0 will be at 0.7V.
  - Thus the output voltage which is taken across the diode can never

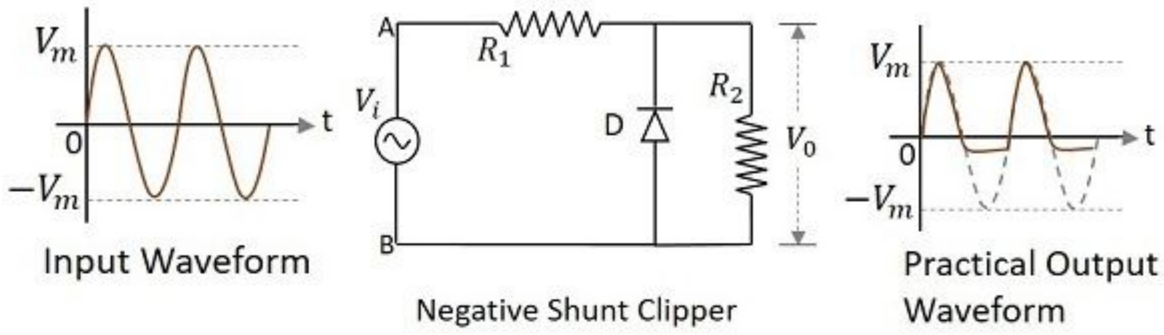


- **Negative Cycle of the Input**
  - The negative cycle of the input makes the point A in the circuit negative with respect to the point B.
  - This makes the diode reverse biased and hence it behaves like an open switch.
  - Thus the voltage across the load resistor will be equal to the applied input voltage as it completely appears at the output V_0.

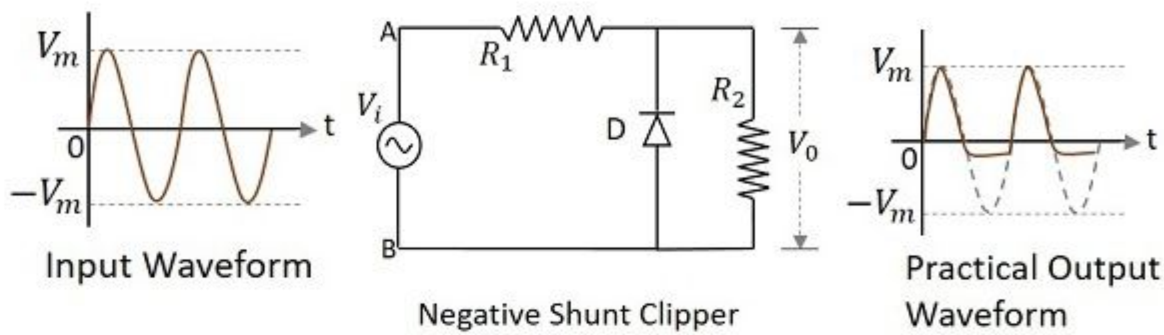
Thus the diode limits the positive half of the input waveform and is known as a positive clipper circuit.

- **Shunt negative clipper**

  A Clipper circuit in which the diode is connected in shunt to the input signal and that attenuates the negative portions of the waveform, is termed as **Negative Shunt Clipper**.



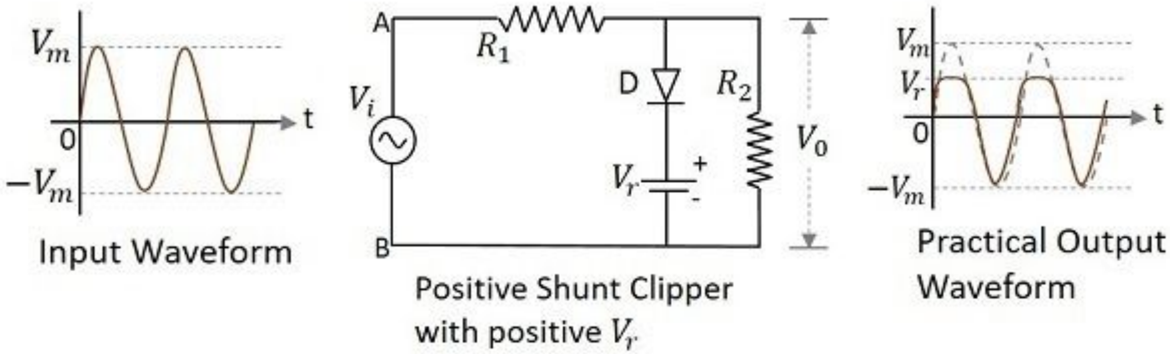
  - Positive cycle of the input makes the point A in the circuit positive with respect to the point B.
  - This makes the diode reverse biased and hence it behaves like an open switch.
  - Thus the voltage across the load resistor equals the applied input voltage as it completely appears at the output V_0



– The negative cycle of the input makes the point A in the circuit negative with respect to the point B.
– This makes the diode forward biased and hence it conducts like a closed switch.
– Thus the voltage across the load resistor becomes zero as no current flows through it.

- **Positive Shunt Clipper with positive reference voltage**

A Clipper circuit in which the diode is connected in shunt to the input signal and biased with positive reference voltage V_r ar the waveform, vith **positive V_r**



Input Waveform

Positive Shunt Clipper with positive V_r

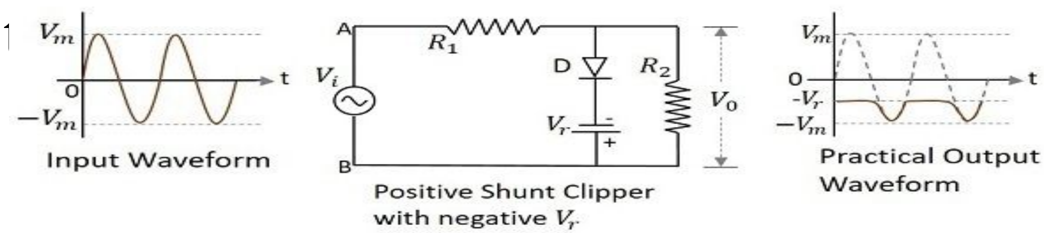
Practical Output Waveform

– During the positive cycle of the input the diode gets forward biased and nothing but the reference voltage appears at the output.

– During its negative cycle, the diode gets reverse biased and

- **Positive Shunt Clipper with negative reference voltage**

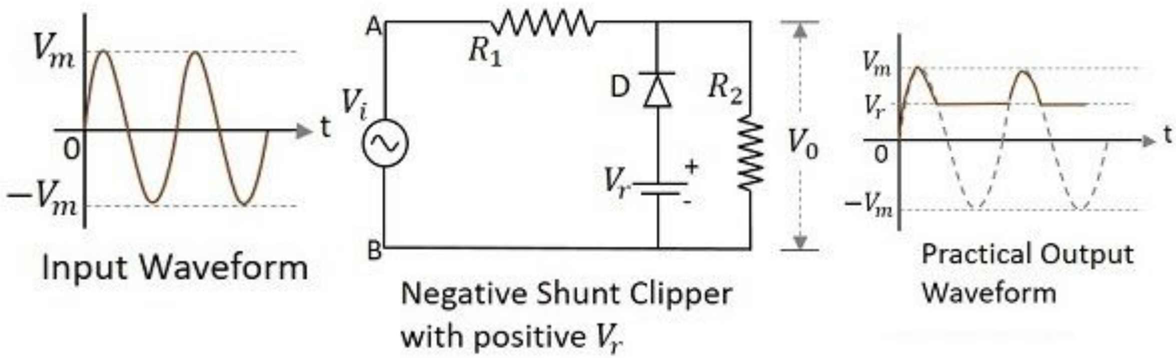
A Clipper circuit in which the diode is connected in shunt to the input signal and biased with negative reference voltage V_r and f the waveform, is **with negative** V_r.



- During the positive cycle of the input, the diode gets forward biased and the reference voltage appears at the output.
- During its negative cycle, the diode gets reverse biased and behaves as an open switch. Hence the input signal that is greater than the reference voltage, appears at the output.

- **Negative Shunt Clipper with positive reference voltage**

A Clipper circuit in which the diode is connected in shunt to the input signal and biased with positive reference voltage V_r and that attenuates the negative portions of the waveform, is termed as **Negative Shunt Clipper with positive** V_r

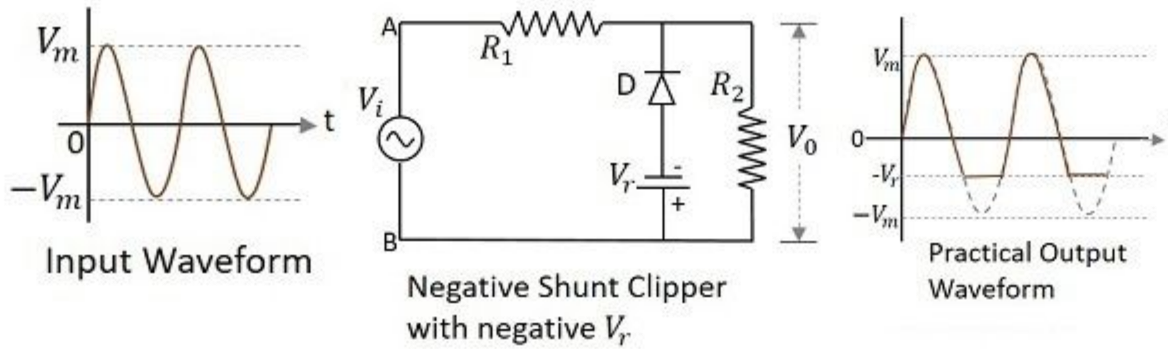


– During the positive cycle of the input the diode gets reverse biased and behaves as an open switch.

– Whole of the input voltage, which is greater than the reference voltage applied, appears at the output.

– The signal below reference voltage level gets clipped off.

- **Negative Shunt Clipper with negative reference voltage**

A Clipper circuit in which the diode is connected in shunt to the input signal and biased with negative reference voltage V_r and that attenuates the negative portions of the waveform, 

Input Waveform

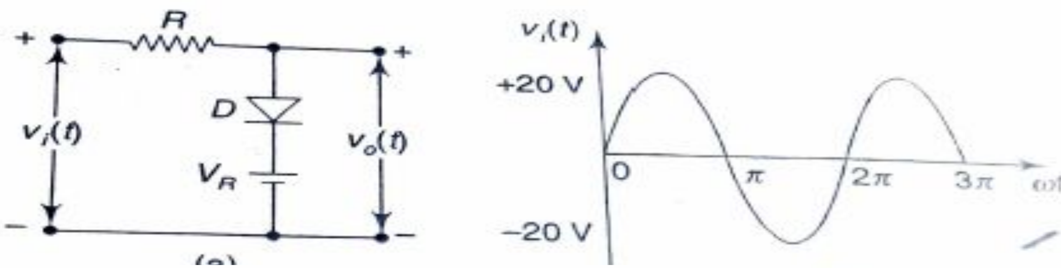
Negative Shunt Clipper with negative V_r

Practical Output Waveform

ith negative V_r

- During the positive cycle of the input the diode gets reverse biased and behaves as an open switch.
- So whole of the input voltage, appears at the output V_o.
- During the negative half cycle, the diode gets forward biased.
- The negative voltage up to the reference voltage, gets at the output and the remaining signal gets clipped off.

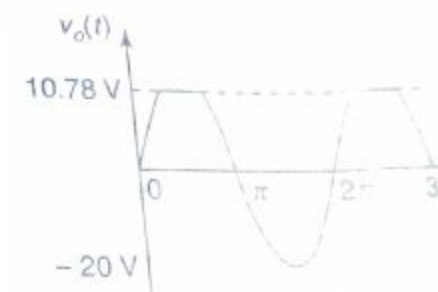
In the diode positive peak limiting circuit of Fig. 16.54(a), $V_R = 10$ V, $v_i(t) = 20 \sin 2\pi ft$ and the diode forward resistance is $R_f = 100\ \Omega$ while $R_r = \infty$ and $v_r = 0$. Neglect all capacitances in the circuit. Draw the input and output waveform if $R = 1.2$ kΩ.



(a) (b)

Solution From the circuit shown in Fig. 16.54(a), and the input waveform shown in Fig. 16.54(b), $v_i(t)$(max) = 20 V. Given $R_f = 100\ \Omega$ and $V_R = 10$ V.

When $v_i(t) > V_R$, the diode conducts. The reference voltage, $V_R = 10$ V. When $v_i(t) = v_o(t)$, the diode does not conduct. When the diode conducts i.e. in ON state, the following equations are valid.



(c)

$$v_o(t) = (v_i(t) - V_R)\frac{R_f}{R + R_f} + V_R$$

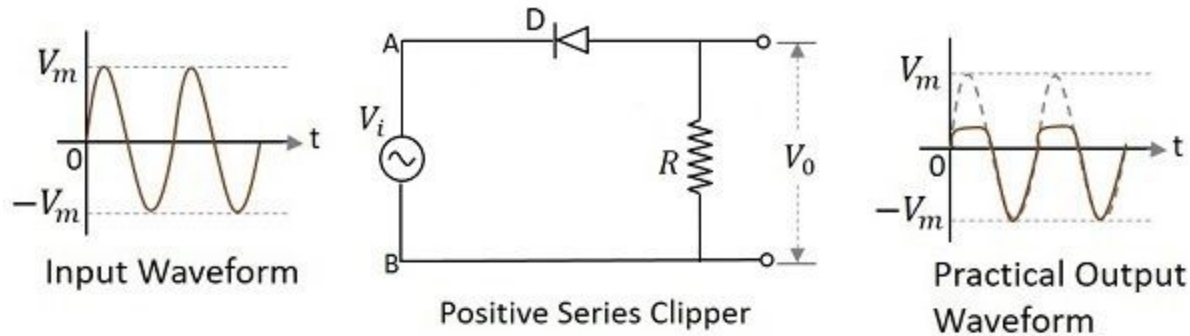
$$v_o(t)_{\max} = V_R\left(\frac{R + 2R_f}{R + R_f}\right), \text{ since } v_i(t)_{\max} = 2V_R.$$

The maximum value of the output waveform for $R = 1.2$ kΩ is calculated as

$$v_o(t)_{\max} = 10 \times \left(\frac{1200 + 200}{1200 + 100}\right) = 10 \times 1.078 = 10.78 \text{ V}$$

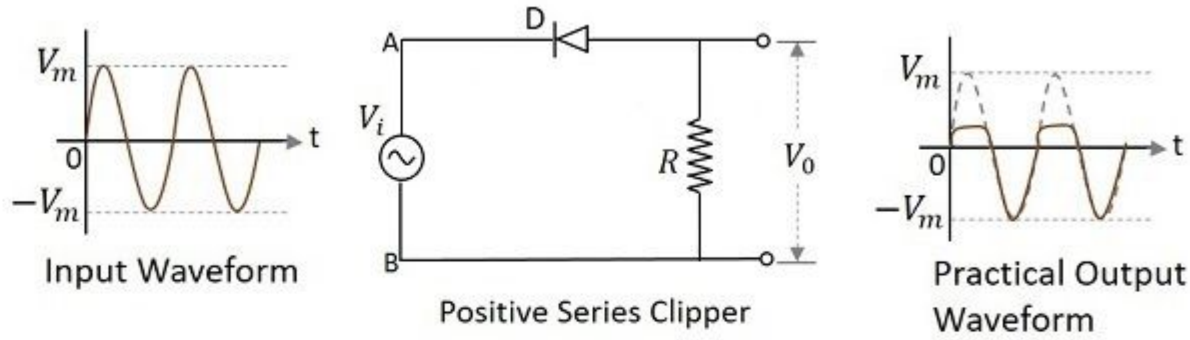
- **Positive Series Clipper**

  A Clipper circuit in which the diode is connected in series to the input signal and that attenuates the positive portions of the waveform, is termed as **Positive Series Clipper**



Positive Cycle of the Input

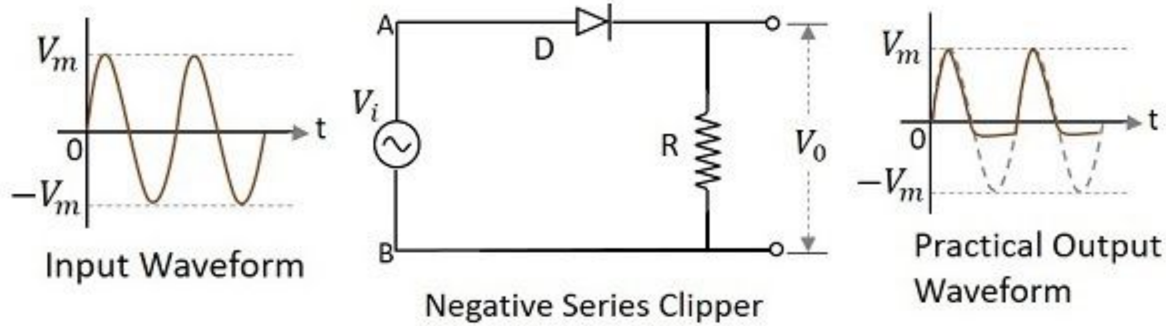
- Positive cycle of the input makes the point A in the circuit positive with respect to the point B.
- This makes the diode reverse biased and hence it behaves like an open switch.
- Thus the voltage across the load resistor becomes zero as no current flows through it and hence V_0 will be 0.7V.



- **Negative Cycle of the Input** −
  - The input makes the point A in the circuit negative with respect to the point B.
  - This makes the diode forward biased and hence it conducts like a closed switch.
  - Thus the voltage across the load resistor will be equal to the applied input voltage as it completely appears at the output V_0.

Negative Series Clipper

- A Clipper circuit in which the diode is connected in series to the input signal and that attenuates the negative portions of the waveform, is termed as **Negative Series Clipper**.

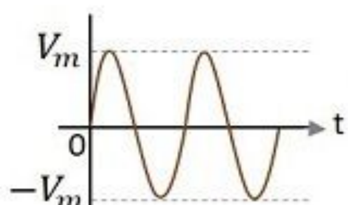


- **Positive Cycle of the Input** – When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode forward biased and hence it acts like a

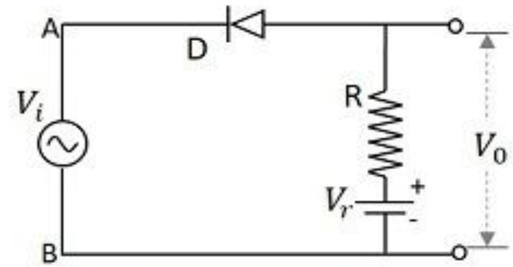
- **Negative Cycle of the Input** − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode reverse biased and hence it acts like an open switch. Thus the voltage across the load resistor will be zero making V_0 zero.

Positive Series Clipper with positive V_r

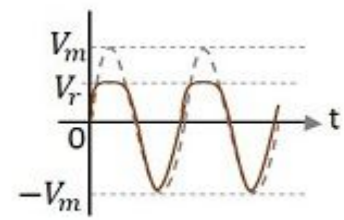
- A Clipper circuit in which the diode is connected in series to the input signal and biased with positive reference voltage V_r and that attenuates the positive portions of the waveform, is termed as **Positive Series Clipper with positive V_r**



Input Waveform



Positive Series Clipper with positive V_r

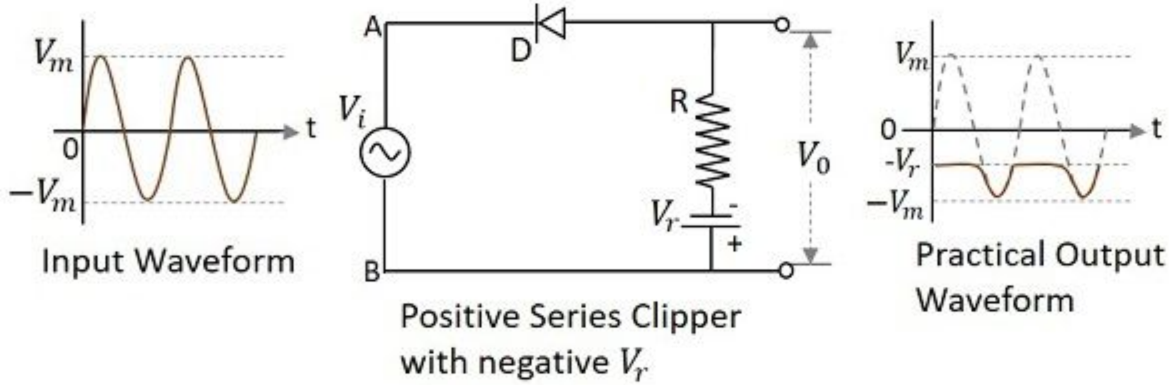


Practical Output Waveform

- During the positive cycle of the input the diode gets reverse biased and the reference voltage appears at the output.
- During its negative cycle, the diode gets forward biased and conducts like a closed switch.

Positive Series Clipper with negative V_r

- A Clipper circuit in which the diode is connected in series to the input signal and biased with negative reference voltage V_r and that attenuates the positive portions of the waveform, is termed as **Positive Series Clipp**

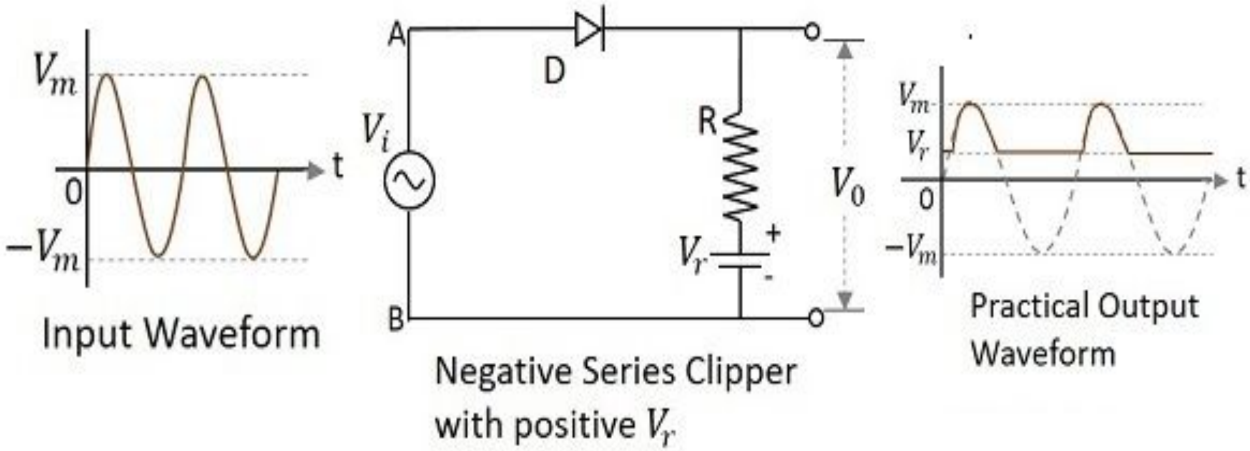


- During the positive cycle of the input the diode gets reverse biased and the reference voltage appears at the output. As the reference voltage is negative, the same voltage with constant amplitude is shown.

- During its negative cycle, the diode gets forward biased and conducts like a closed switch. Hence the input signal that is greater than the reference voltage, appears at the output.

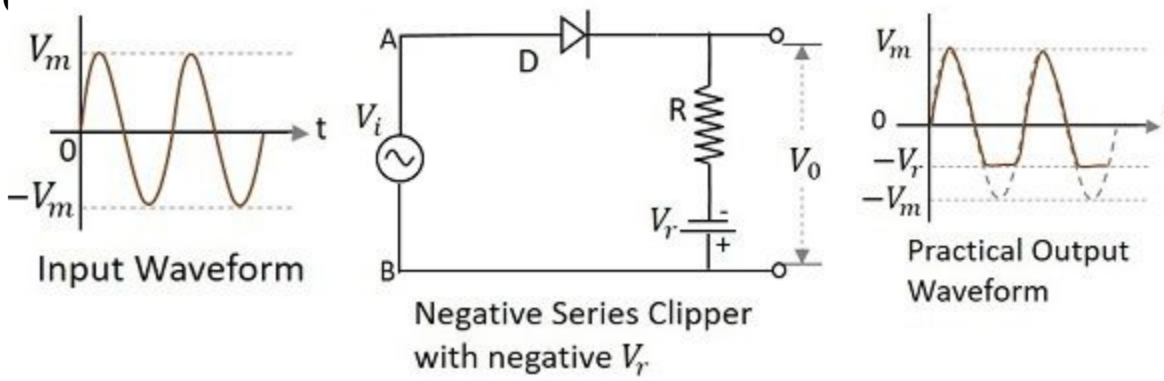
Negative Series Clipper with positive V_r

- A Clipper circuit in which the diode is connected in series to the input signal and biased with positive reference voltage V_r and that attenuates the negative portions of the waveform, is termed as **Negative Series Clipper with positive V**



- During the positive cycle of the input, the diode starts conducting only when the anode voltage value exceeds the cathode voltage value of the diode. As the cathode voltage equals the reference voltage applied, the output

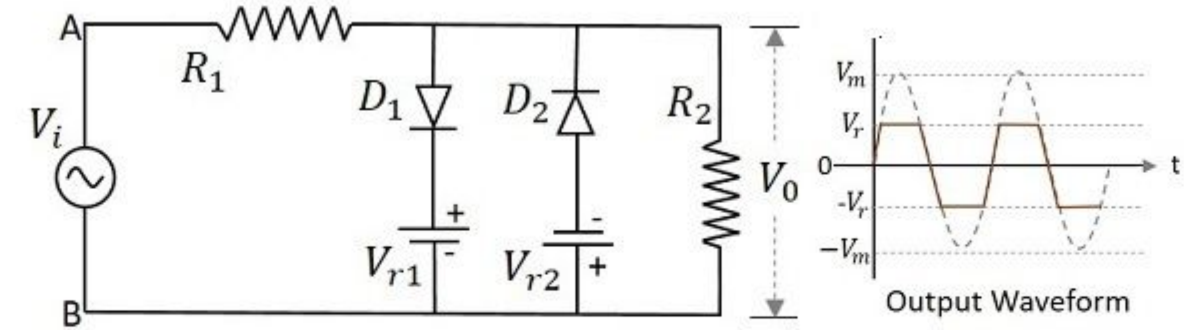
- **Negative Series Clipper with negative V_r**
- A Clipper circuit in which the diode is connected in series to the input signal and biased with negative reference voltage V_r and that attenuates the negative portions of the waveform, is termed as **Negative Series Clipper with negativ**



- During the positive cycle of the input the diode gets forward biased and the input signal appears at the output.
- During its negative cycle, the diode gets reverse biased and hence will not conduct. But the negative reference voltage being applied, appears at the output. Hence the negative cycle of the output waveform gets

Two-way Clipper

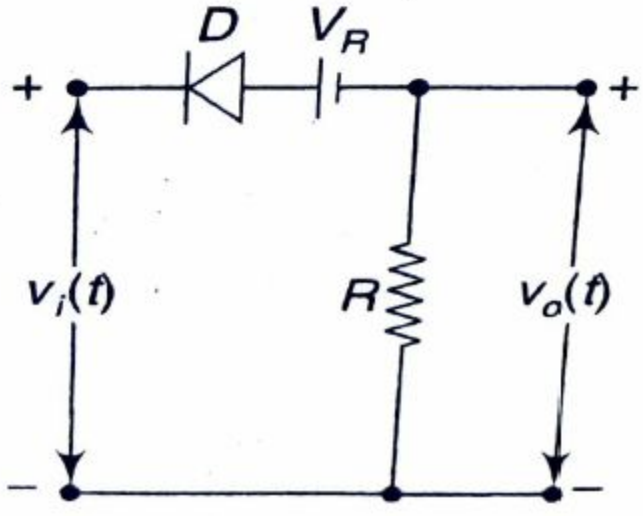
- This is a positive and negative clipper with a reference voltage V_r. The input voltage is clipped two-way both positive and negative portions of the input waveform with two reference voltages. For this, two diodes D_1 and D_2 along with two reference voltages



- This circuit is also called as a **Combinational Clipper** circuit.
- During the positive half of the input signal, the diode D_1

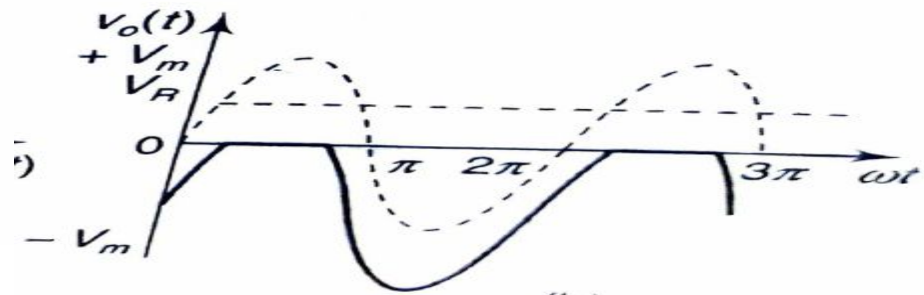
Problems

1.

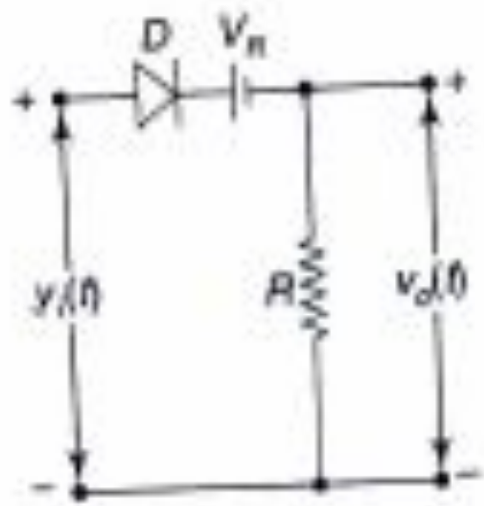


When $v_i < V_R$, D is ON, and $v_o = v_i - V_R$

When $v_i > V_R$, D is OFF, and $v_o = 0$

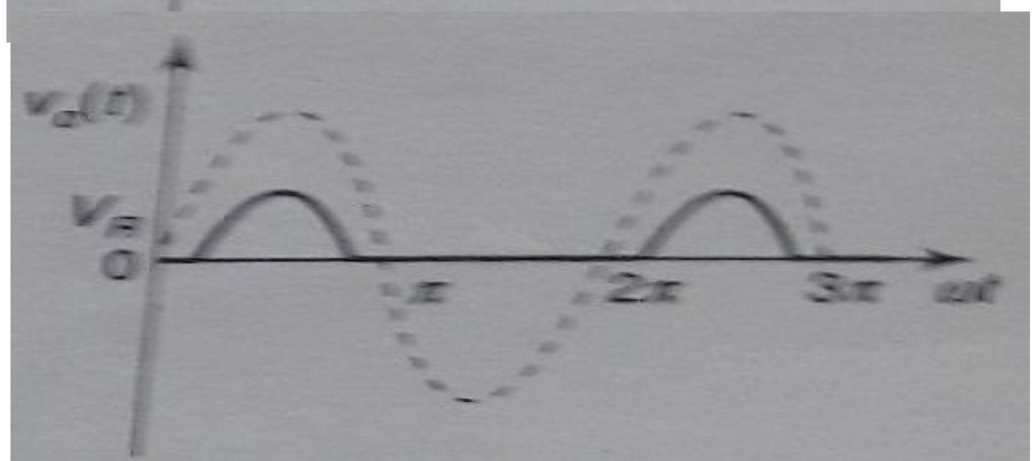


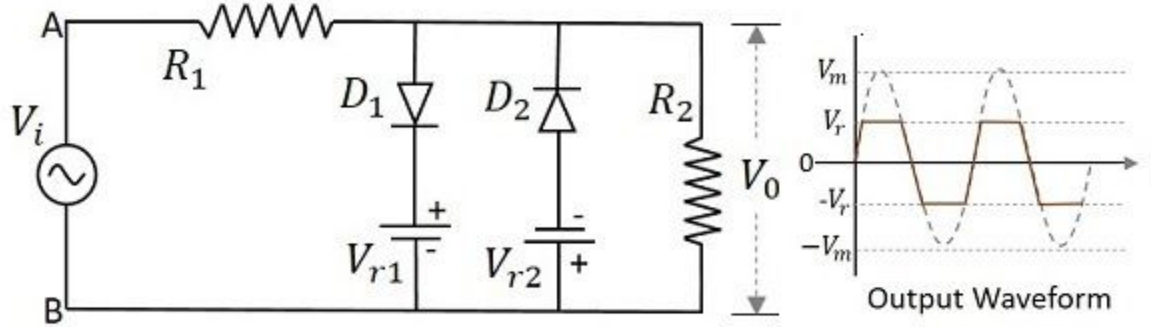
2.



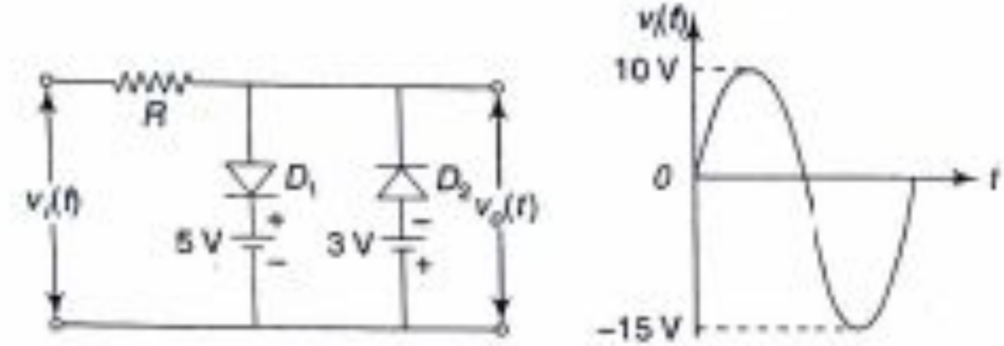
When $v_i < V_R$, D is OFF, and $v_o = 0$

When $v_i > V_R$, D is ON, and $v_o = v_i - V_R$

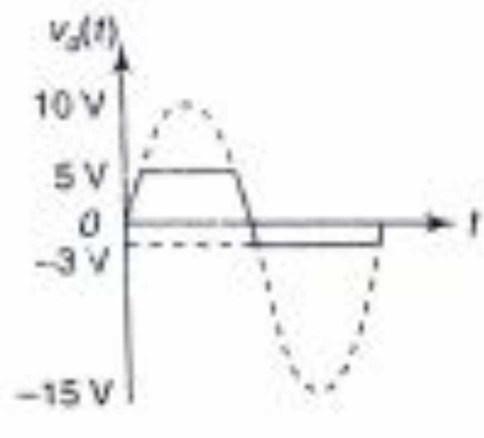


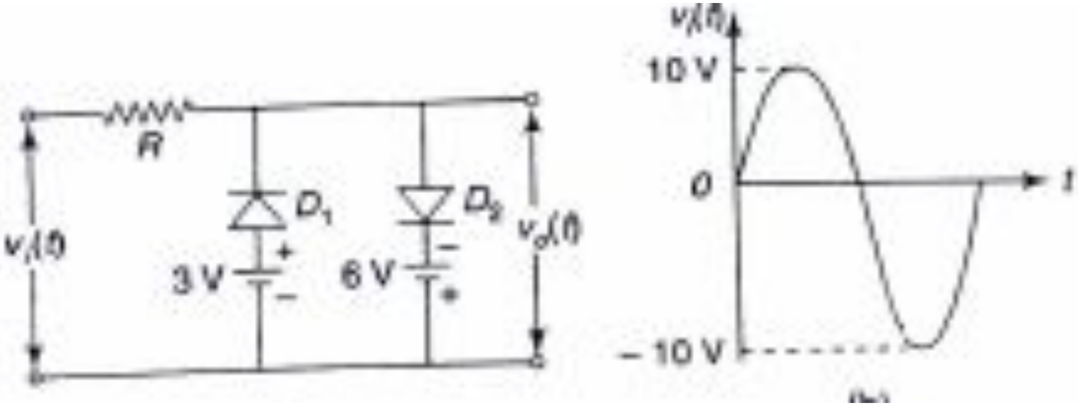


- During the negative half of the input signal, the diode D_2 conducts making the reference voltage V_{r1} appear at the output.
- Hence both the diodes conduct alternatively to clip the output during both the cycles. The output is taken across the load resistor.

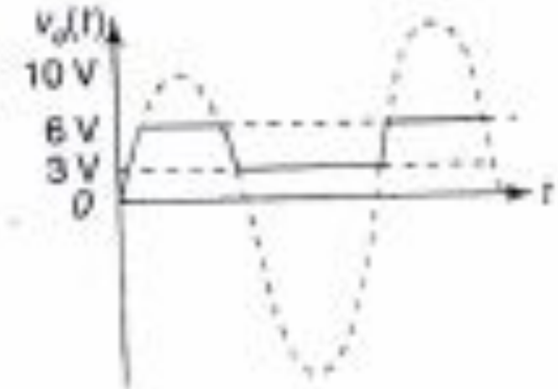


When the input voltage $v_i \geq 5\,V$, the diode D_1 conducts when $v_i \leq -3\,V$, diode D_2 conducts. ence, the positive half cycle of the input voltage is clipped at +5 V and the negative half cycle is clipped -3 V





olution When the input voltage $v_i \le 3V$, D_1 conducts. When $v_i \ge 6V$, conducts. Hence, both D_1 and D_2 will not conduct and act as open itches and allow the signal to pass during $3\ V \ge v_i \le 6\ V$. The resultant aveform is shown in Fig. 16.52(c).



(c)

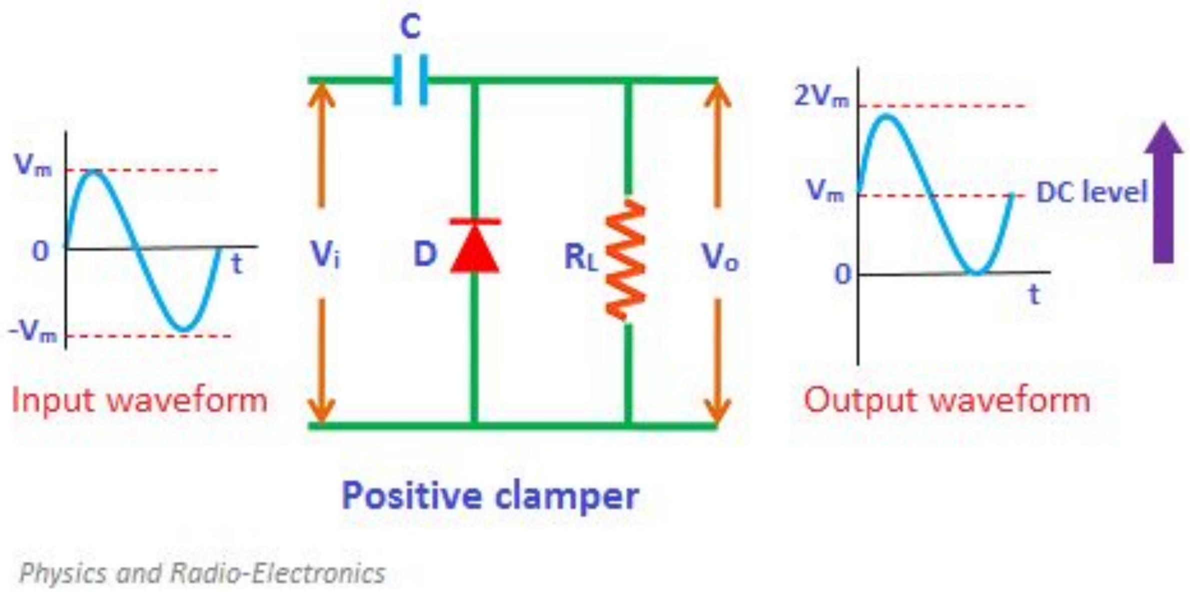
- **CLAMPERS**
- A clamper is an electronic circuit that changes the DC level of a signal to the desired level without changing the shape of the applied signal.
- In other words, the clamper circuit moves the whole signal up or down to set either the positive peak or negative peak of the signal at the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

Clamper circuits are of three types:

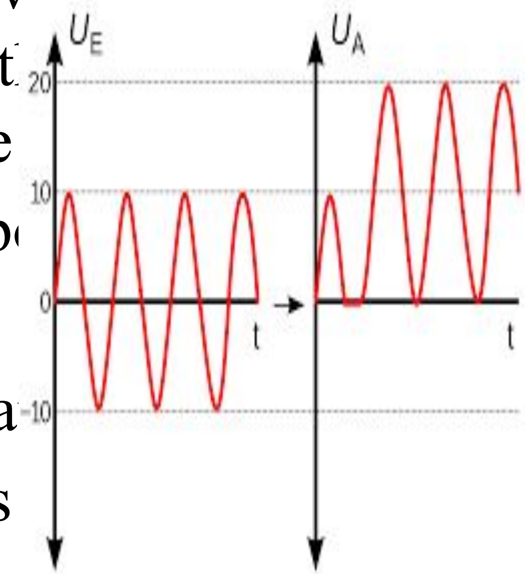
- Positive clampers
- Negative clampers
- Biased clampers

Positive clamper

- The positive clamper is made up of a voltage source V_i, capacitor C, diode D, and load resistor R_L.
- 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 positive half cycle:
  - the diode is reverse biased. In reverse biased condition, the diode does not allow electric current through it. So the input current directly flows towards the output and hence the signal appears at the output.
- During negative half cycle:
  - 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 t
    charges it to the peak value of input voltage
  - The capacitor charged in inverse polarity (p
    with the input voltage.
    As input current or voltage decreases after a
    its maximum value $-V_m$, the capacitor holds
    charge until the diode remains forward biased.

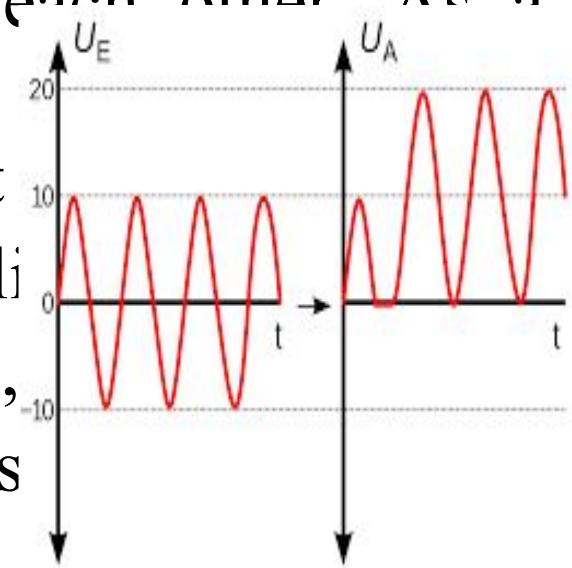


- When next positive half cycle begins, the diode is in the non-conducting state and the charge stored in the capacitor is discharged (released).
- Therefore, the voltage appeared at the output is equal to the sum of the voltage stored in the capacitor (V_m) and the input voltage (V_m)

  $V_o = V_m + V_m = 2V_m$}

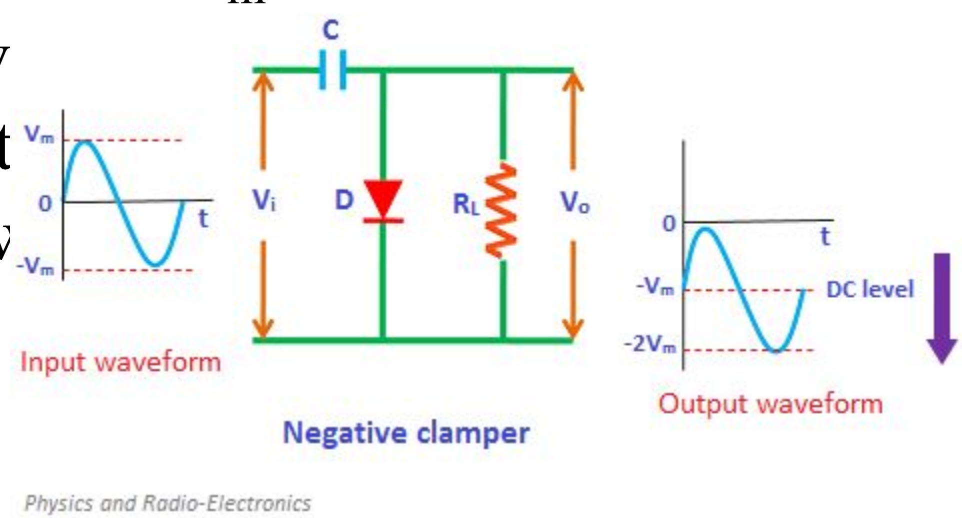
  which have the same polarity with each other. As a result, the signal shifted upwards.

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



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 v … its maximum value V_m, t … ntil the diode remains forv



- During negative half cycle:
  - 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 ($-V_m$)

$$V_o = -V_m - V_m = -2V_m$$

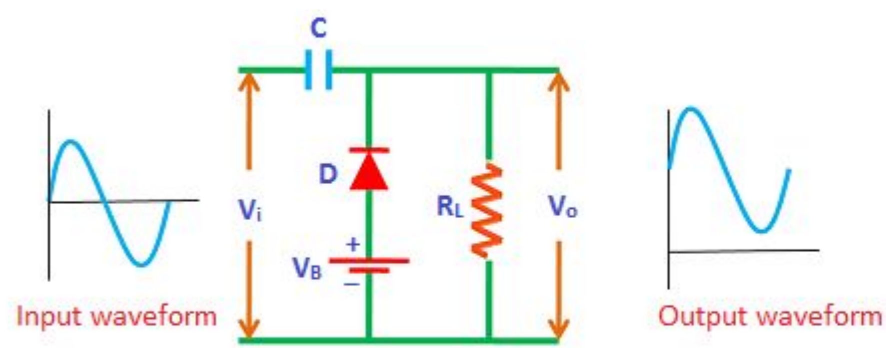
which have the same polarity with each other. As a result, the signal shifted downwards.

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

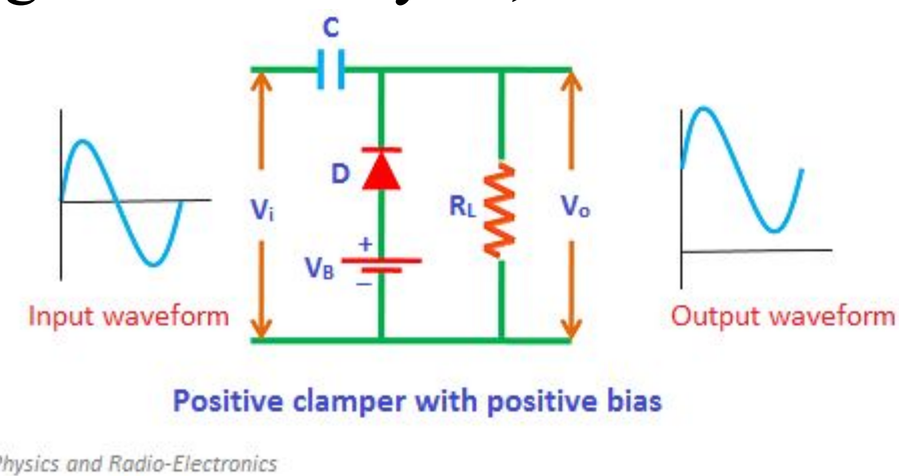
- If positive biasing is applied to the clamper then it is said to be a positive c



Positive clamper with positive bias

Physics and Radio-Electronics

- 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.
- During negative half cycle:
  - During the negative half cycle, the diode is forward biased by both ... y voltage. So the diode ... urrent will flows to the ca



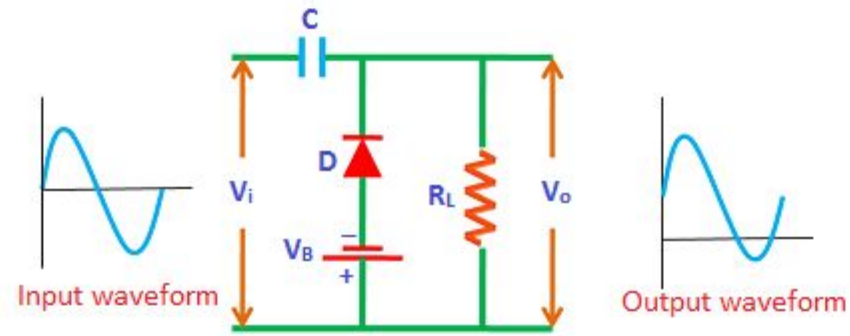
Positive clamper with positive bias

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 ar lt, the signal appears at the ou ıe output

    is equal to the sum of the inpu

    voltage and capacitor voltage

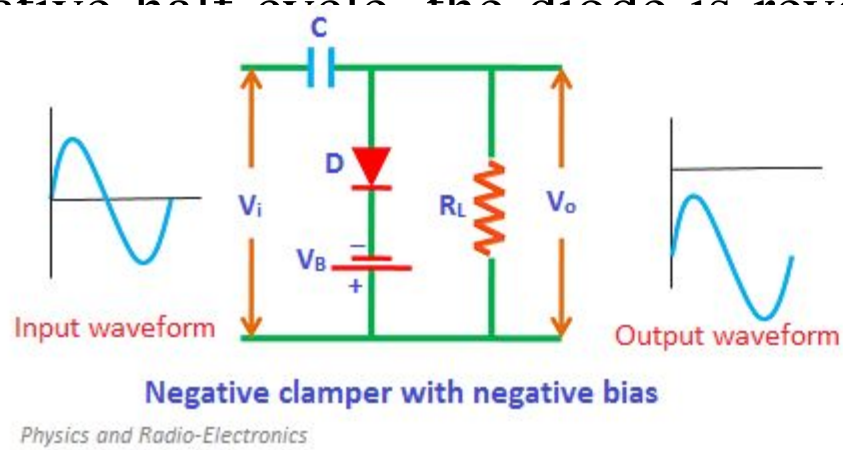


Positive clamper with negative bias

Physics and Radio-Electronics

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.
- During negative half cycle:
  - During the neg... rse biased by both input sup... s a result, the signal appears ...



Negative clamper with negative bias