CLIPPER

ELA 1110

Clipper

- Clippers are networks that employ diodes to “clip” away a portion of an input signal without distorting the remaining part of the applied waveform.
- The half-wave rectifier is an example of the simplest form of diode clipper having one resistor and a diode.
- Depending on the orientation of the diode, the positive or negative region of the applied signal is “clipped” off.
- Two general categories
  - Series Clipper (Diode is in series with the load)
  - Parallel Clipper(Diode in a branch parallel to the load)

Series Clipper

- The series configuration is defined as one where the diode is in series with the load.
- Fig.1(a) shows the circuit of series clippers.
- The response of the series configuration of Fig. 1(a) to a variety of alternating waveforms is shown in Fig. 1(b).
- There are no boundaries on the type of signals that can be applied to a clipper.

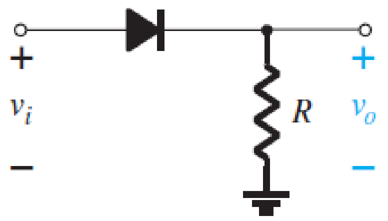


Fig.1(a) Series Clipper

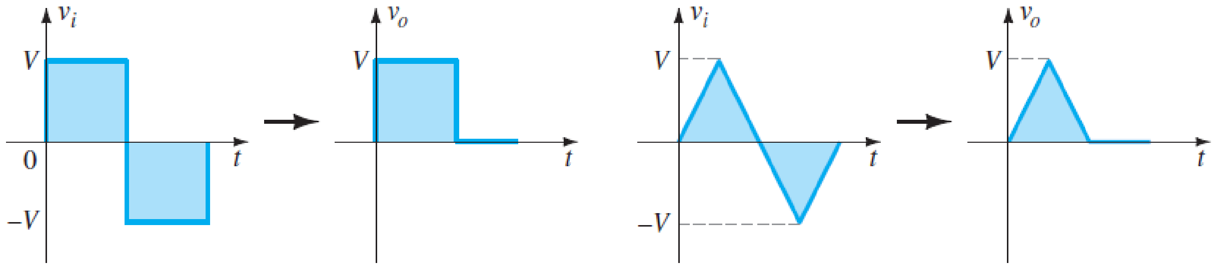


Fig.1(b): Input-output Waveforms

- Fig.2 shows the series clipper with DC supply.
- The following procedure is used to analyze the circuit shown in fig.2
  - Take careful note of where the output voltage is defined.(In fig. 2,it is directly across the resistor *R*).
  - Develop an overall sense of the response by simply noting the “pressure” established by each supply and the effect it will have on the conventional current direction through the diode.
  - Determine the applied voltage (transition voltage) that will result in a change of state for the diode from the “off” to the “on” state.
  - Draw the output waveform directly below the applied voltage using the same scales for the horizontal axis and the vertical axis.

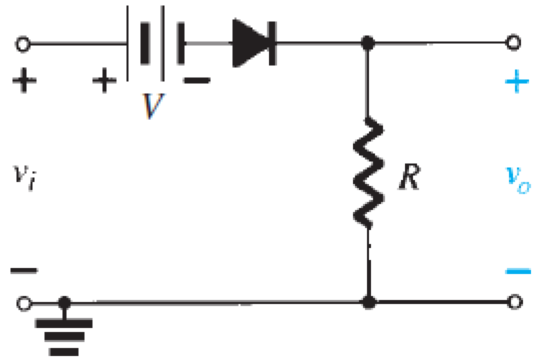


Fig.2: Series clipper with DC supply

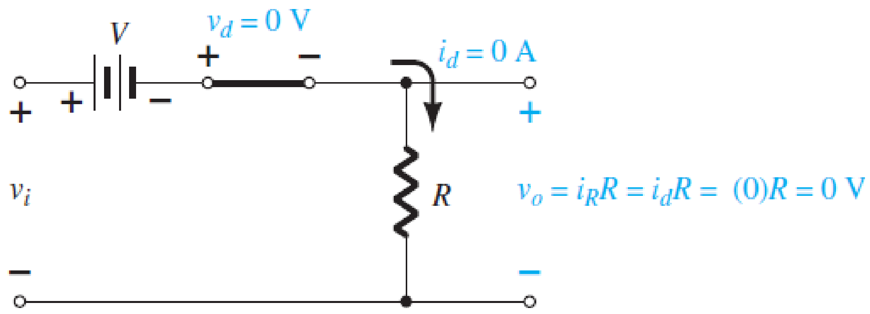


Fig.3:Determining the Transition Voltage

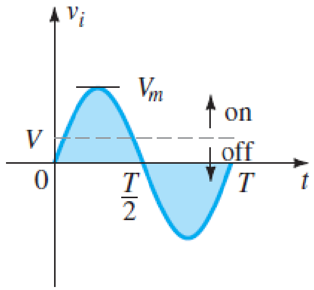


Fig.4:Define the “on” and “off” regions.

EXAMPLE 1: Determine the output waveform for the sinusoidal input of Fig. 5.

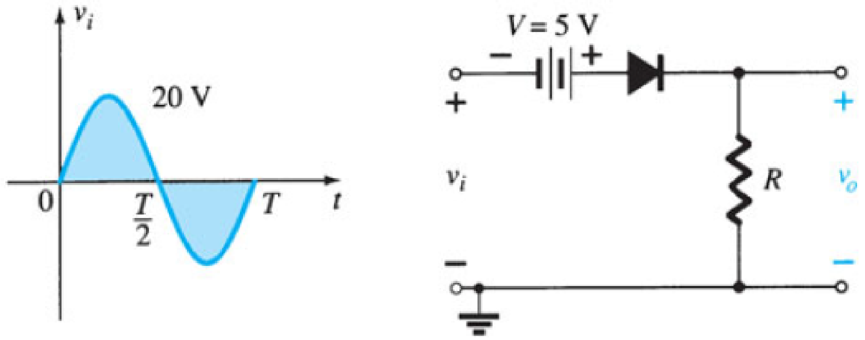


Fig.5

Solution:

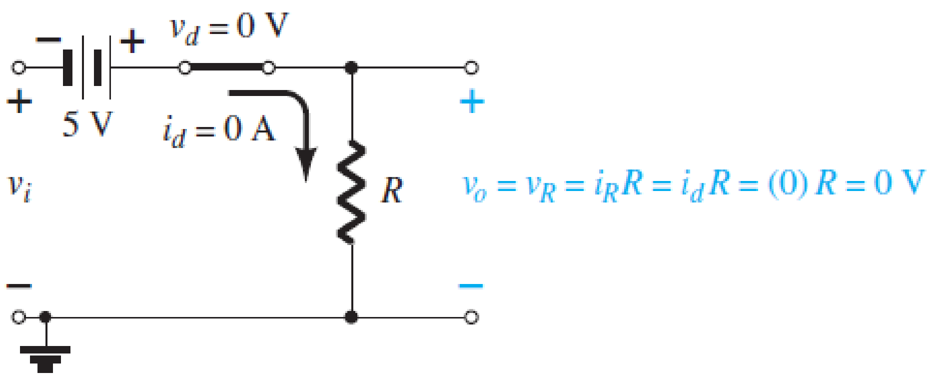
Step 1: The output is again directly across the resistor *R*.

Step 2: The positive region of v_i and the dc supply are both applying "pressure" to turn the diode on. The result is that we can safely assume the diode is in the "on" state for the entire range of positive voltages for v_i.

Once the supply goes negative, it would have to exceed the dc supply voltage of 5 V before it could turn the diode off.

Step 3: The transition model is substituted in Fig. 2.75 , and we find that the transition from one state to the other will occur when

$$v_i + 5\text{ V} = 0\text{ V}$$
$$v_i = -5\text{ V}$$



Step 4:

- In Fig.6 a horizontal line is drawn through the applied voltage at the transition

level.

- For voltages less than 5 V the diode is in the open-circuit state and the output is 0V, as shown in the sketch of v_o.
- Using Fig. 6 , we find that for conditions when the diode

is on and the diode current is established the output voltage will be the following, as determined using Kirchhoff's voltage law:

$$v_o = v_i + 5\text{ V}$$

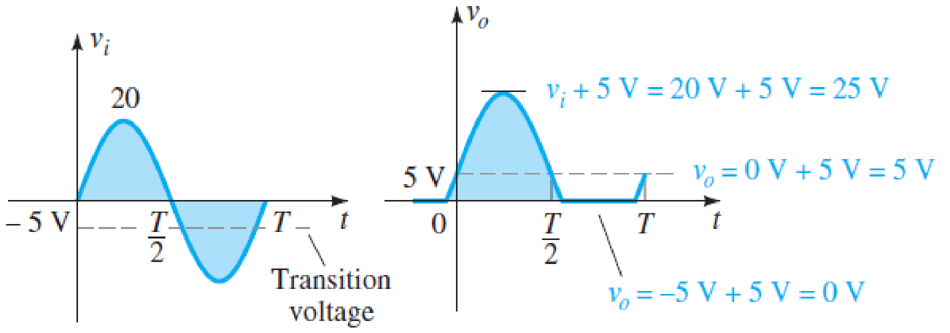


Fig.6 Output Waveform

Parallel Clipper

- Diode is connected in parallel with the load.
- The analysis of parallel configurations is very similar to that of series configurations.
- The simplest parallel clipper is shown in fig.7.

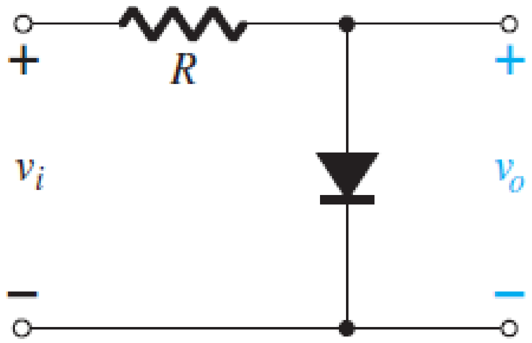


Fig. 7: Parallel Clipper

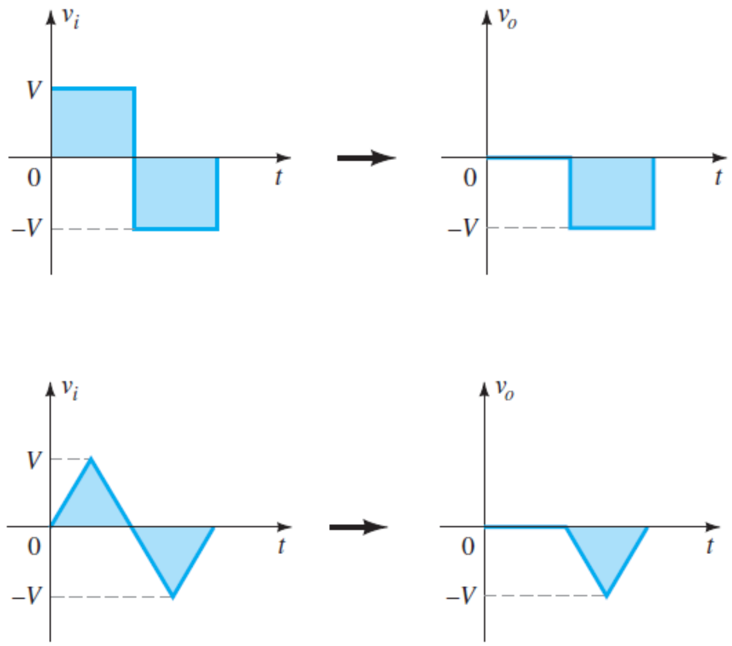


Fig. 8:Response to a parallel clipper.

EXAMPLE 2: Determine v_o for the network of Fig.9.

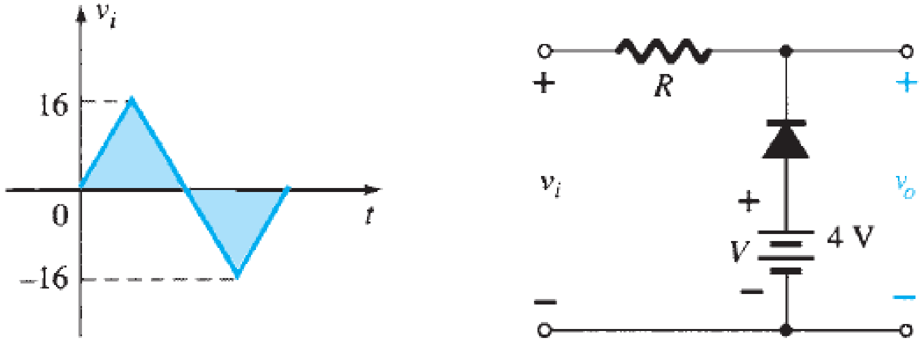


Fig. 9

Solution:

Step 1: In this example the output is defined across the series combination of the 4-V supply and the diode, not across the resistor *R*.

Step 2: The polarity of the dc supply and the direction of the diode strongly suggest that the diode will be in the "on" state for a good portion of the negative region of the input signal.

$V_o = Vi$ *(Diode "off")*

$V_o = 4V$ *(Diode "On")*

Step 3: The transition level of the input voltage can be found from Fig.9 by substituting the short-circuit equivalent and remembering the diode current is 0 mA at the instant of transition.
The result is a change in state when

$$V_i = 4\text{ V}$$

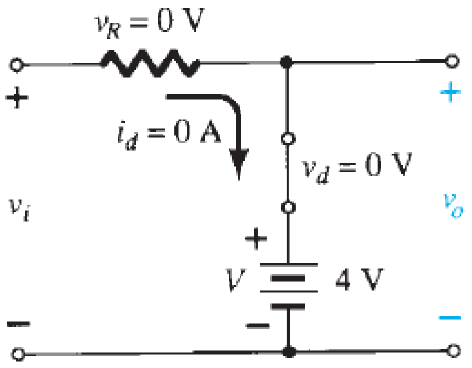


Fig. 9

Step 4: In Fig. 10, the transition level is drawn along with $V_o = 4$ V when the diode is on.

$$\text{For } V_i \geq 4\text{ V},\ V_o = 4\text{ V}$$

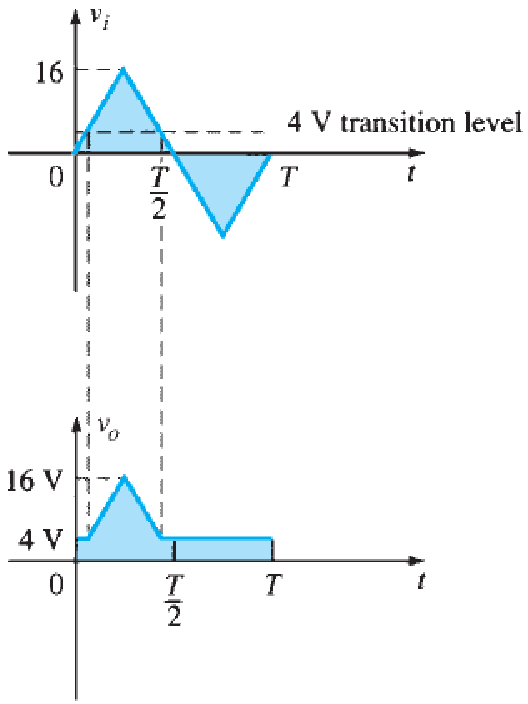
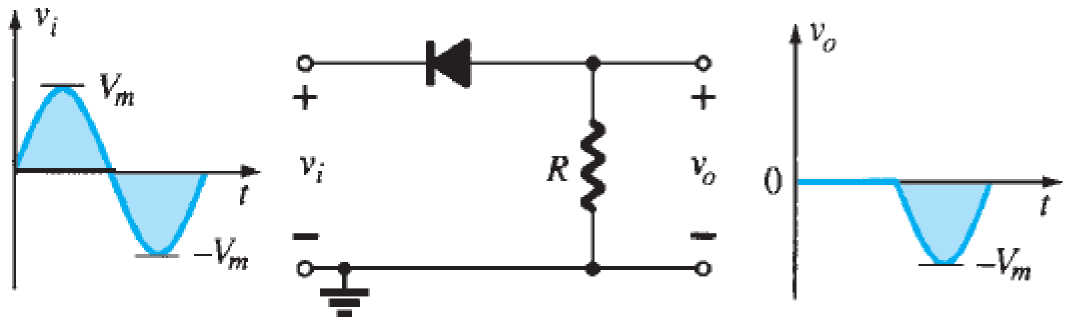


Fig. 10 Output Sketch

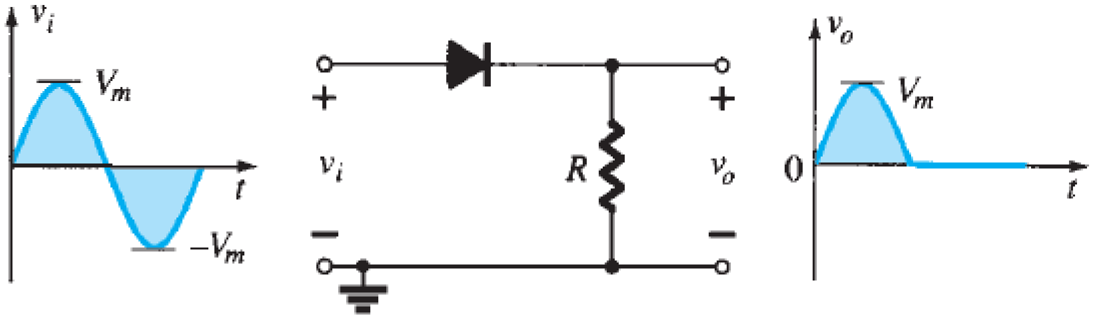
EXAMPLE 3: Repeat Example 2, using a silicon diode with $V_K = 0.7$ V.

Simple Series Clipper(Ideal Diodes)

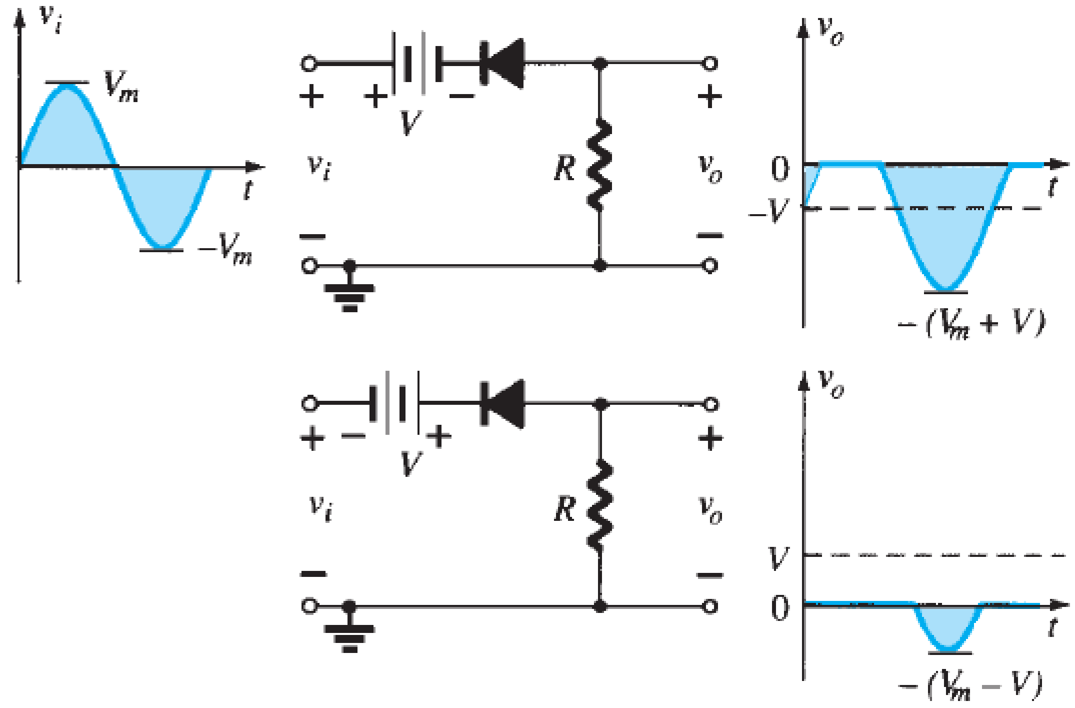


POSITIVE

NEGATIVE

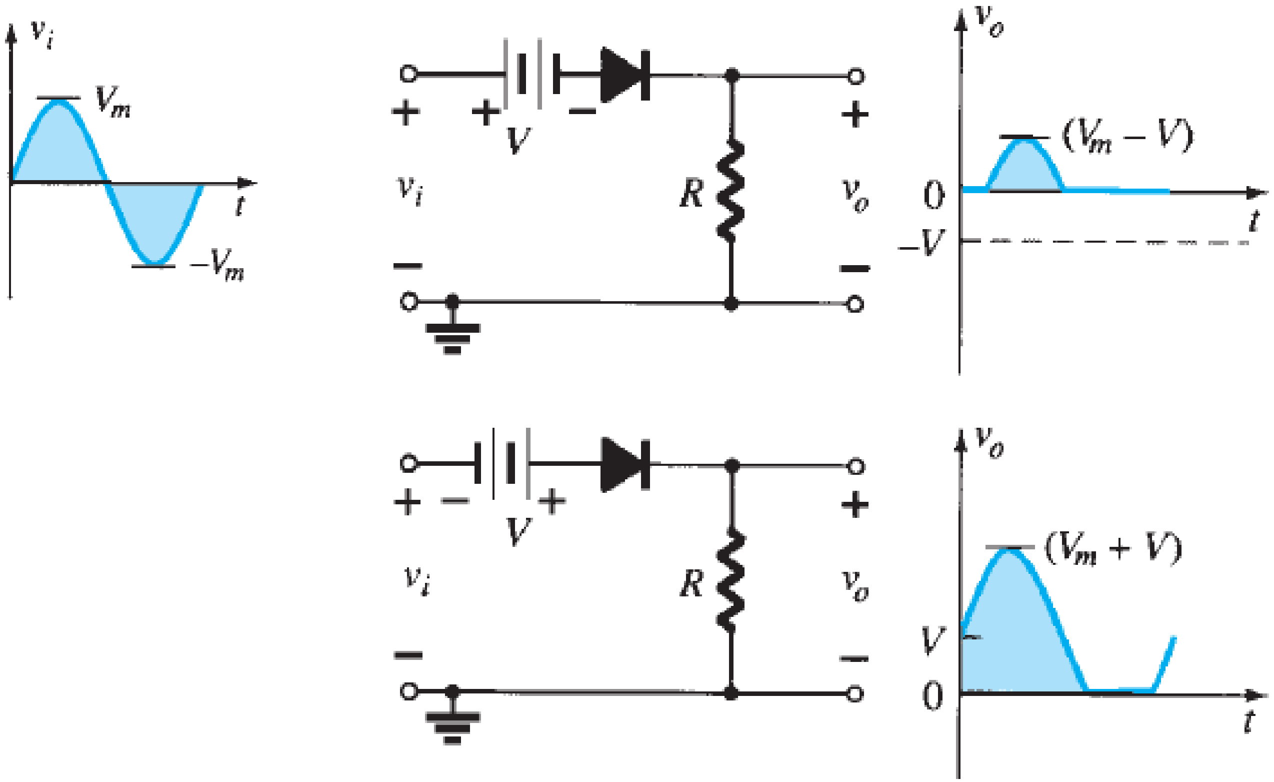


Biased Series Clipper(Ideal Diodes)



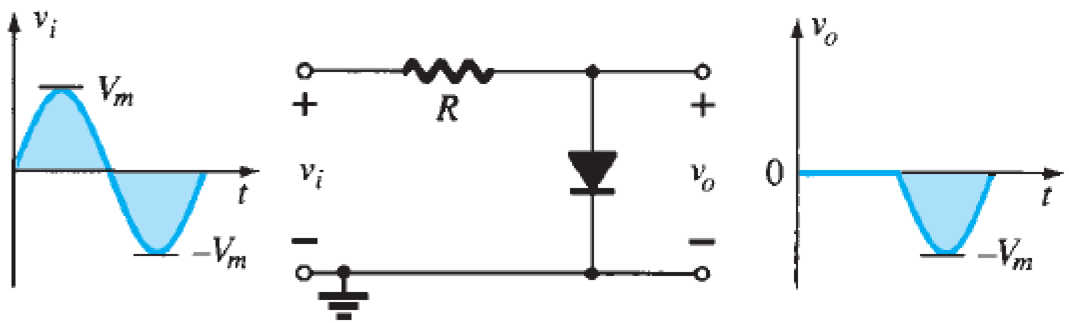
POSITIVE

Biased Series Clipper(Ideal Diodes)



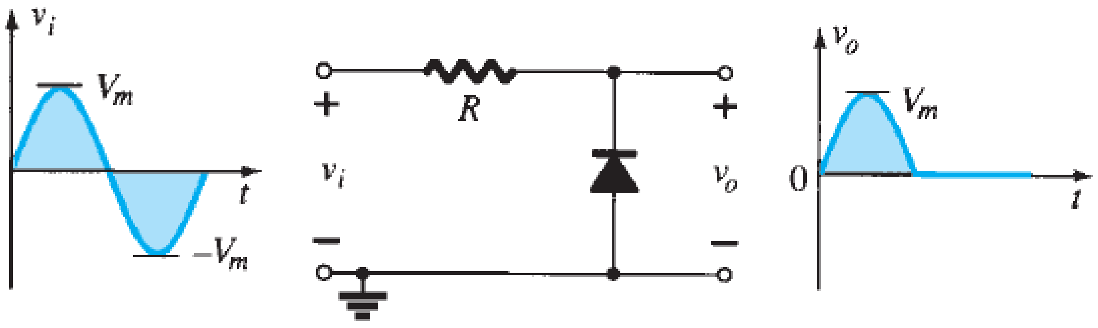
NEGATIVE

Simple Parallel Clippers(Ideal Diodes)



POSITIVE

NEGATIVE



Biased Parallel Clipper