

Clippers

**Semiconductor Devices and Circuits
(ECE 181302)**

30th November 2021

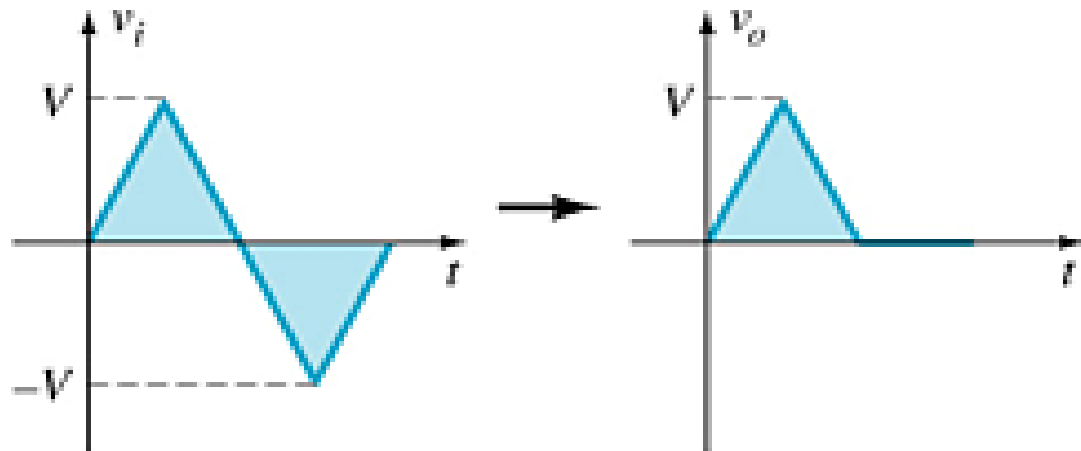
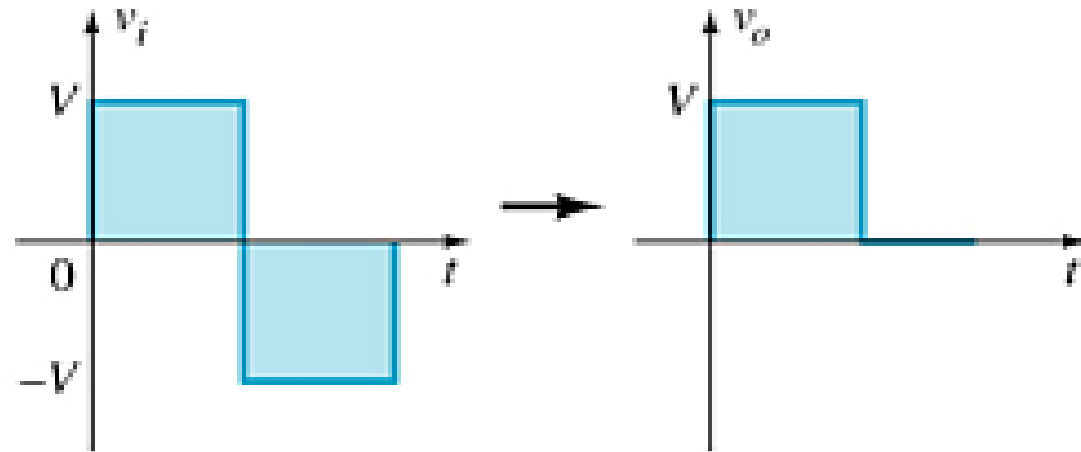
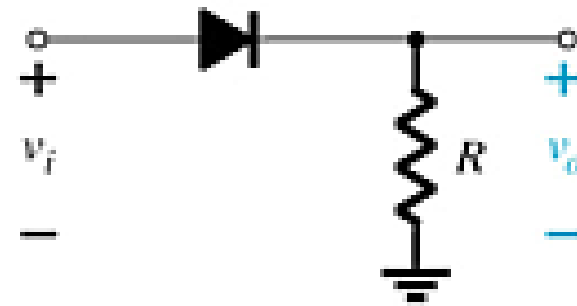
Clippers

- Also known as limiters, amplitude selectors, or slicers.
- Used to remove the part of a signal that is above or below some defined reference level.
- Controls the shape of the output waveform by removing or clipping a portion of the applied wave.
- E.g. the half-wave rectifier – that circuit basically cut off everything at the reference level of zero and let only the positive-going (or negative-going) portion of the input waveform through.
- Applications:
 - In radio, radars, digital computers and other electronic systems.
 - Generation for different waveforms such as trapezoidal, or square waves.
 - Helps in processing the picture signals in television transmitters.

Diode Clippers

The diode in a **series clipper** “clips” any voltage that does not forward bias it:

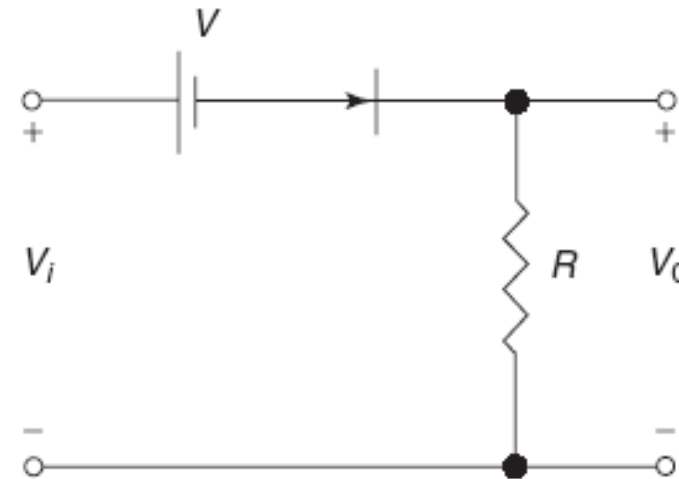
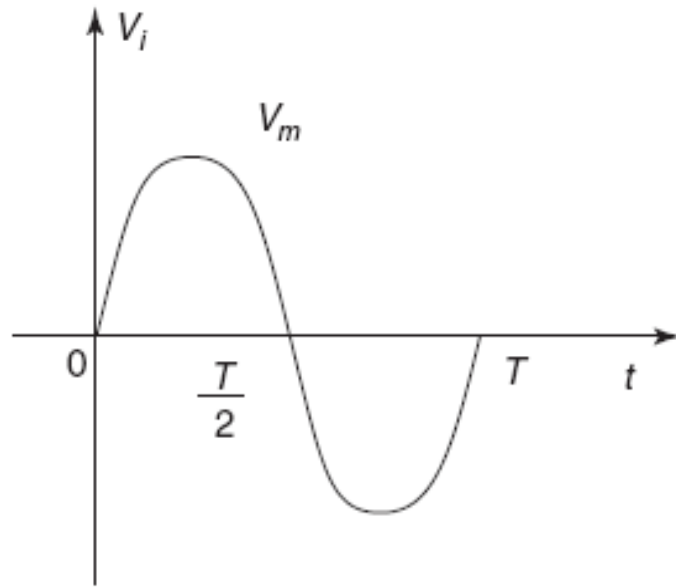
- A reverse-biasing polarity
- A forward-biasing polarity less than 0.7 V (for a silicon diode)



Key Points:

- Make a mental sketch of the response of the network based on the direction of the diode and the applied voltage levels.
- Determine the applied voltage (transition voltage) that will cause a change in state for the diode.
- $v_D = 0 \text{ V}$ (SC) and $i_D = 0 \text{ A}$ (OC).
- Determine the level of input voltage that will cause the transition either to SC or OC state of the diode.
- Be continually aware of the defined terminals and polarity of output voltage.
- Sketch the input signal above the output and determine the output at instantaneous values of the input.

1. The first step is to find out in which interval of the input signal the diode is in forward-bias.
2. The direction of the diode suggests that the signal V_i must be positive to turn it on.
3. The dc supply requires the voltage V_i to be greater than V volts to turn the diode on.
4. The negative region of the input signal turns the diode into the OFF state. Therefore, in the negative region the diode is an open circuit.

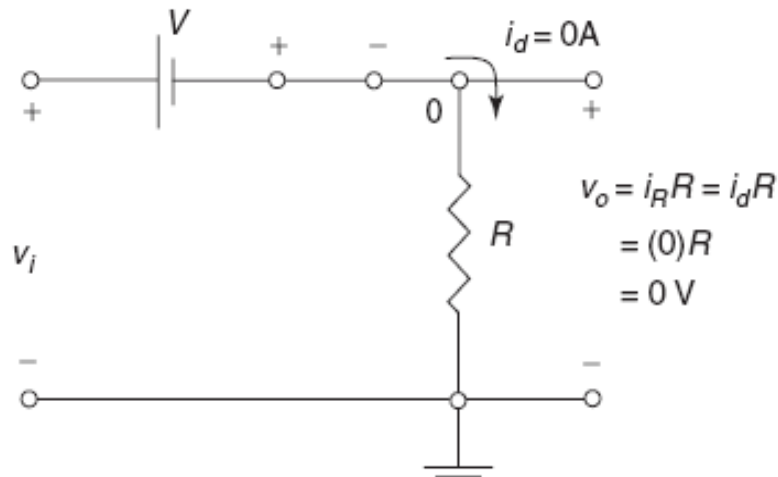


Series clipper with a dc supply

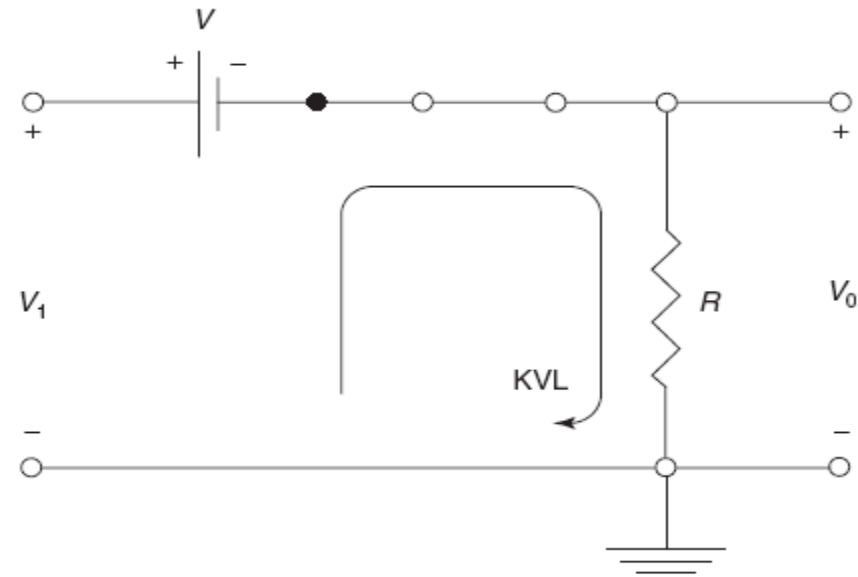
5. Determine the applied voltage (transition voltage) that will cause a change in state for the diode.
6. For the ideal diode the transition between states will occur at that point on the characteristics where $V_d = 0$ V and $i_d = 0$ A. Applying this condition, it is recognized that the level of V_i that will cause a transition in state is:

$$V_i = V$$

For an input voltage greater than V volts, the diode is in the short-circuit (SC) state, while for input voltage less than V volts it is in the open-circuit (OC) or OFF state (as it is reverse-biased).



Determining the transition level of the input signal



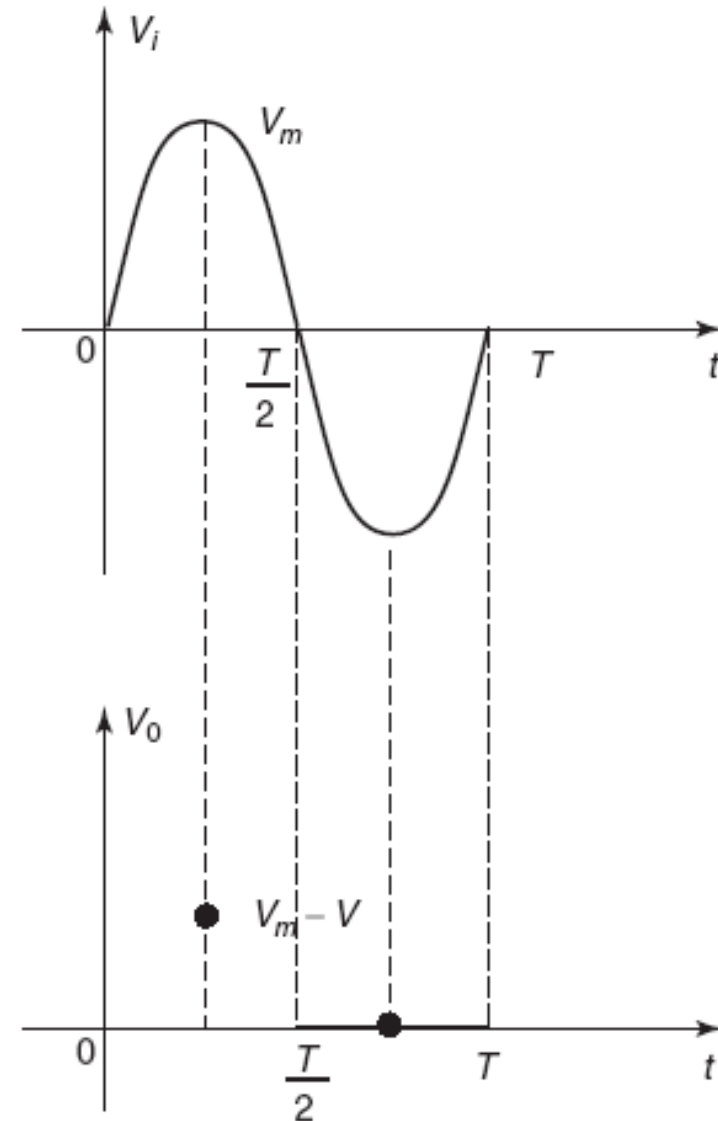
Determining v_o in the clipper circuit

- Be continually aware of the defined terminals and polarity of V_o . When the diode is in the short-circuit state, the output voltage V_o can be determined by applying KVL in the clock-wise direction:

$$v_i - V - v_o = 0$$

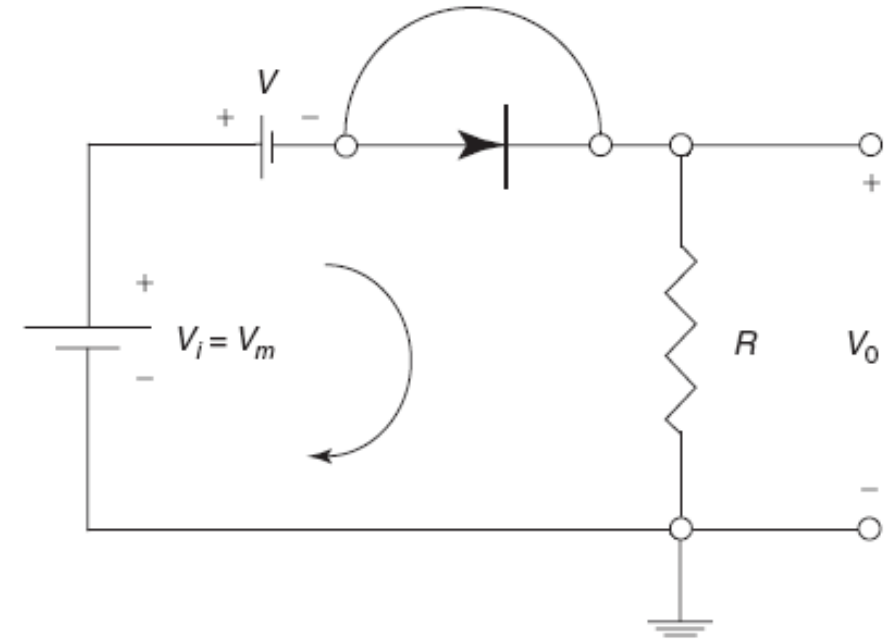
$$\text{or, } v_o = v_i - V$$

- It can be helpful to sketch the input signal above the output and determine the output at instantaneous values of the input. It is then possible to sketch the output voltage from the resulting data points of V_o .

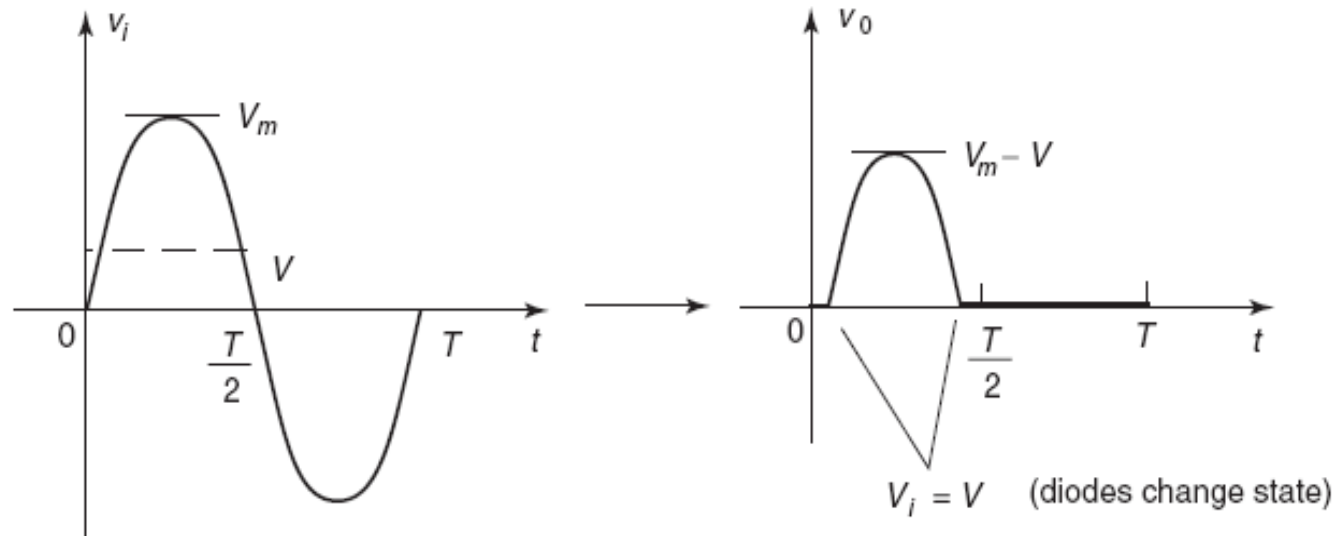


Determining levels of v_o

- For $V_m > V$, the diode is in the short-circuit state and $v_o = V_m - V$.
- At $V_i = V$, the diode changes state and at $V_i = -V_m$, $V_o = 0$ V. The complete curve for V_o can be sketched.

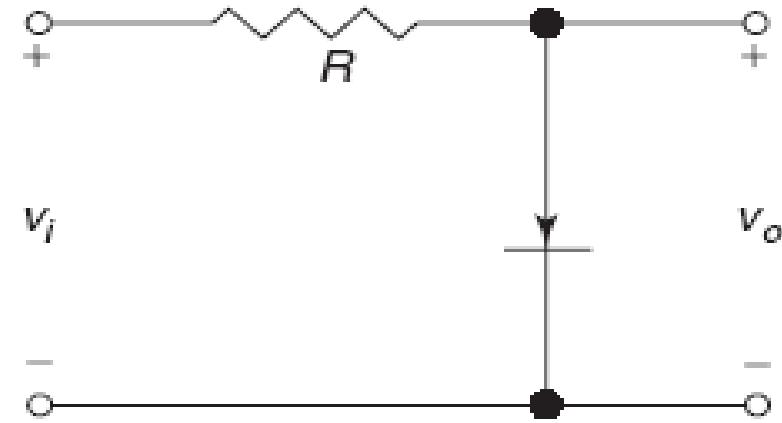


Determining v_o when $v_i = V_m$

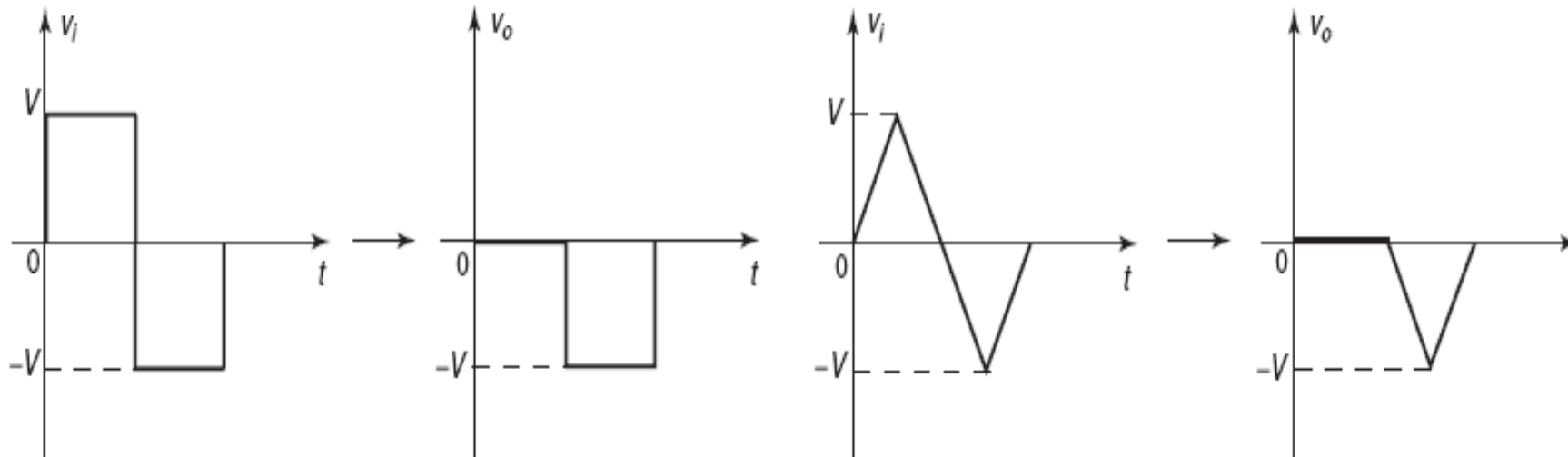


Sketch for v_o

➤ **Parallel clipper:-** Input V_i is applied for the output V_o . The analysis of parallel configuration is very similar to the series configuration.



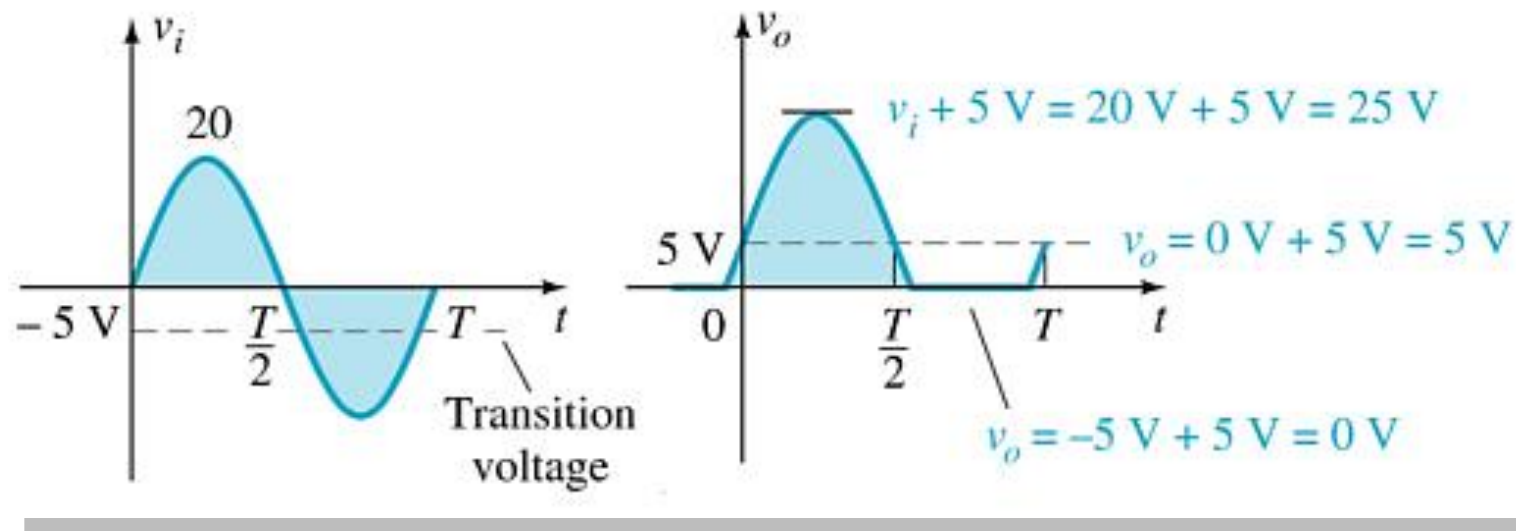
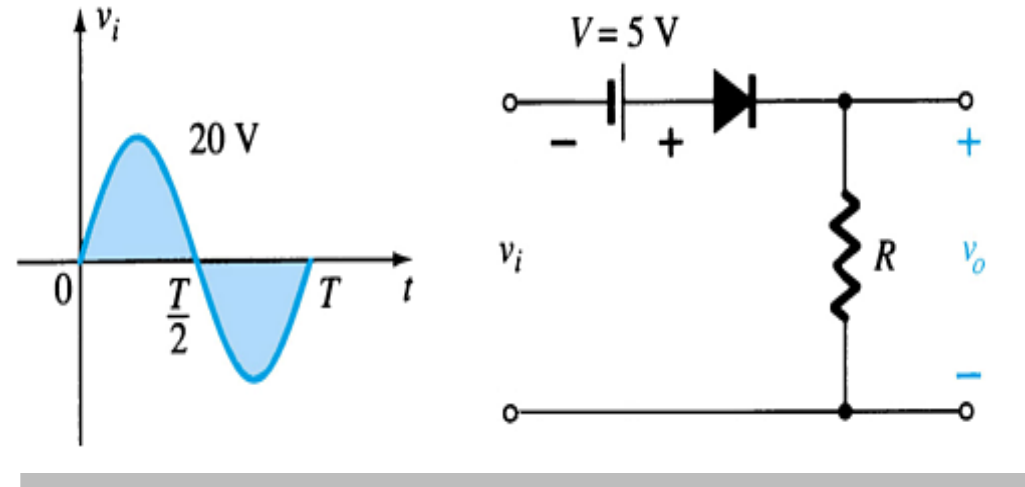
Parallel clipper



Response of parallel clipper

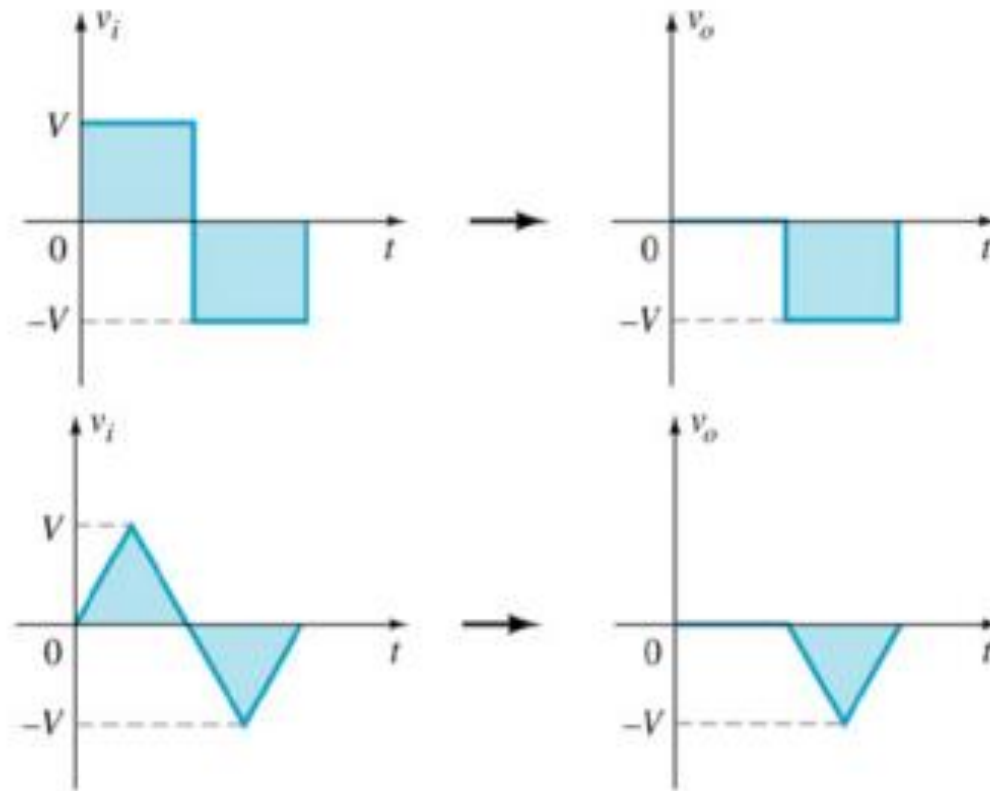
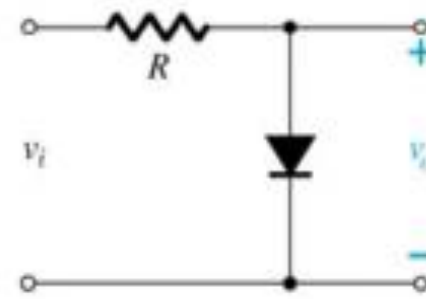
Biased Clippers

- Adding a DC source in series with the clipping diode changes the effective forward bias of the diode.



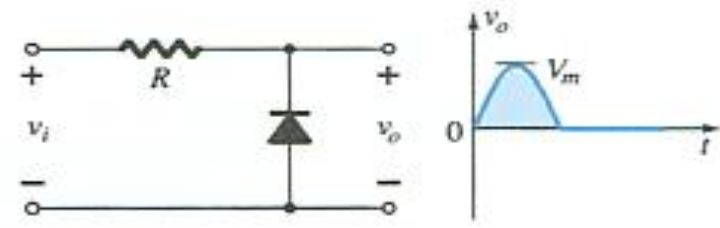
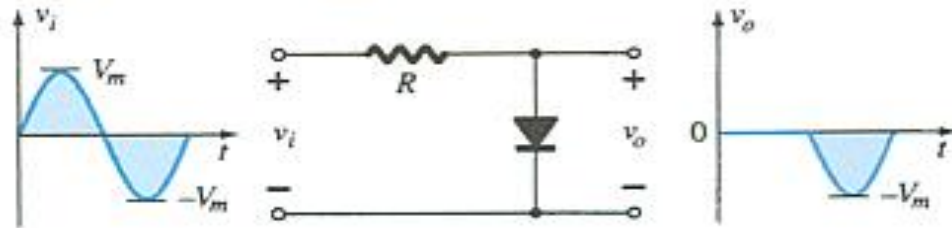
Parallel Clippers

- The diode in a **parallel clipper** circuit “clips” any voltage that forward bias it.
- DC biasing can be added in series with the diode to change the clipping level.

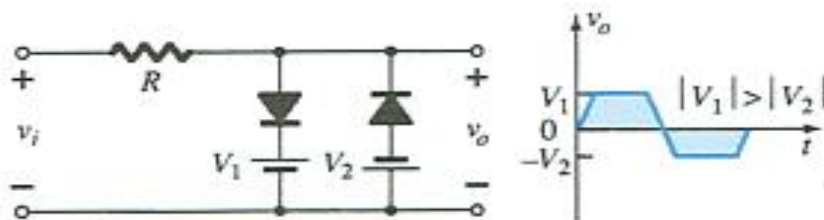
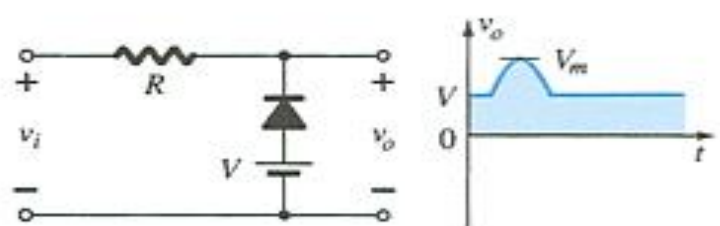
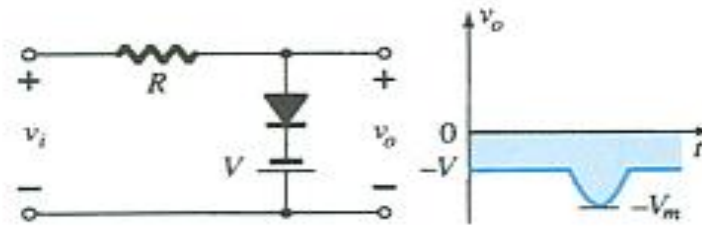
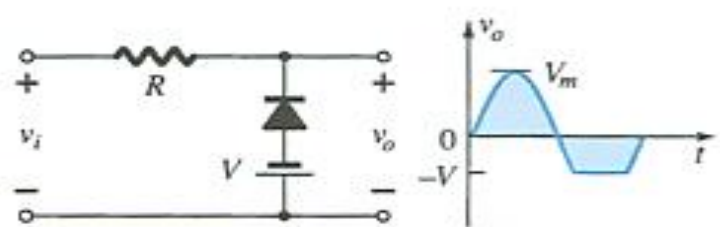
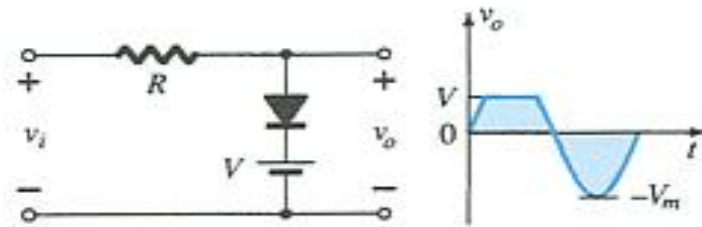


Summary of Clipper Circuits

Simple Parallel Clippers (Ideal Diodes)



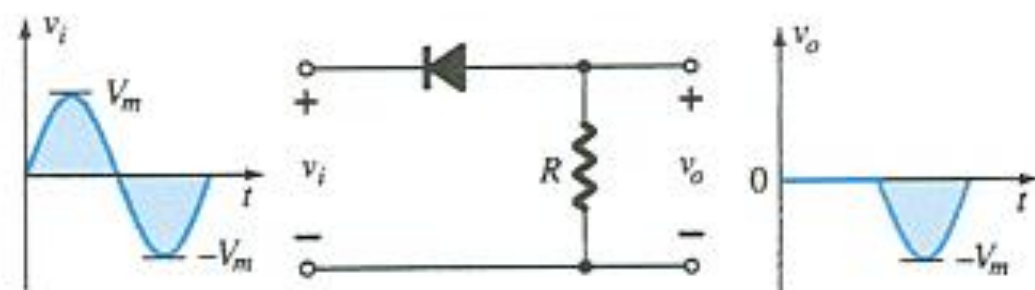
Biased Parallel Clippers (Ideal Diodes)



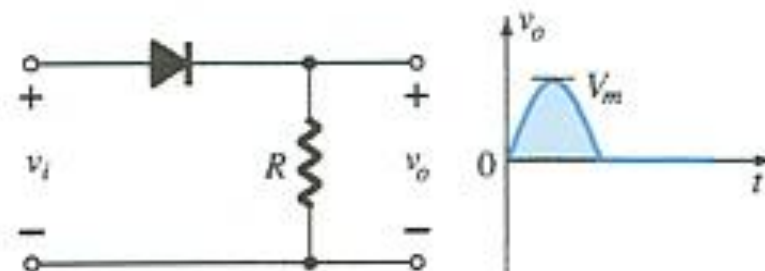
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Simple Series Clippers (Ideal Diodes)

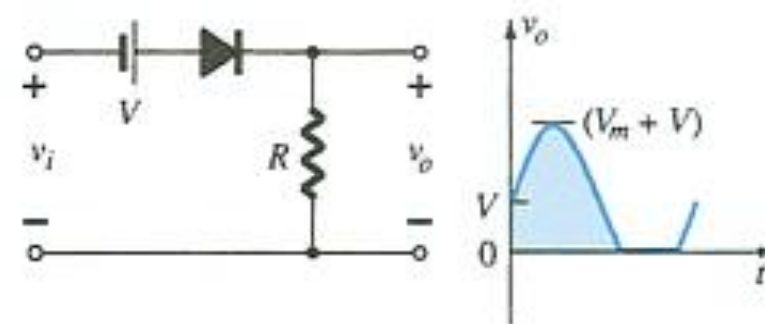
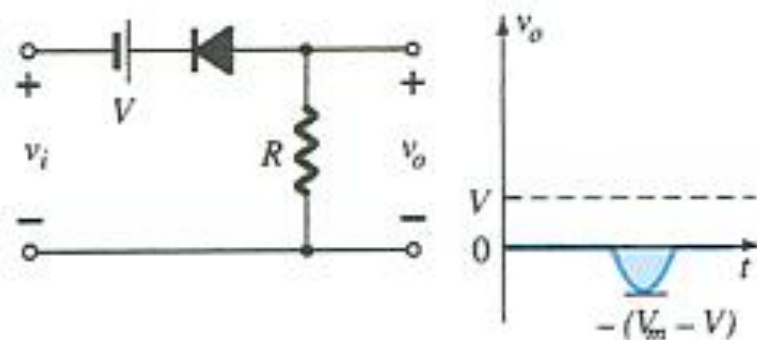
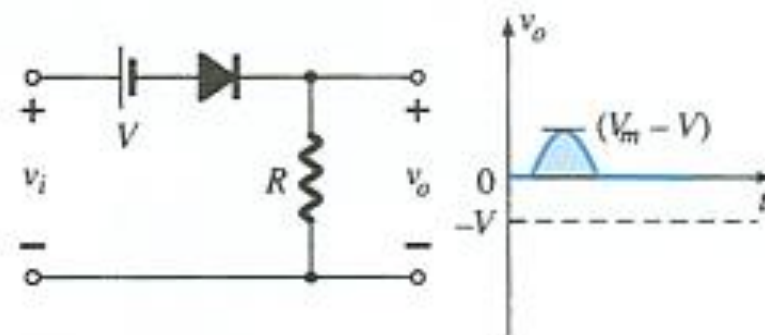
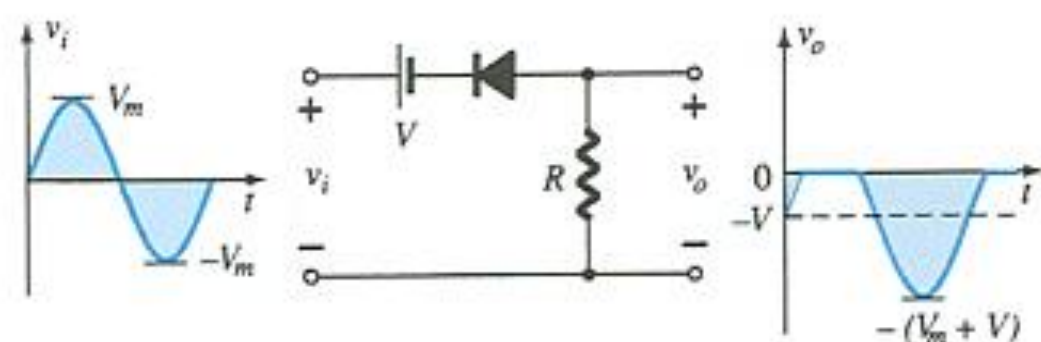
POSITIVE



NEGATIVE



Biased Series Clippers (Ideal Diodes)





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