ELECTRONICS ENGINEERING DEPARTMENT SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY, SURAT

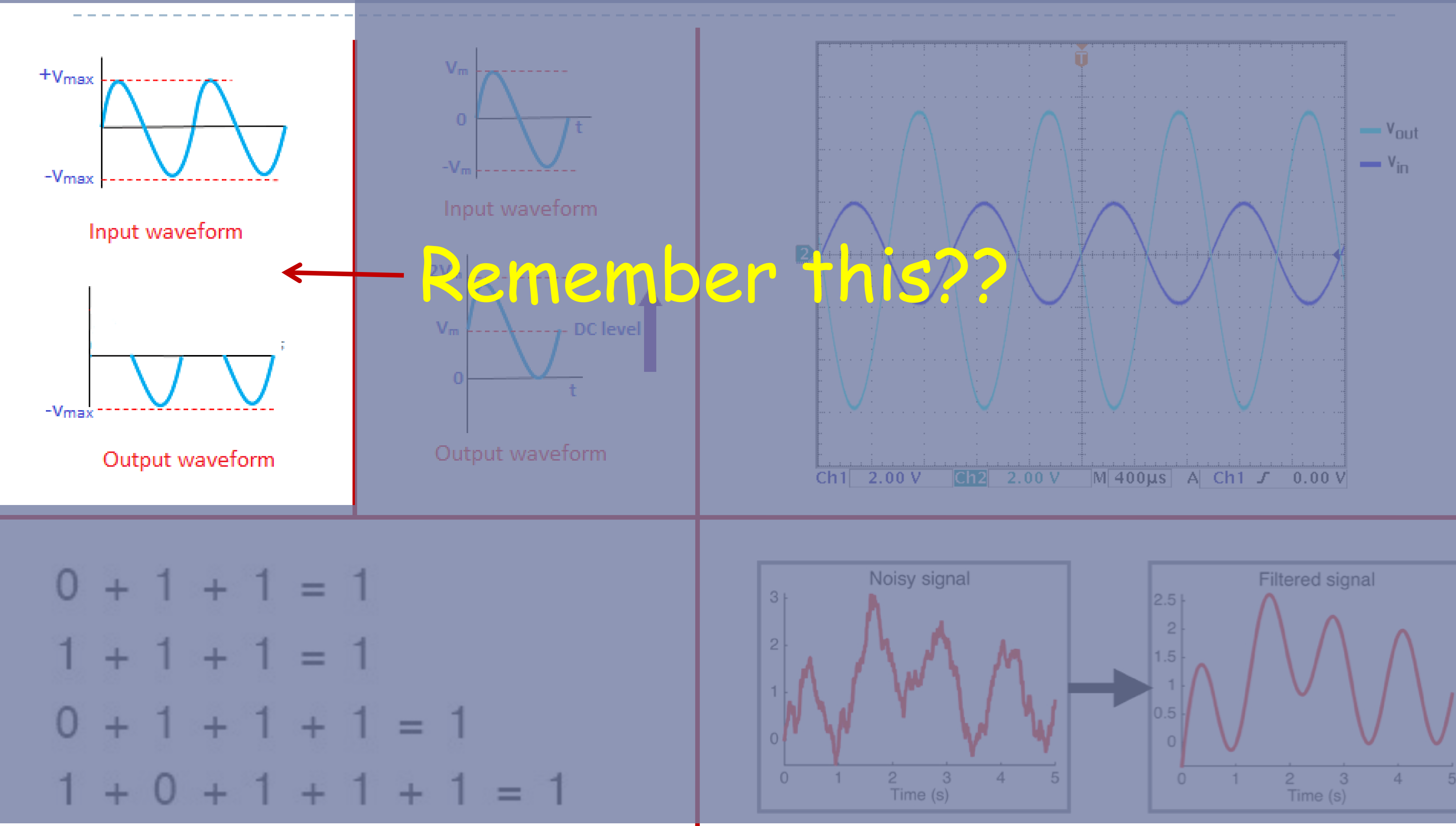
DIGITAL ELECTRONICS & LOGIC DESIGN LAB

LAB 6 & 7: 16.09.2020-17.09.2020
23.09.2020-24.09.2020

Objectives of Today's Lab

- Implement the following circuits using Multisim Online and verify the functionality.
  - Series Clipper Circuits (✓)
    - Positive and Negative
    - With and without bias
  - Shunt Clipper Circuits
    - Positive and Negative
    - With and without bias
  - Dual Clipper circuits
- Assignment.

A FEW EXAMPLES OF APPLICATIONS



What are clippers?

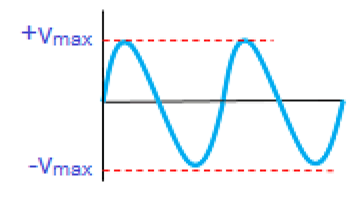
- Clipper circuits are the circuits that clip off or removes a portion of an input signal, without causing any distortion to the remaining part of the waveform.

- These are also known as clippers, clipping circuits, limiters, slicers etc.

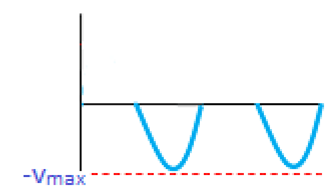
- Clippers are basically wave shaping circuits that control the shape of an output waveform.

- It consists of linear and non-linear elements e.g. Resistor, diode etc.

- But it does not contain energy storing elements e.g. capacitor etc.



Input waveform



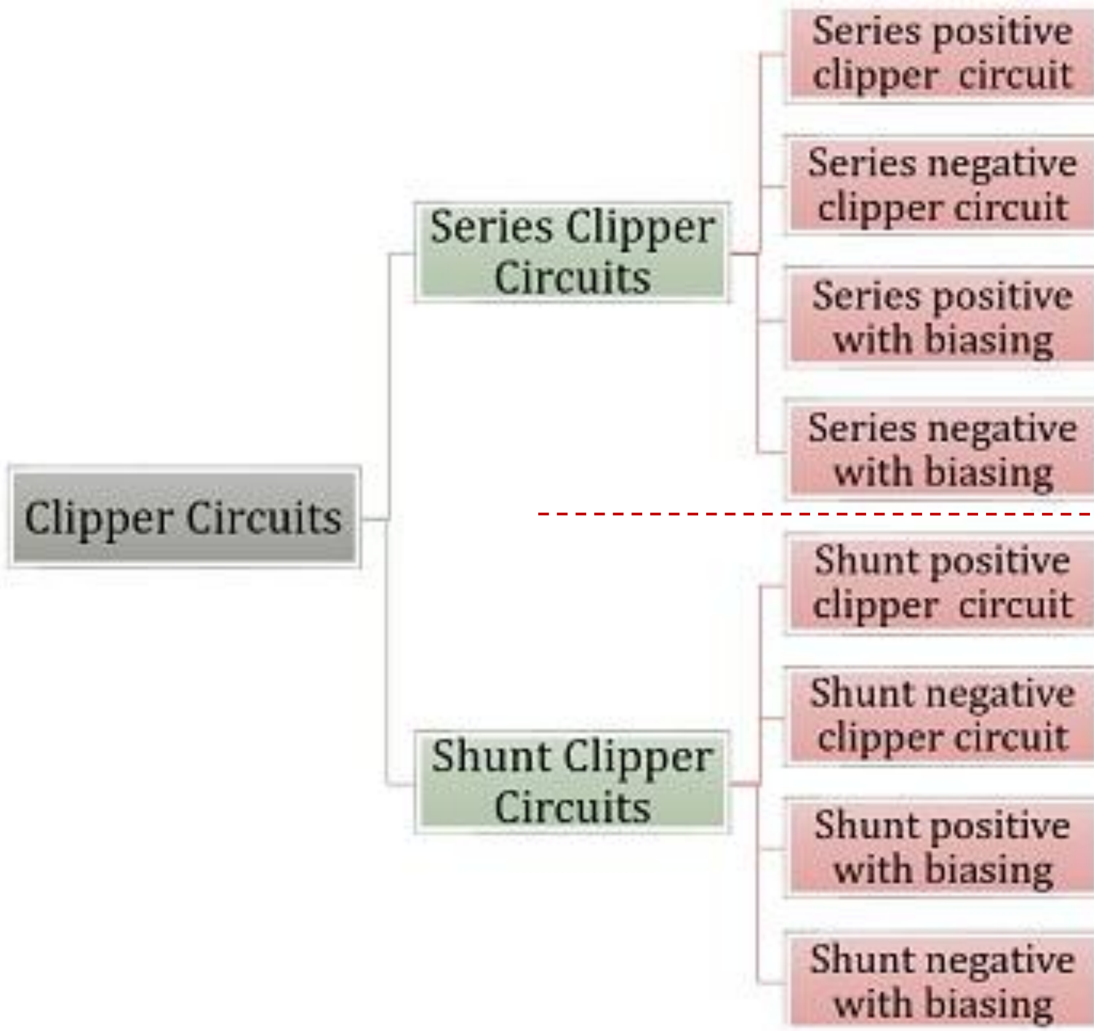
Output waveform

What are their applications?

- For the generation of new waveforms or shaping the existing waveform.
- For protection of transistor and circuits from transients.
- Employed as noise limiters in FM transmitters, by clipping excessive noise peaks above a specified level.
- As voltage limiters and amplitude selectors.

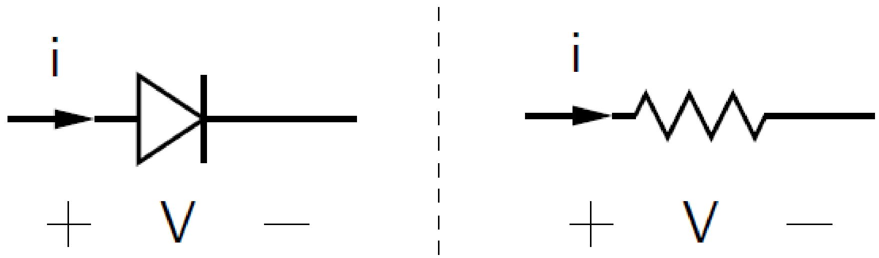
and many more.....

Classification



(✓)

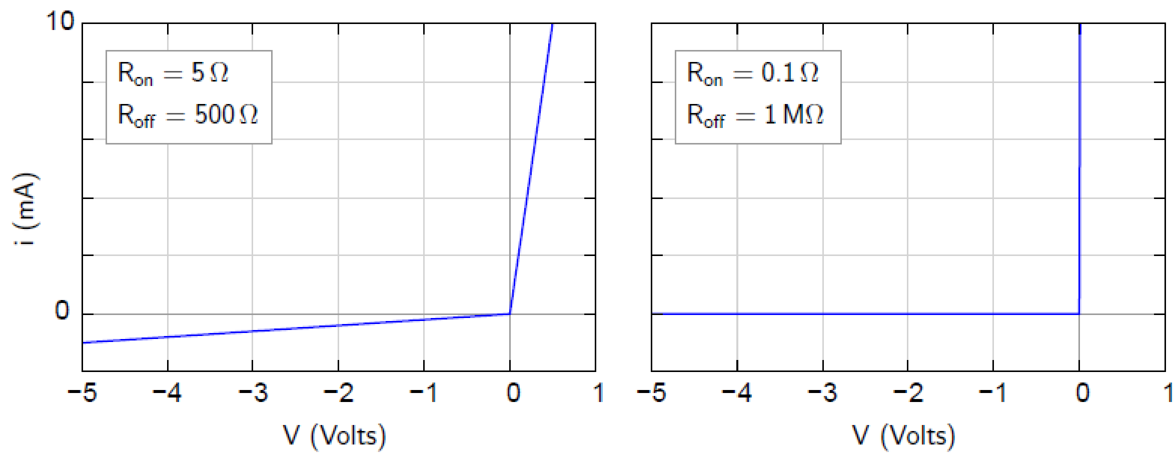
Getting Started: Diode R_{on}/R_{off} Model



$R = R_{on}$ if $V > 0$

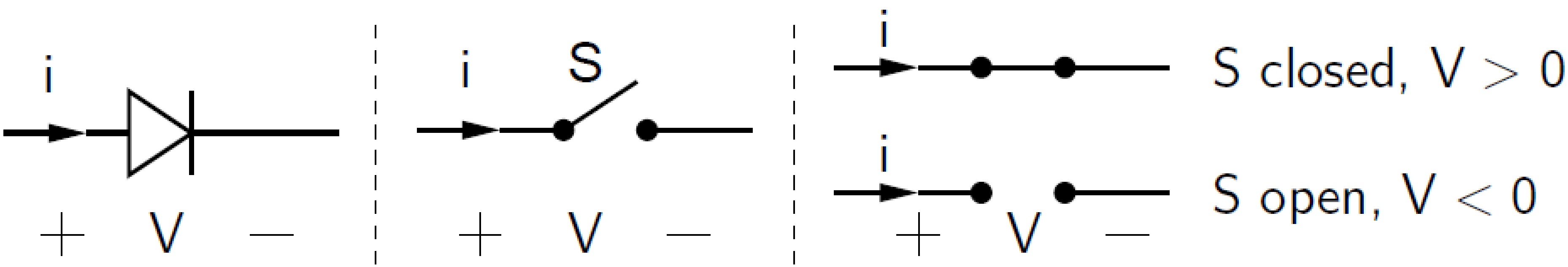
$R = R_{off}$ if $V < 0$

- Since the resistance is different in the forward and reverse directions, the I-V relationship is not symmetric.



Credits: Diode Circuits, EE101,MB Patil, IIT Bombay

Getting Started: Ideal Switch Model



- V > 0 Volts

$\Rightarrow$ S is closed (a perfect contact), and it can ideally carry any amount of current.

$\Rightarrow$ The voltage drop across the diode is 0 V.

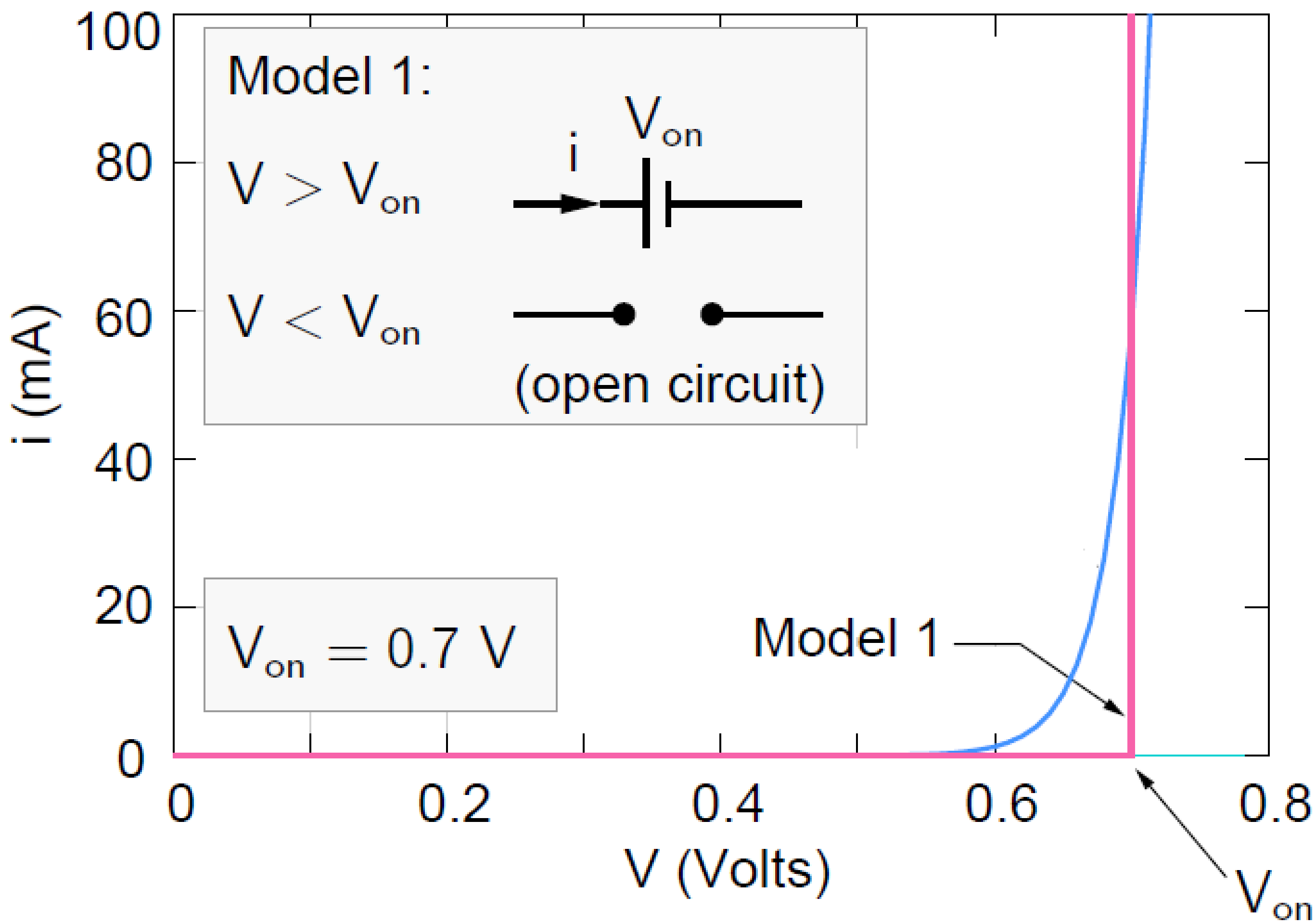
- V < 0 Volts

$\Rightarrow$ S is open (a perfect open circuit), and it can ideally block any reverse voltage.

$\Rightarrow$ The current through the diode is 0 A.

Credits: Diode Circuits, EE101, MB Patil, IIT Bombay

Getting Started: Practical Model



Getting Started: How to Analyze??

a) Identify with intuition which state the diode is operating in (forward or reverse).

b) Substitute appropriate model into circuit in place of diode.

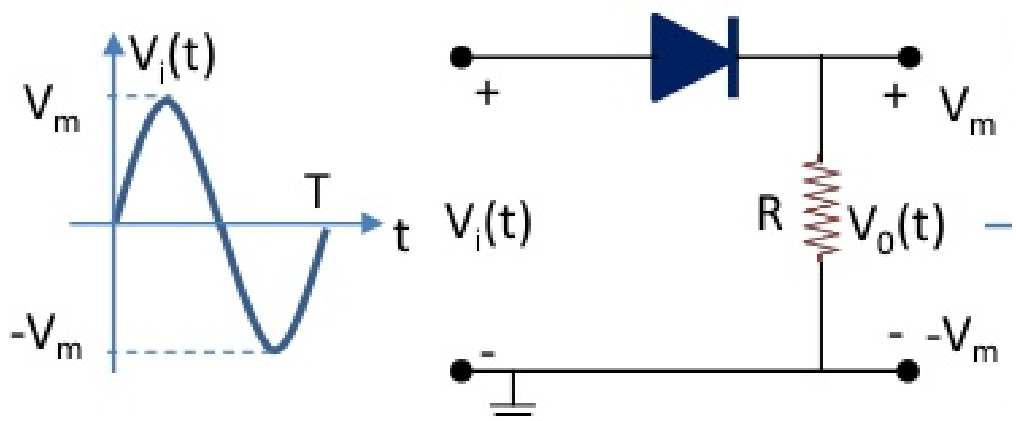
c) Analyze resulting circuit using standard linear circuit analysis techniques.

d) Check for contradictions (i.e., current flow in wrong direction or voltage polarity wrong) for state defined in step (a).

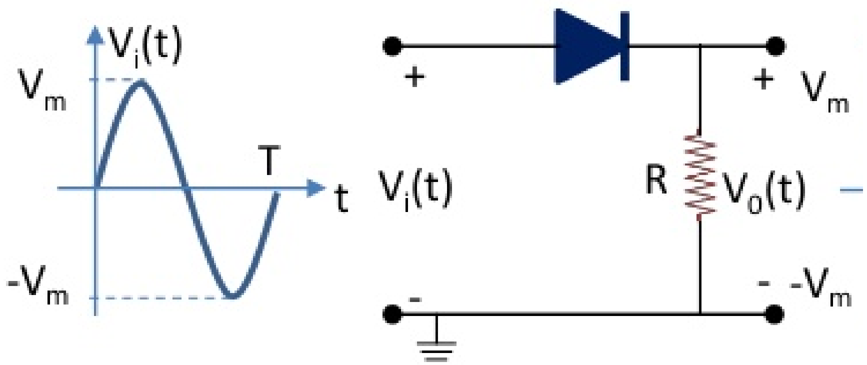
e) If no contradictions, the original guess was correct. If something is not satisfactory, go back, assume the other state for the diode and repeat the procedure.

Negative Series Clipper

- From the name of the circuit, we can conclude that :
  - It will eliminate the negative half of the input signal.
  - It is a series clipper, as the Diode is in series with the input source.
- The circuit is shown in given below circuit.

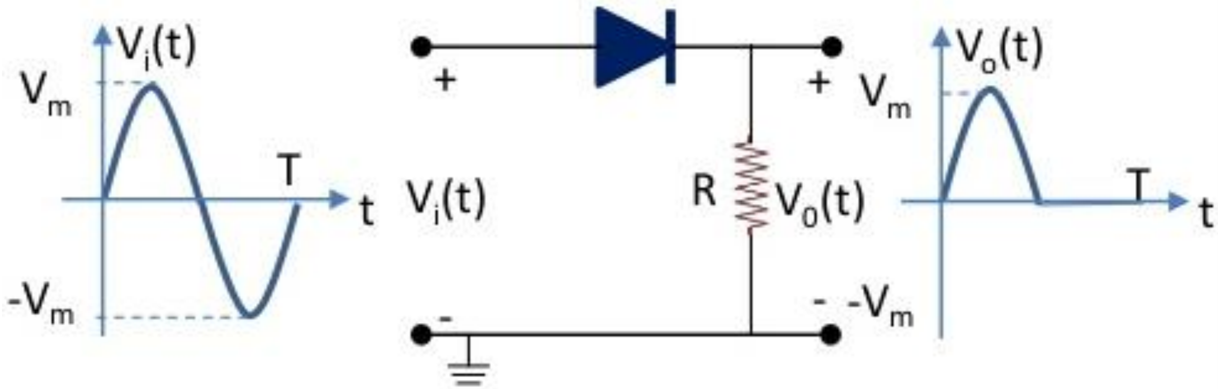


Negative Series Clipper



- Here, during the positive half cycle of input waveform, the diode becomes forward biased, thus ensuring a closed circuit. Due to which current appears across the resistor of the circuit.
- For negative half cycle of the input waveform, the diode now becomes reverse biased acting as an open switch. This causes no current to flow through the circuit. Resultantly providing no output for negative half of the input waveform.

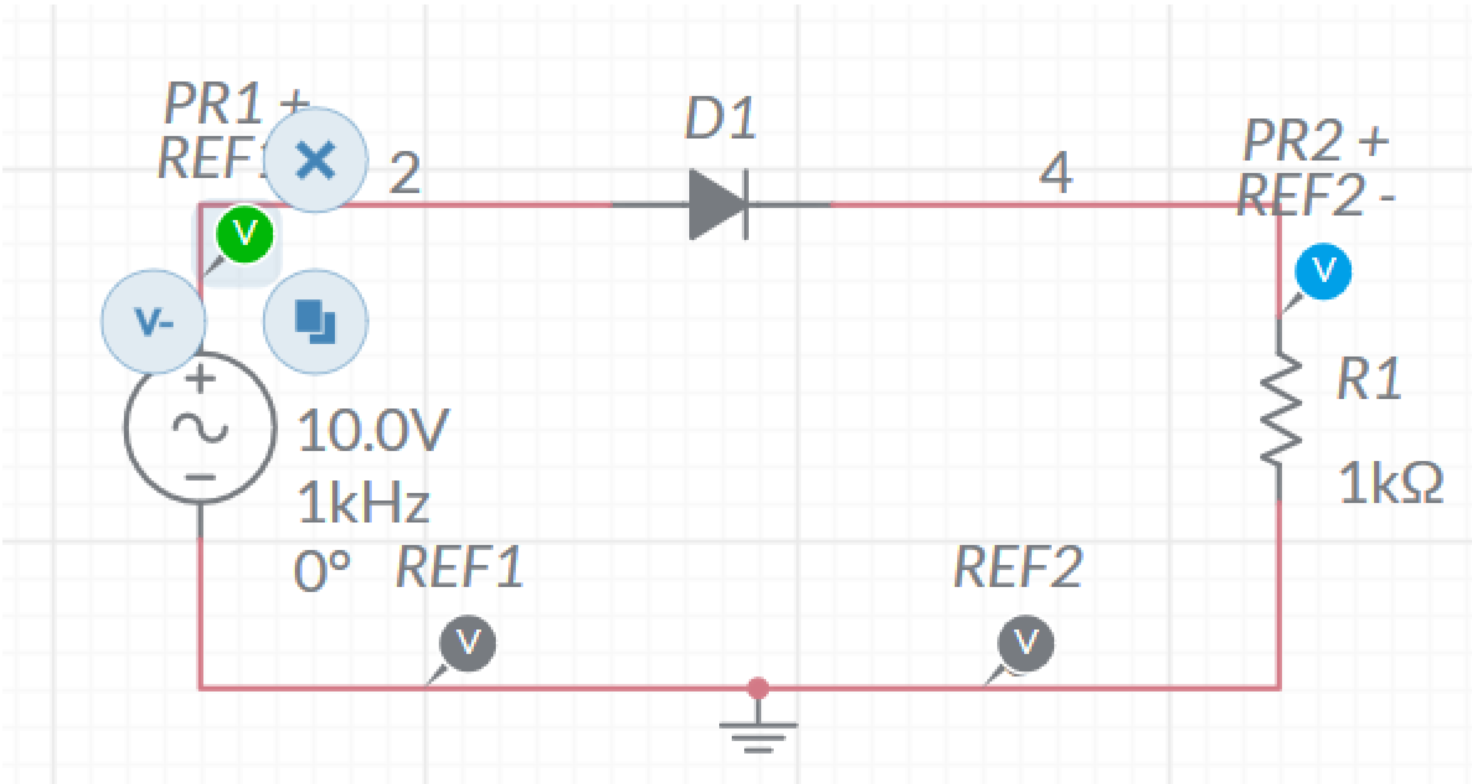
Negative Series Clipper



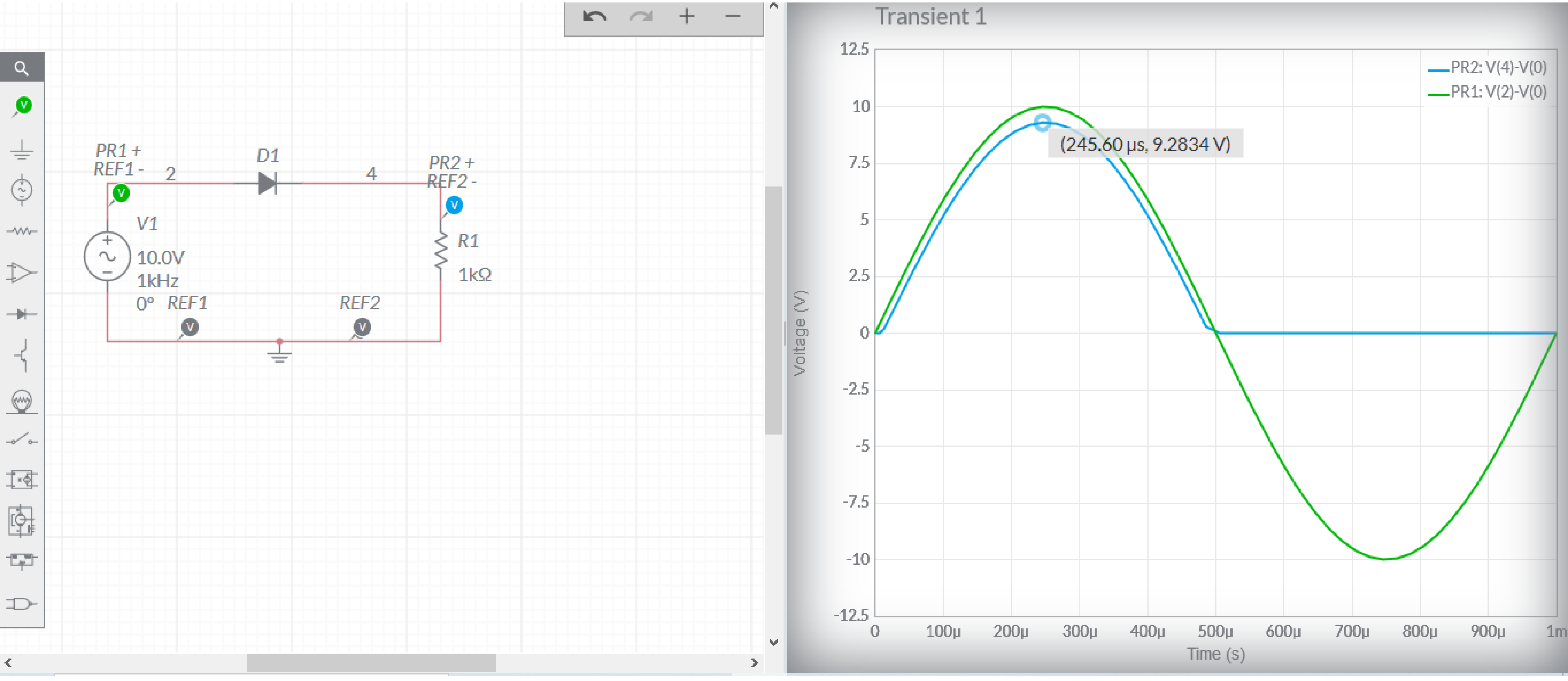
If $V_i(t) \geq 0$, Diode ON, $V_o(t) = V_i(t)$

If $V_i(t) < 0$, Diode OFF, $V_o(t) = 0$

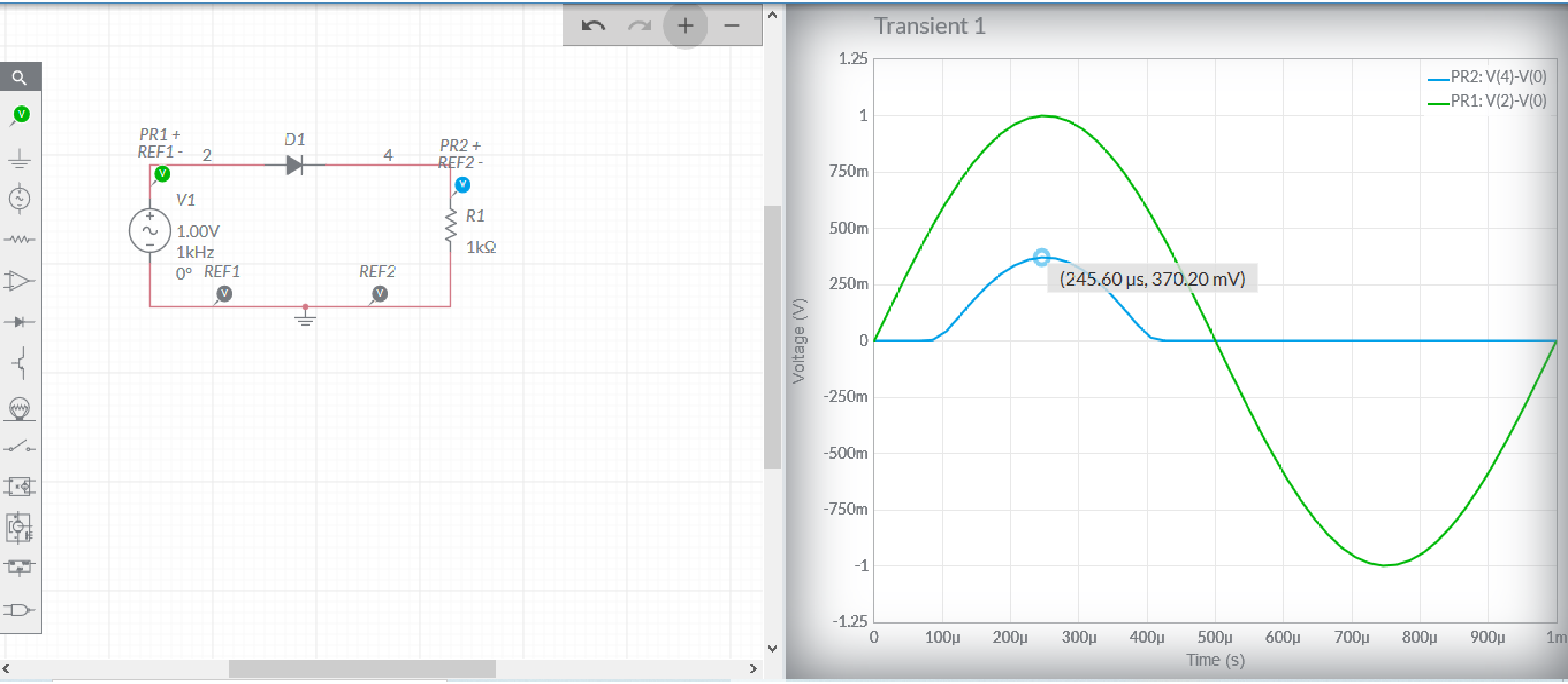
Lets Analyze in Multisim



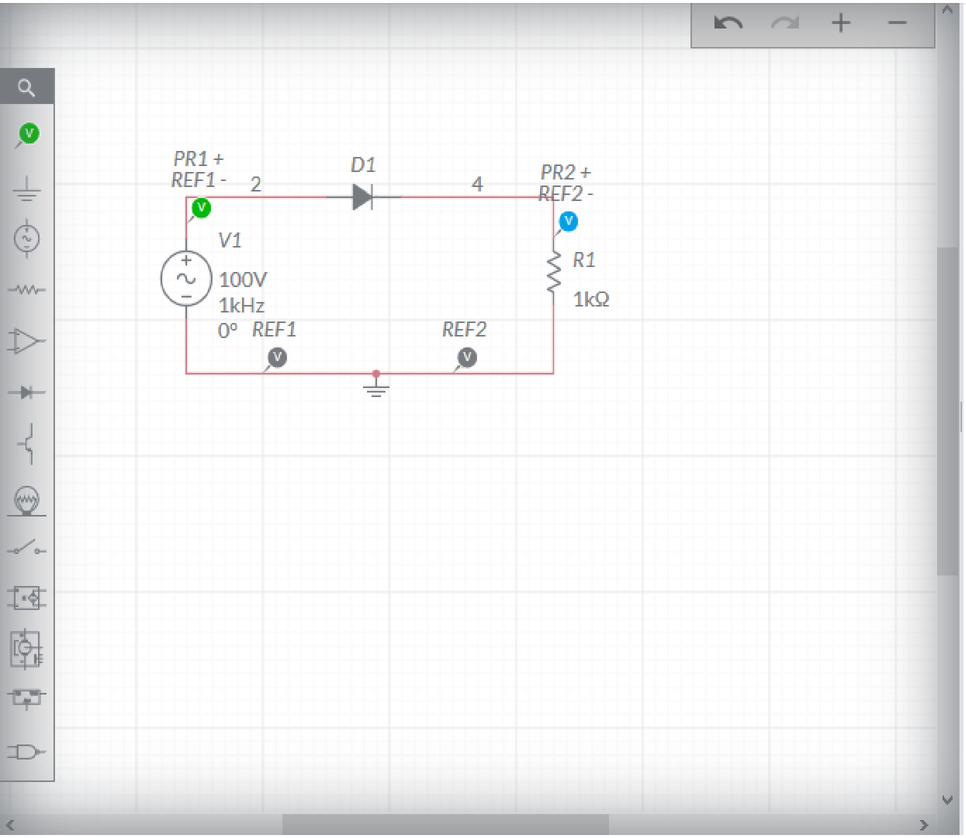
Lets Analyze in Multisim

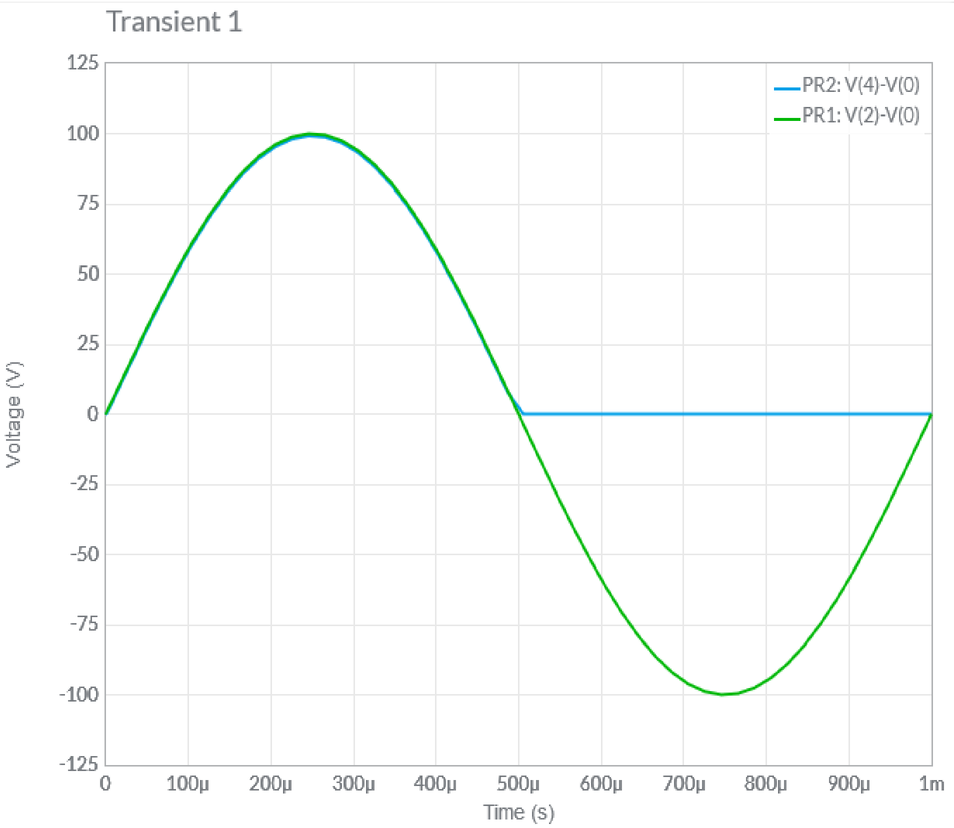


Lets Analyze in Multisim

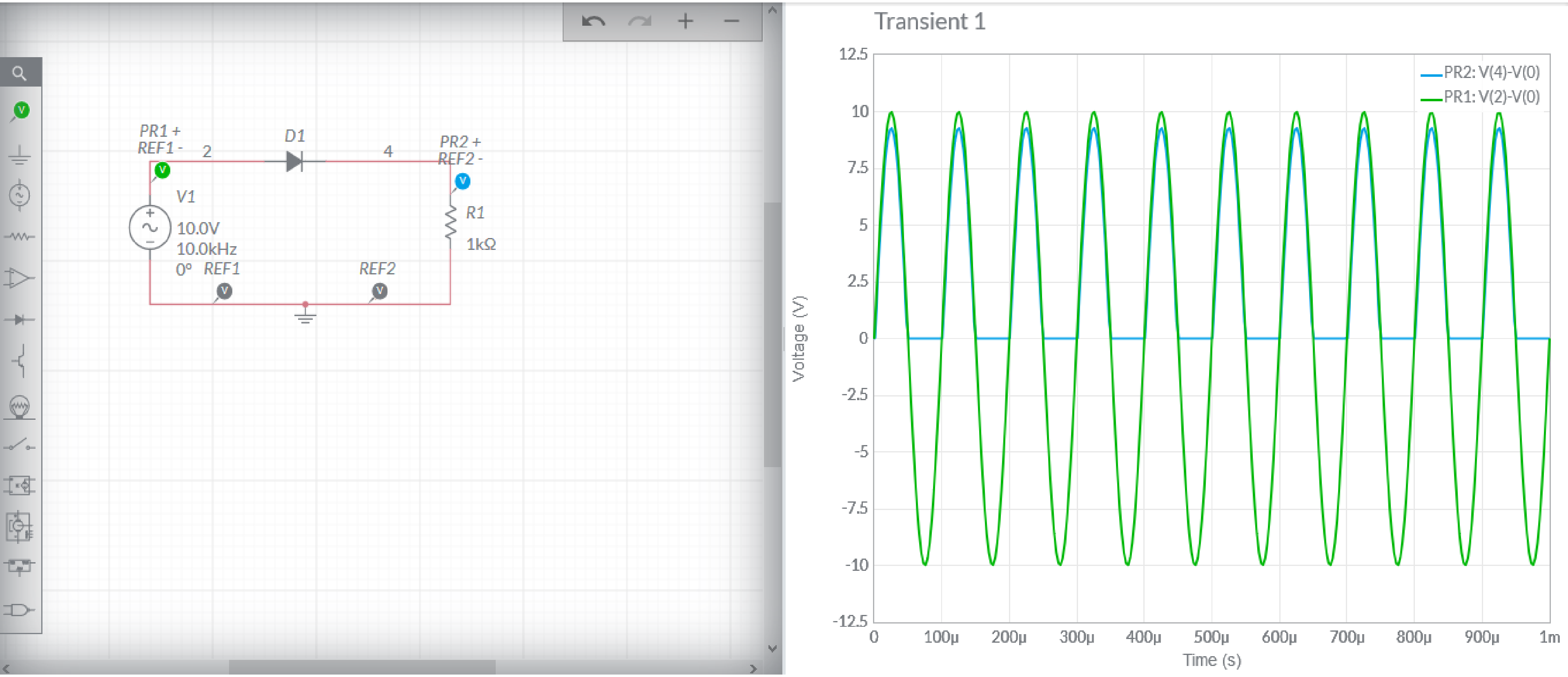


Lets Analyze in Multisim

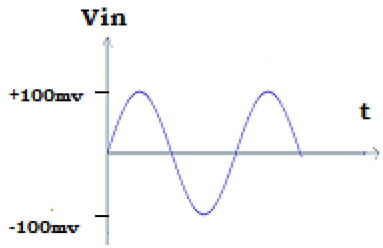


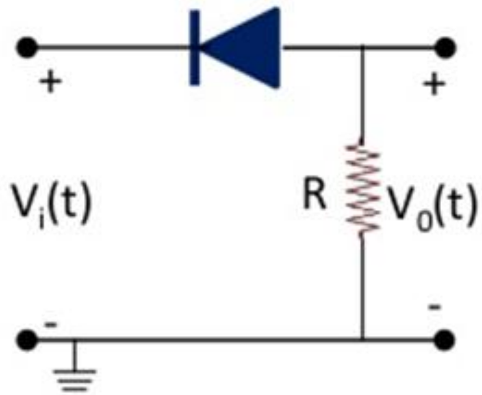


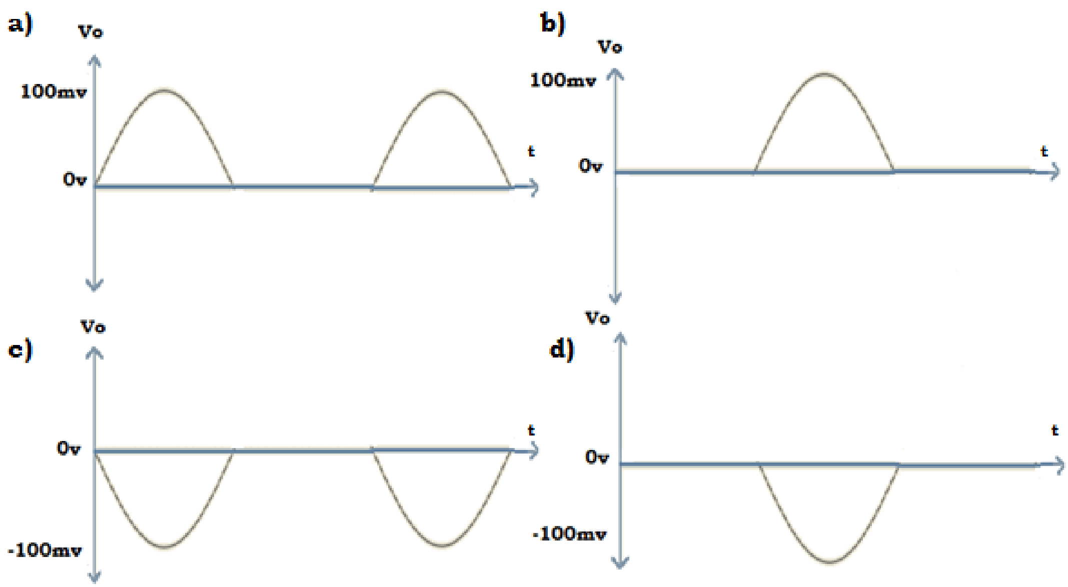
Lets Analyze in Multisim



Identify the output of this circuit

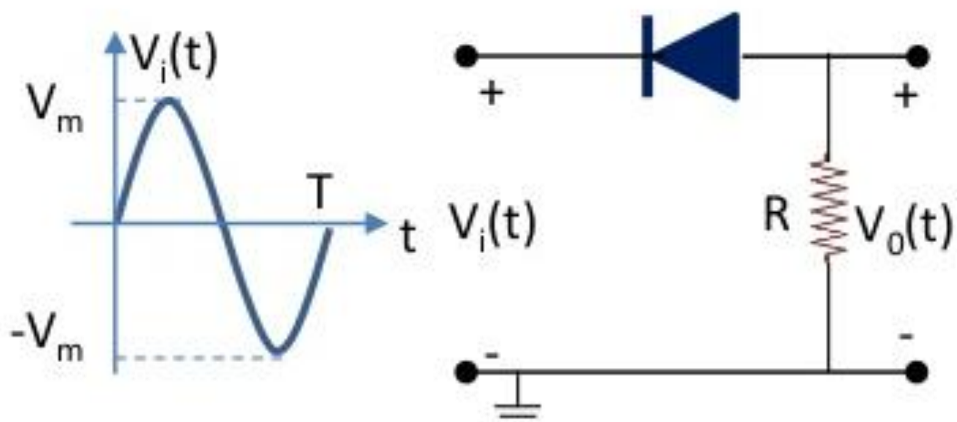




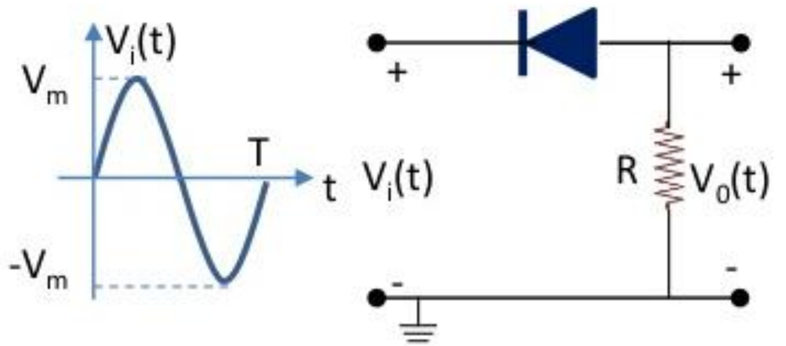


Positive Series Clipper

- From the name of the circuit, we can conclude that :
  - It will eliminate the positive half of the input signal.
  - It is a series clipper, as the Diode is in series with the input source.
- The circuit is shown in given below circuit.

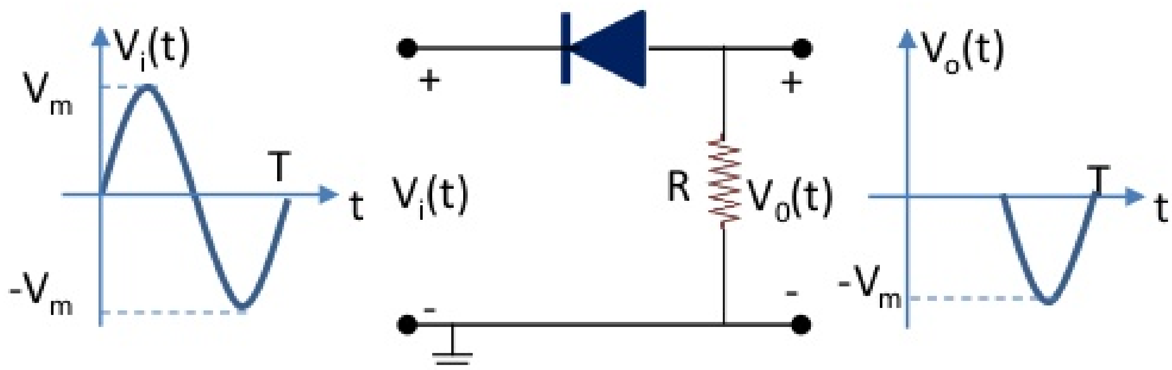


Positive Series Clipper



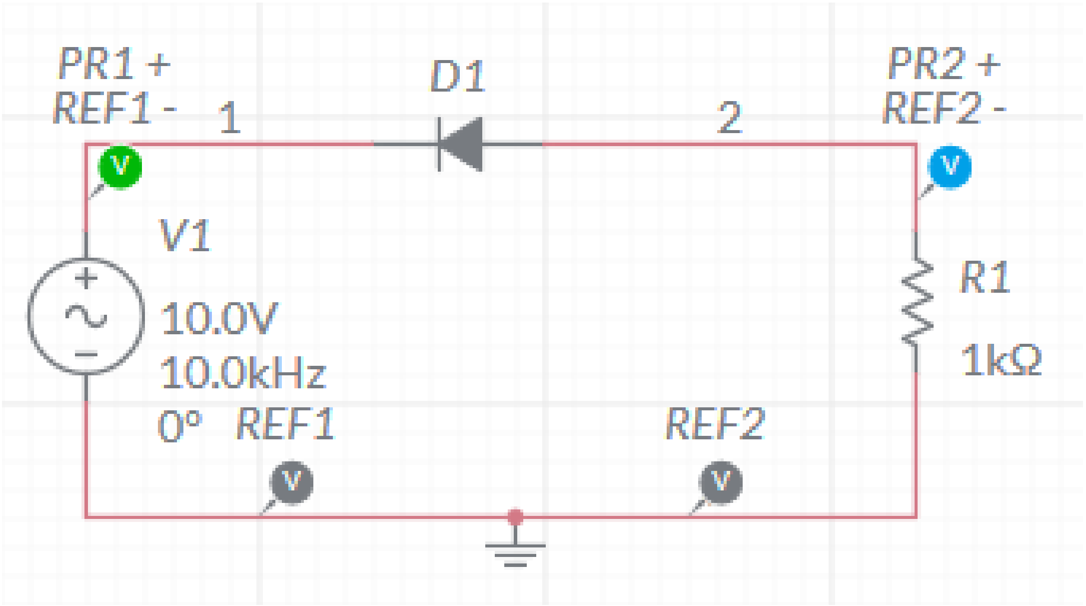
- Here, during the positive half cycle of input waveform, the diode becomes reverse biased, thus acting as closed switch. Therefore, there is no output for positive half of the waveform.
- For negative half cycle of the input waveform, the diode now becomes forward biased, acting as an open switch. This causes current to flow through the circuit. Resultantly output waveform follows the input waveform in negative half-cycle.

Positive Series Clipper

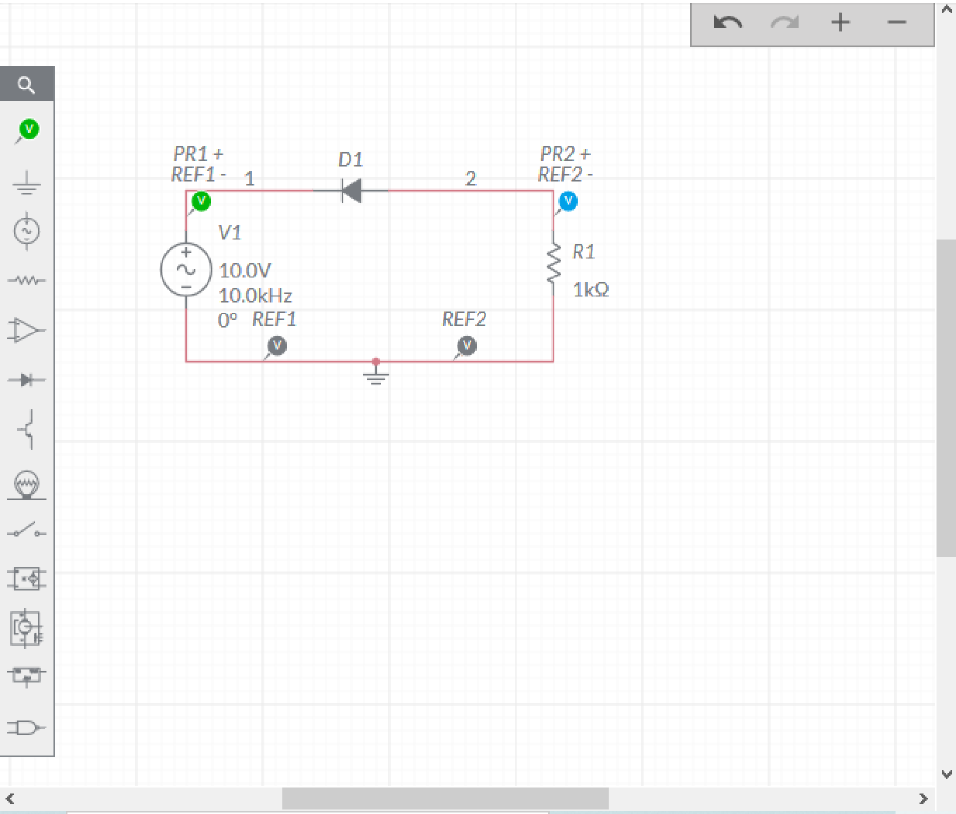


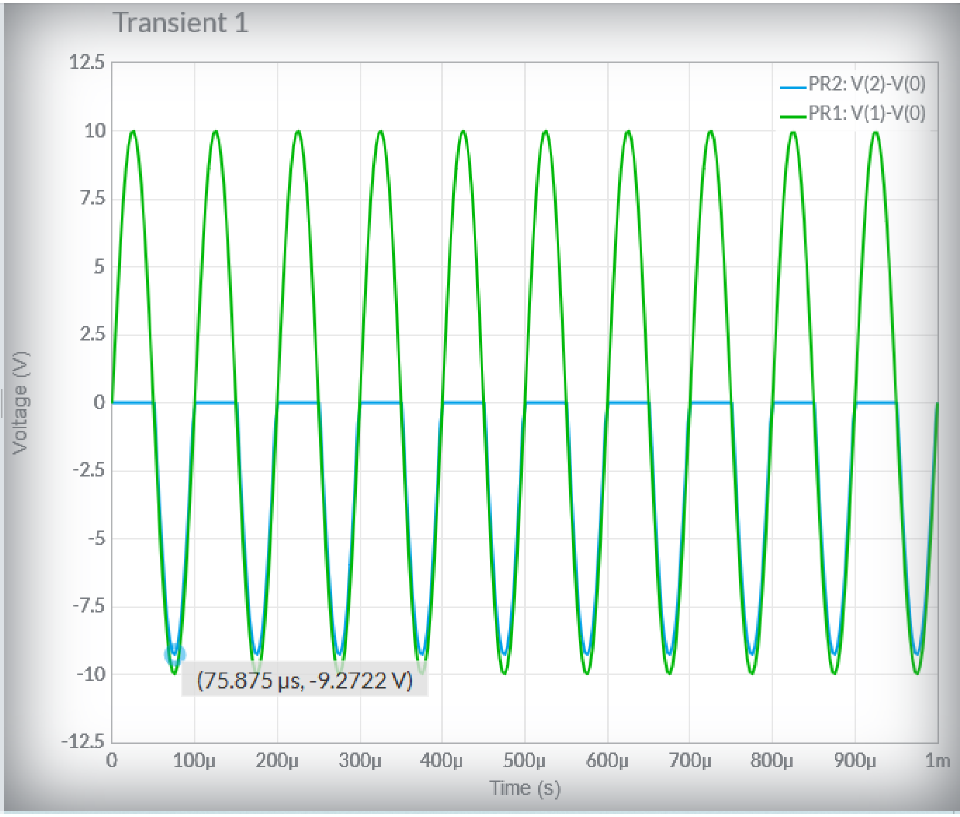
If $V_i(t) > 0$, Diode OFF, $V_o(t) = 0$
If $V_i(t) \leq 0$, Diode ON, $V_o(t) = V_i(t)$

Lets Analyze in Multisim



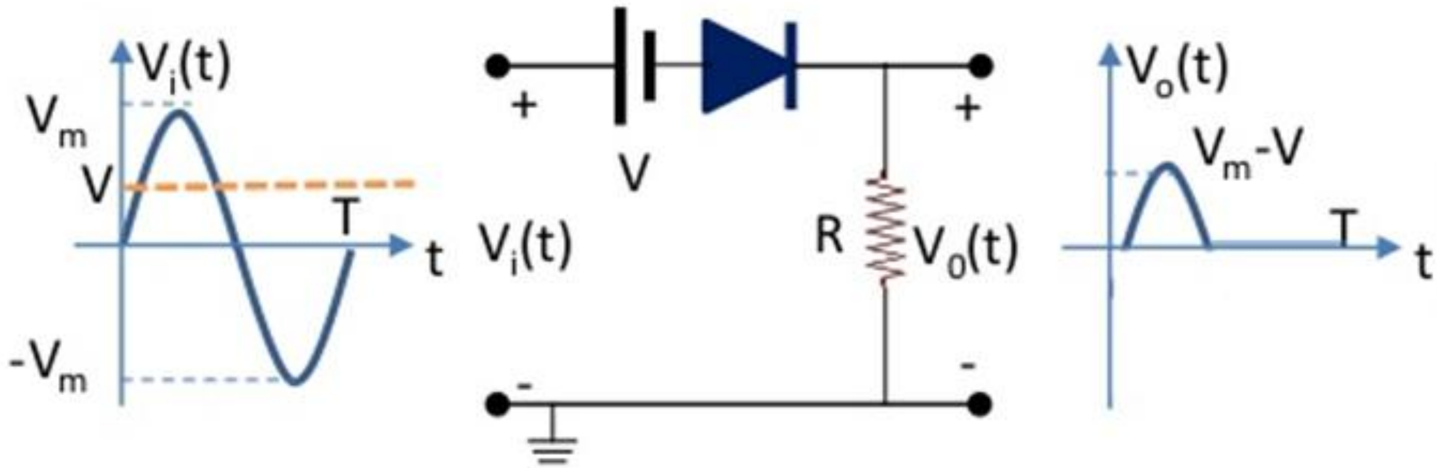
Lets Analyze in Multisim





Lets Analyze few more clipper circuits

- Negative series clipper with bias - I

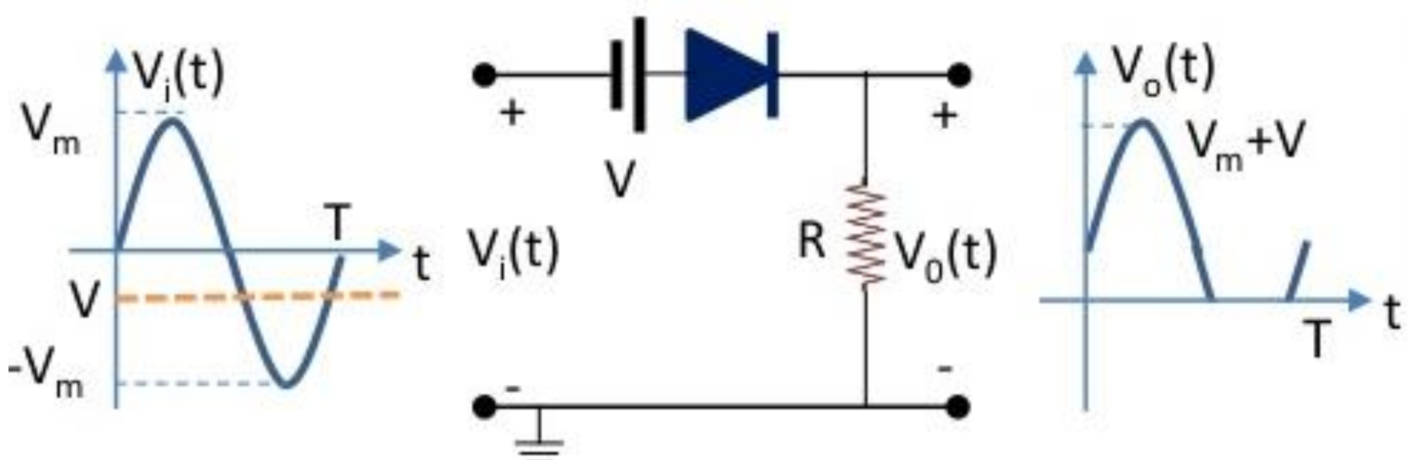


If $V_i(t) - V \geq 0$, Diode ON, $V_o(t) = V_i(t) - V$
If $V_i(t) - V < 0$, Diode OFF, $V_o(t) = 0$

For implementation (in Multisim live) use:
Vin = 10 V, 10 KHz Ac power supply,
V = 1.2 V, R = 1 KOhm

Lets Analyze few more clipper circuits

- Negative series clipper with bias - II



If $V_i(t) + V \geq 0$, Diode ON, $V_o(t) = V_i(t) + V$

If $V_i(t) + V < 0$, Diode OFF, $V_o(t) = 0$

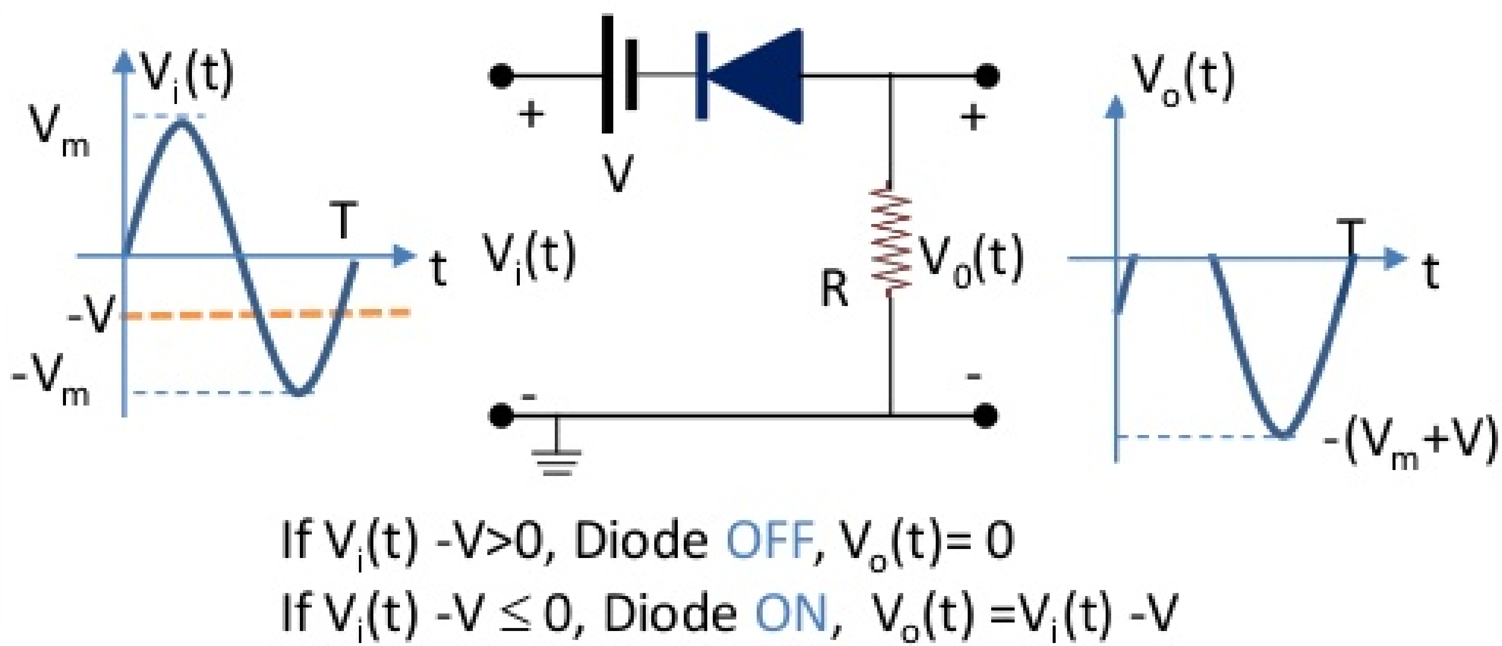
For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V = 1.2 V, R = 1 KOhm

Lets Analyze few more clipper circuits

- Positive series clipper with bias - I



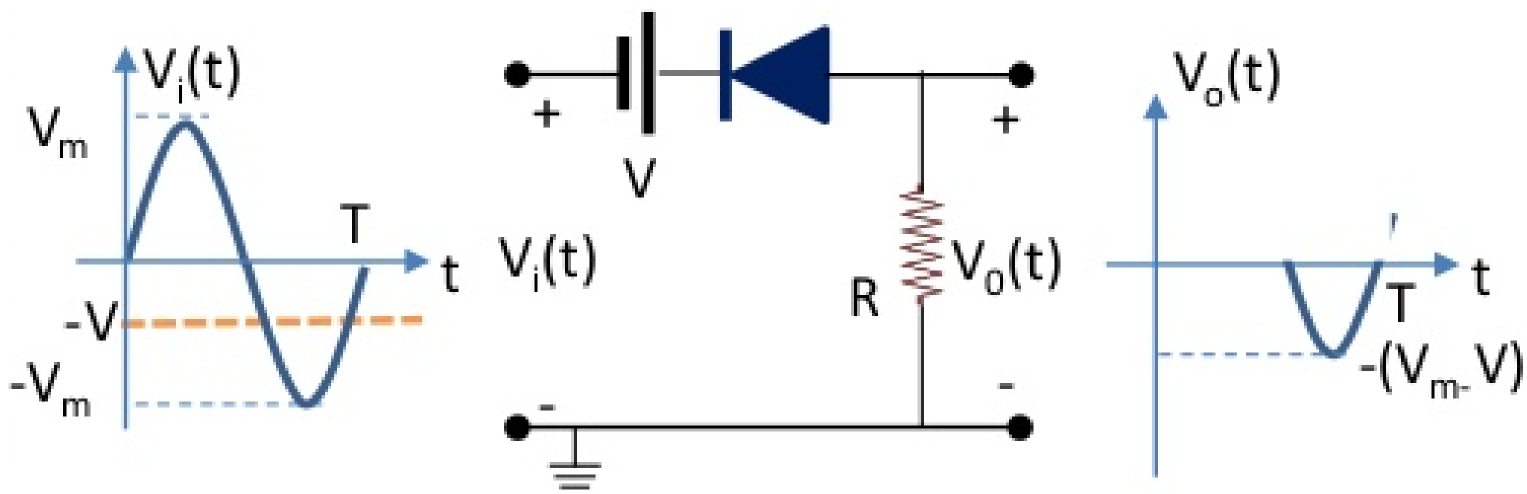
For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V = 1.2 V, R = 1 KOhm

Lets Analyze few more clipper circuits

- Positive series clipper with bias - II



If $V_i(t)+V>0$, Diode OFF, $V_o(t)= 0$

If $V_i(t) +V \leq 0$, Diode ON, $V_o(t) =V_i(t) +V$

For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

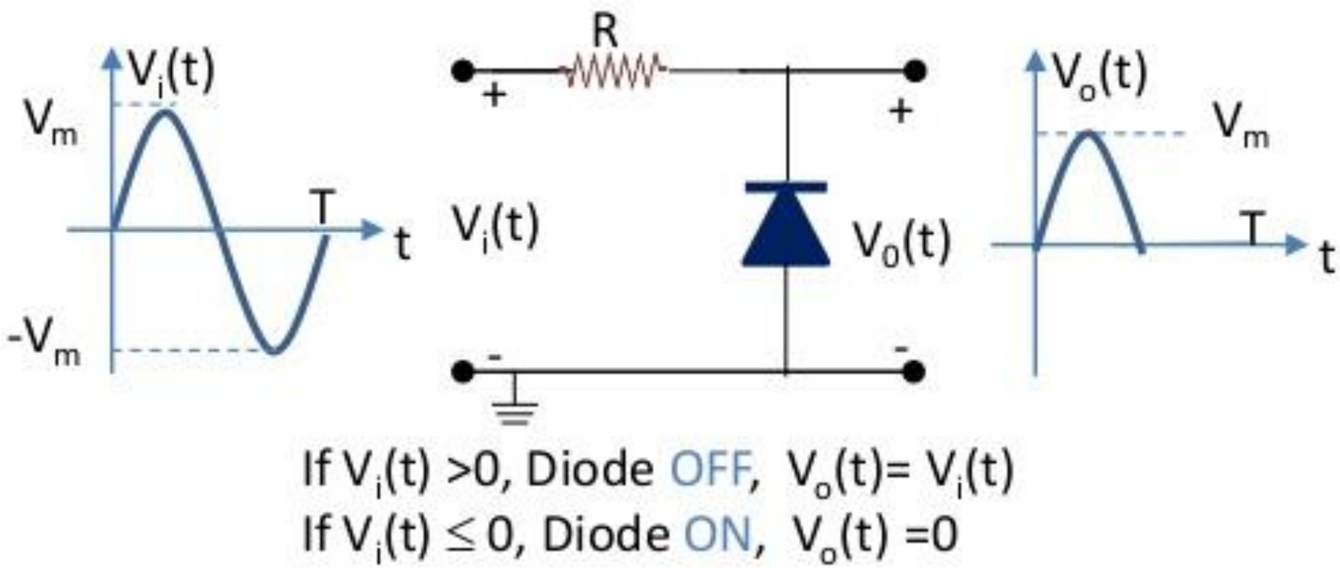
V = 1.2 V, R = 1 KOhm

END OF WEEK 1

- Assignments.

Shunt Clippers

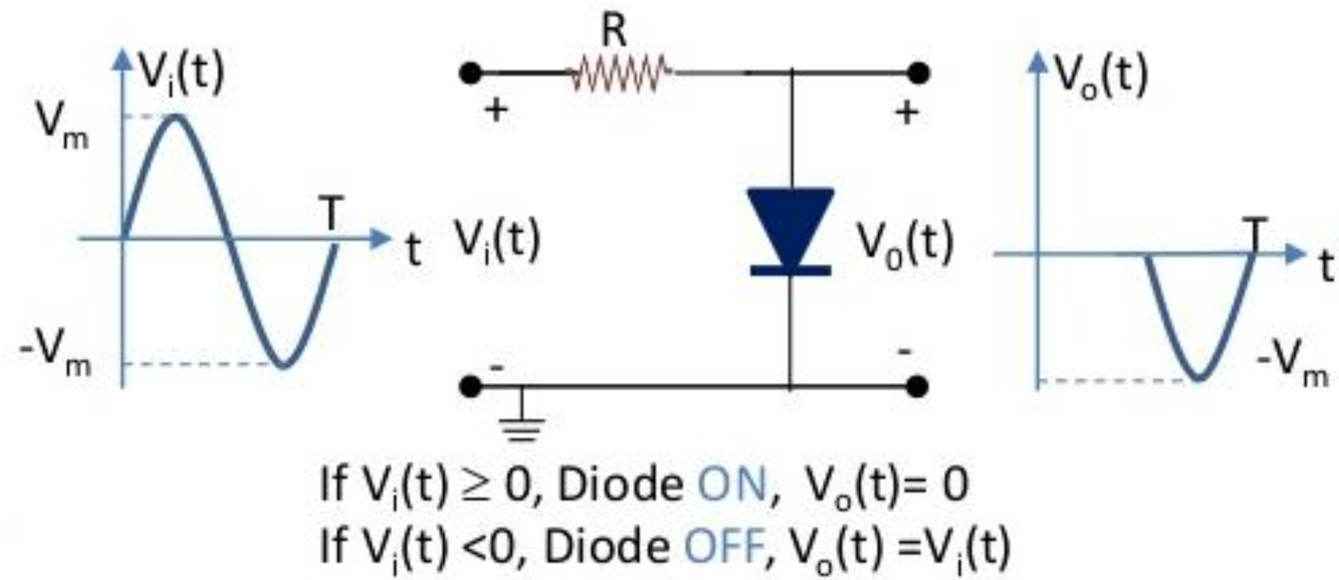
- Shunt Negative Clipper



For implementation (in Multisim live) use:
Vin = 10 V, 10 KHz Ac power supply,
V = 1.2 V, R = 1 KOhm

Shunt Clippers

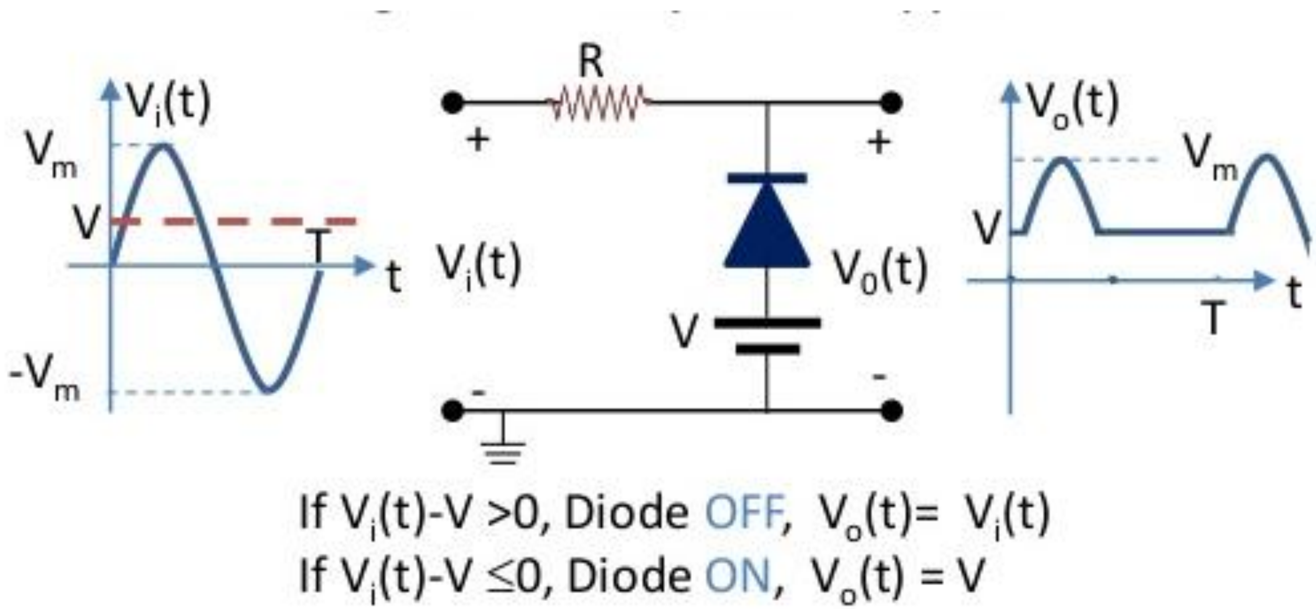
- Shunt Positive Clipper



For implementation (in Multisim live) use:
Vin = 10 V, 10 KHz Ac power supply,
V = 1.2 V, R = 1 KOhm

Shunt Clippers

- Shunt Negative Clipper with Bias- I



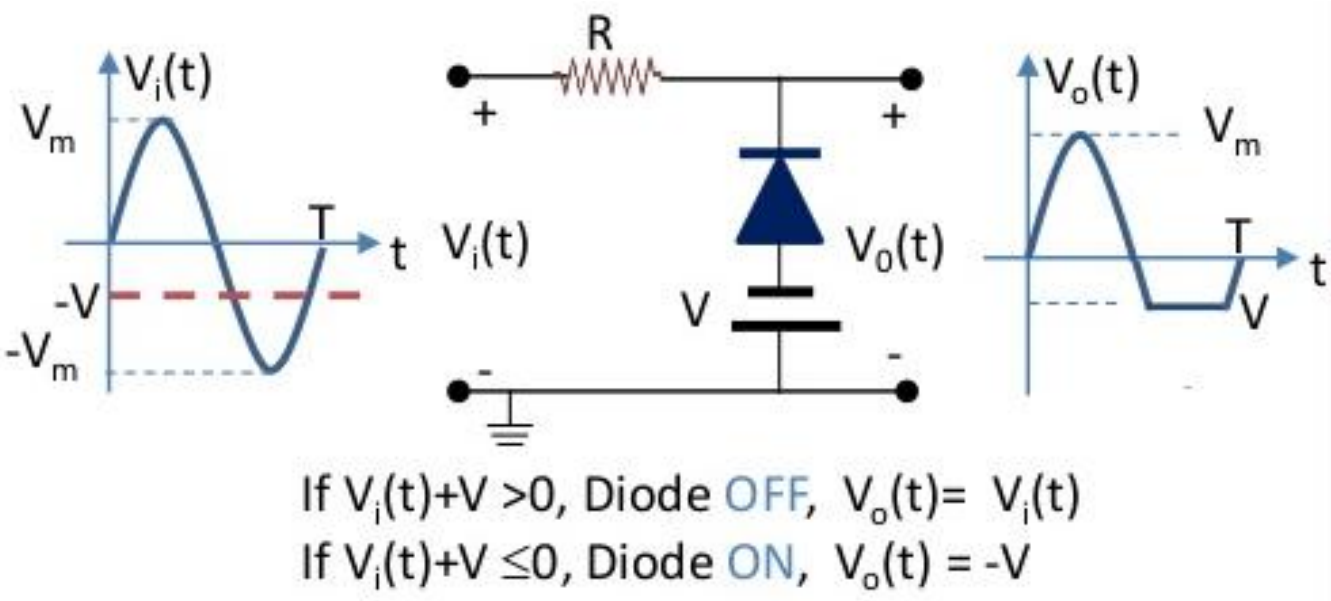
For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V = 1.2 V, R = 1 KOhm

Shunt Clippers

- Shunt Negative Clipper with Bias- II



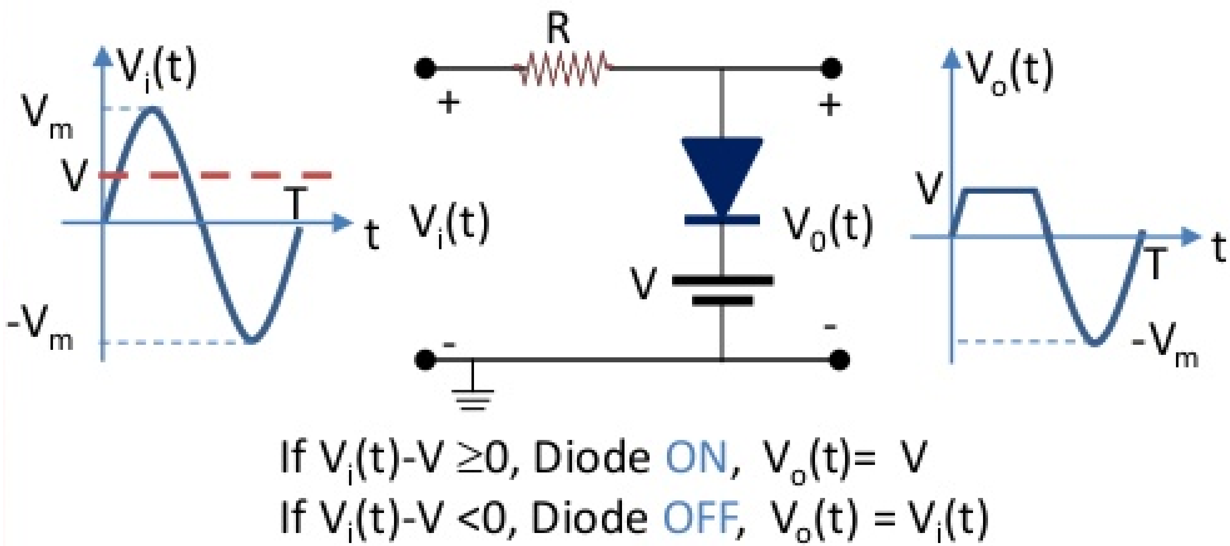
For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V = 1.2 V, R = 1 KOhm

Shunt Clippers

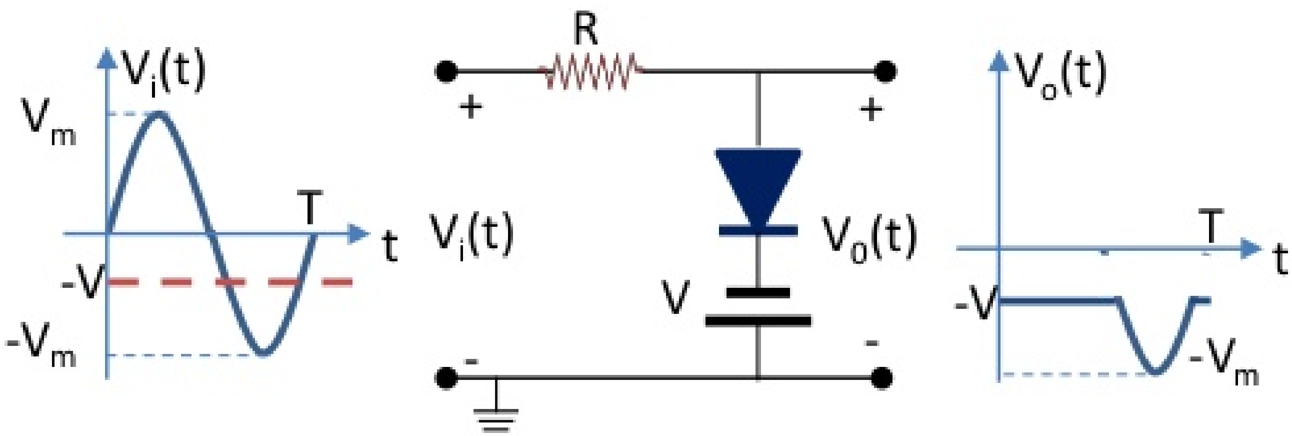
- Shunt Positive Clipper with Bias- I



For implementation (in Multisim live) use:
Vin = 10 V, 10 KHz Ac power supply,
V = 1.2 V, R = 1 KOhm

Shunt Clippers

- Shunt Positive Clipper with Bias- II



If $V_i(t)+V \geq 0$, Diode ON, $V_o(t)= -V$

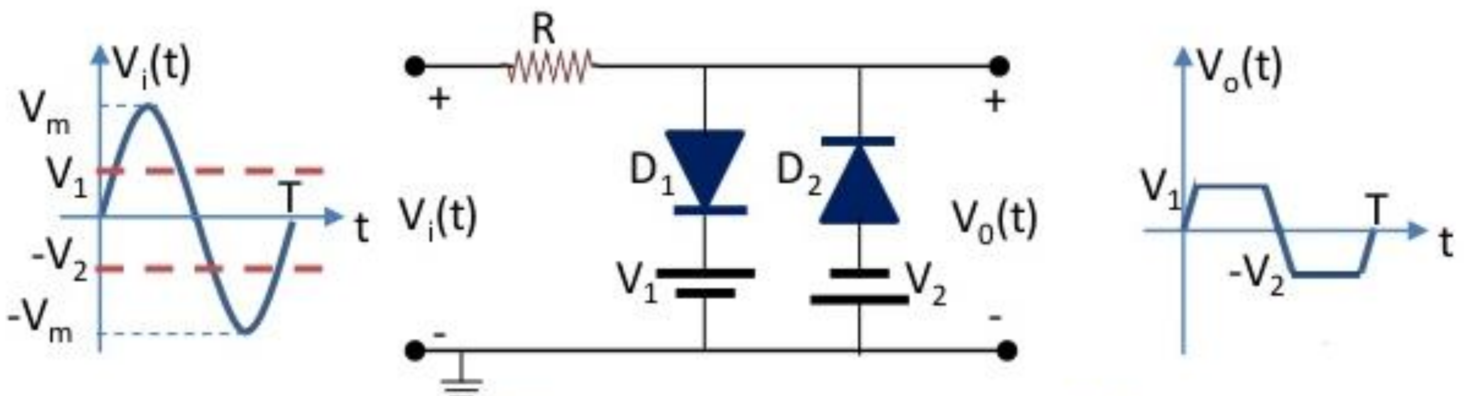
If $V_i(t)+V < 0$, Diode OFF, $V_o(t) = V_i(t)$

For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V = 1.2 V, R = 1 KOhm

Dual Clipper



If $V_i(t)- V_1 \geq 0$, Diode D_1 ON, & $V_i(t)+ V_2 >0$, Diode D_2 OFF, $V_o(t)= V_1$

If $V_i(t)- V_1 <0$, Diode D_1 OFF, & $V_i(t)+ V_2 >0$, Diode D_2 OFF, $V_o(t)= V_i(t)$

If $V_i(t)- V_1 <0$, Diode D_1 OFF, & $V_i(t)+ V_2 \leq 0$, Diode D_2 ON, $V_o(t)= -V_2$

For implementation (in Multisim live) use:

Vin = 10 V, 10 KHz Ac power supply,

V1 = 1.2 V, V2 = 0.5 V R = 1 KOhm