Clippers

Clippers are diode circuit that have the ability to clip of a portion of input signal.

Series clipper

series clipper is defined as one where the diode is in series with the load.

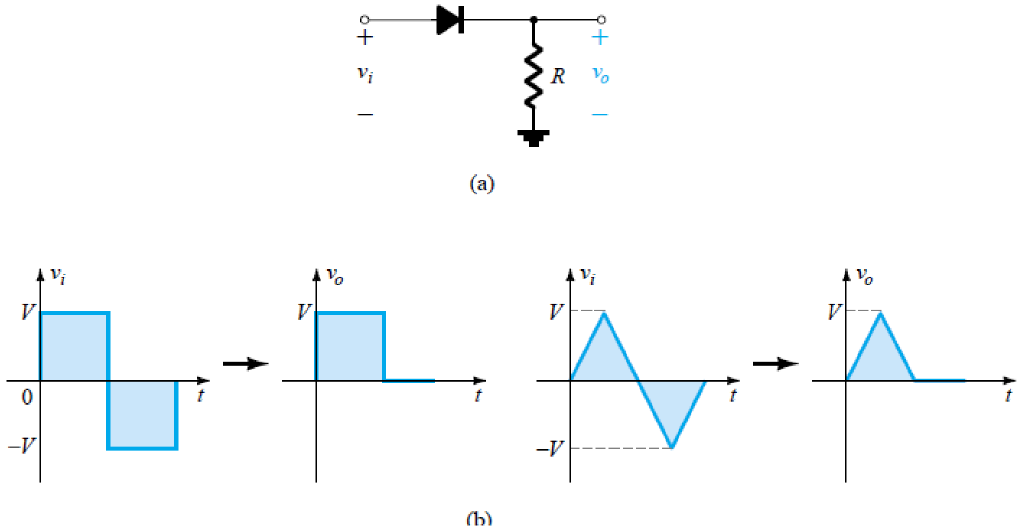


Fig. 11.1 Series clipper.

The addition of a dc supply influences the output of a clipper our initial discussion will be limited to ideal diodes.

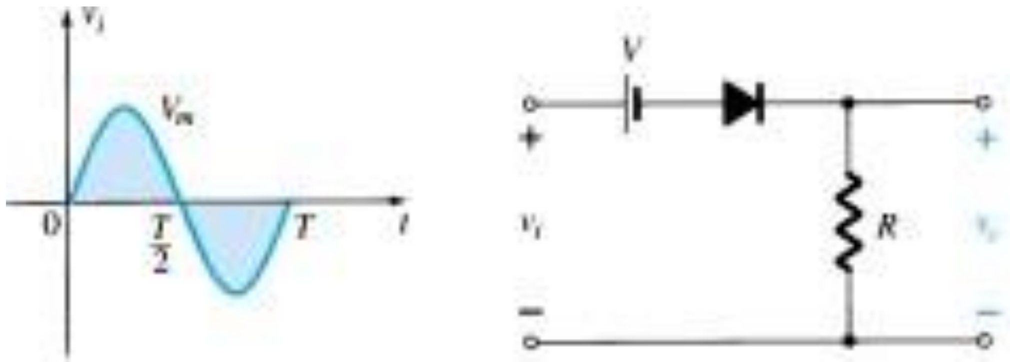
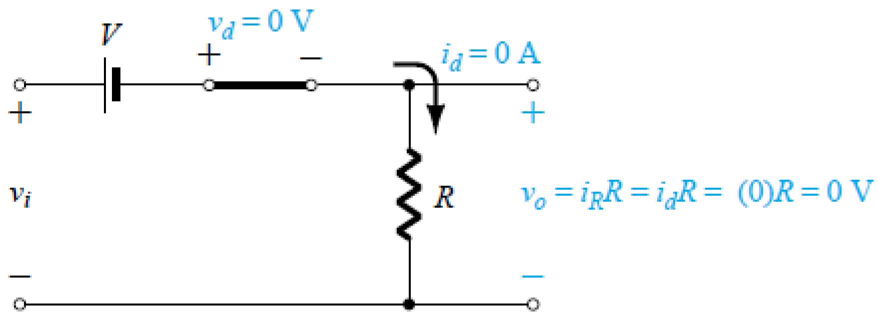


Fig. 11.2 Series clipper with dc supply

To analyzing networks as figure shown there are a few thoughts to keep in mind as you work toward a solution.

1. ***Make a mental sketch of response of the network based on the direction of the diode and applied voltage levels***. The direction of the diode suggests that the signal *vi* must be positive to turn it ***on*** and the voltage *vi* must be greater than V volt to turn it ***on.*** The negative region of the input signal the diode is an open circuit ***off***.
2. Determine the applied voltage (transition voltage) that will cause a change in state of diode.



. Fig. 11.3 Determining the transition level for the circuit

For the ideal diode the transition between states will occur at the point on the characteristics where

id=0A at vd=0V. Applying the condition

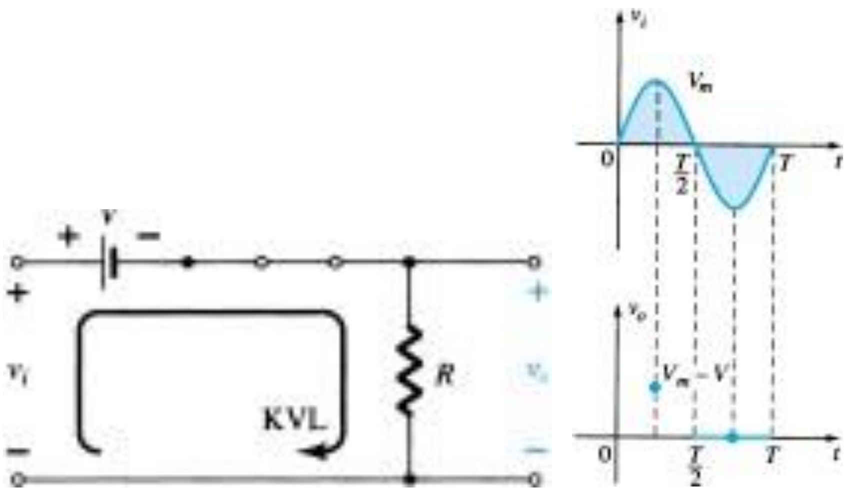


Fig. 11.4 Determining vo.

id=0A at vd=0V to the network will result.

$$v_i - V - v_o = 0$$

$$v_i - V - idR = 0$$

$$v_i - V = 0$$

$$v_i = V$$

The level of *vi* that will cause the transition. For an input voltage greater than V the diode is in **on** state (*vi* >V), while for input voltage less than V the diode is in **off** state (*vi* < V).

3. Applying Kirchhoff's voltage law to define (vo) in each state.

-Diode on

$$v_i - V - v_o = 0$$
$$v_o = v_i - V$$

- Diode off

$$v_o = 0$$

4. Sketch the input signal above the output signal and determine the output at instance values of the input.

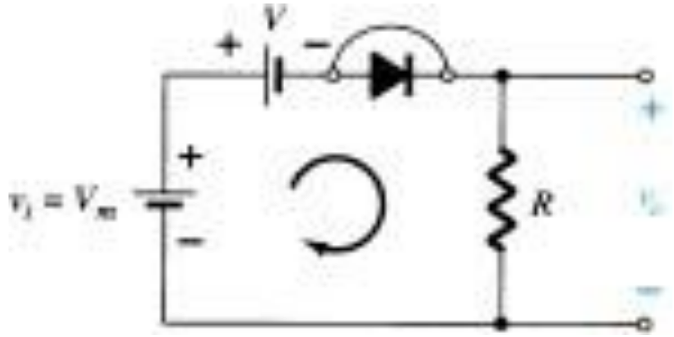


Fig.11.5 Determining vo when vi _ Vm

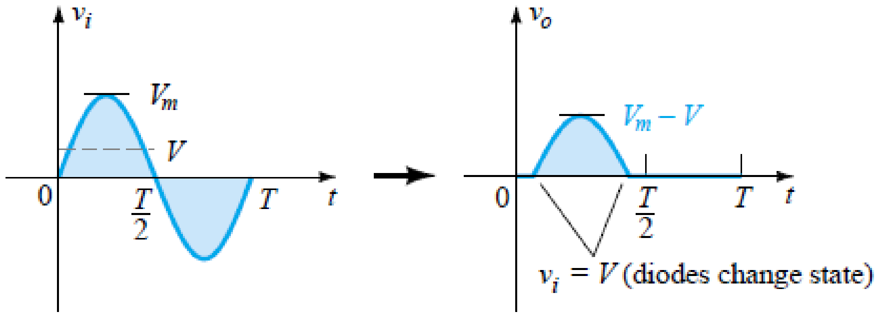


Fig.11.6 Sketching vo.

Example 11.1

Determine the output waveform for the network

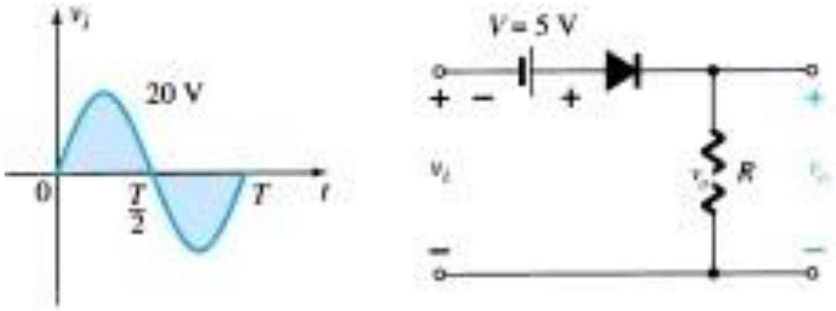


Fig.11.7 Example 11.1

Solution

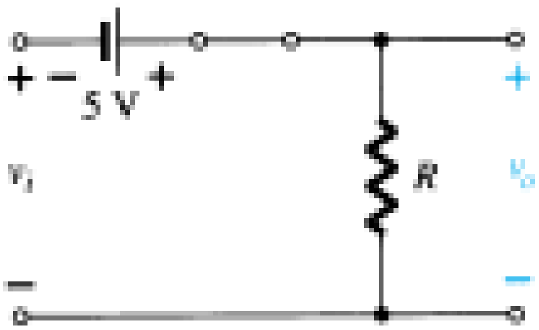


Fig.11.8 vo with diode in the "on" state.

-The diode will be in the **on** state for the positive half cycle v_i

$$v_i + V - i_d R = 0$$

-Applying *id*=0 and *vd*=0 to obtain transition level

$$v_i + V - 0 = 0$$

$$v_i = -V = -5V$$

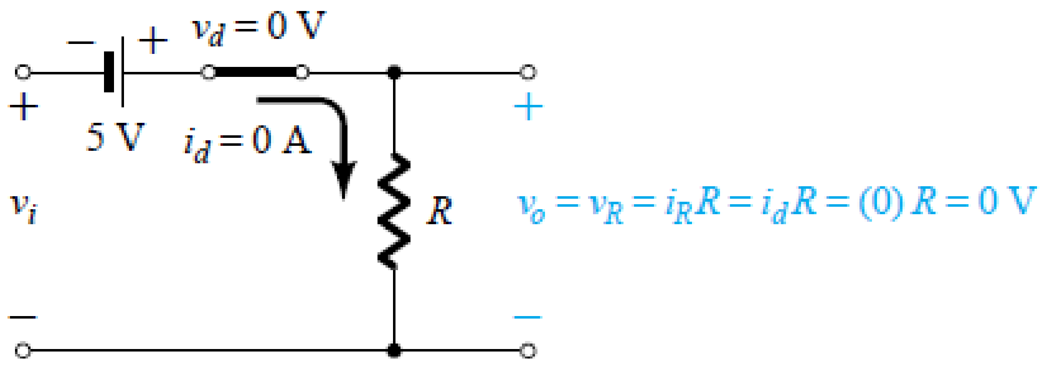


Fig.11.9 Determining the transition level for the clipper

For *vi* more than -5V the diode on, for *vi* less than -5V the diode off.

-When diode **on**

$$v_i + 5 - v_o = 0$$

$$v_o = v_i + 5$$

-When diode **off**

$$v_o = 0$$

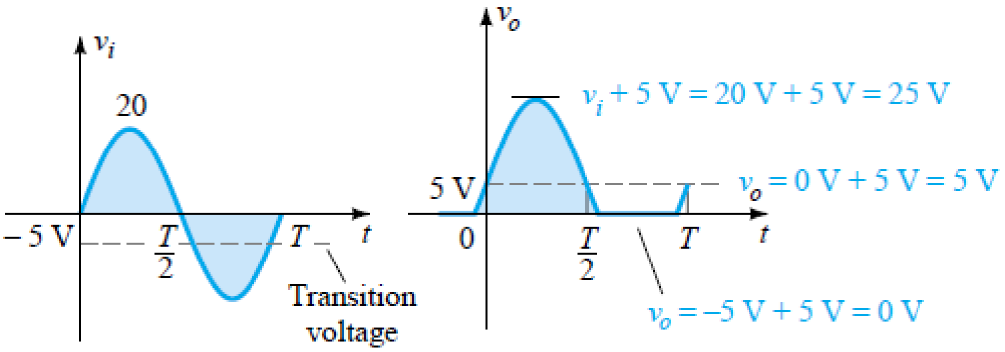


Fig.11.10 Sketching vo

Clippers with square wave

The analysis of clippers with square wave inputs is much easier than clippers with sinusoidal input, the network can be analyzed as if it had only two dc level inputs.

Example 11.2

Repeat the example for the square wave input

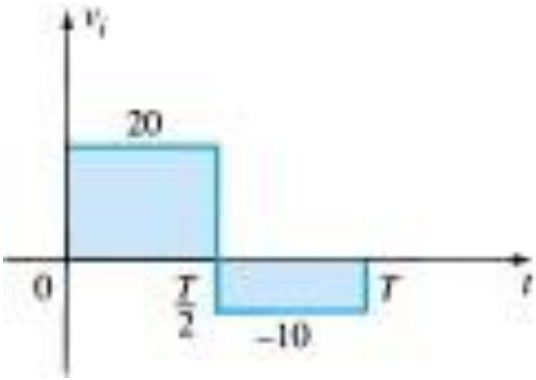


Fig 11.11 Applied signal for Example 11.2.

Solution

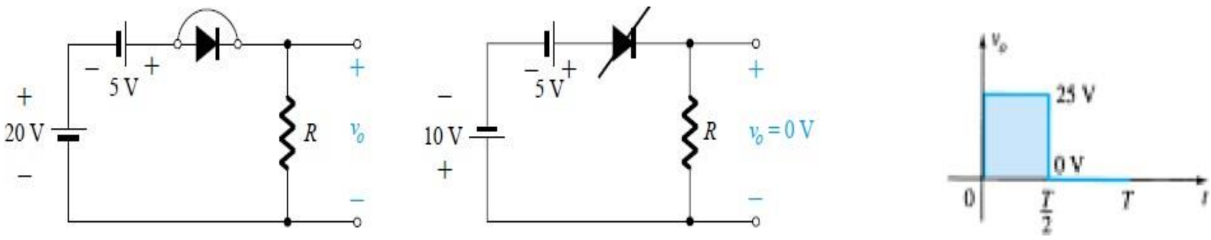


Fig 11.12 Determining vo

-For *vi*=20V the diode on

$$v_o = v_i + 5 = 20 + 5 = 25V$$

-For *vi*=-10V the diode of

$$v_o = v_i + 5 = 20 + 5 = 25V$$

Parallel clipper:

parallel clipper is defined as one where the diode is in branch parallel with the load.

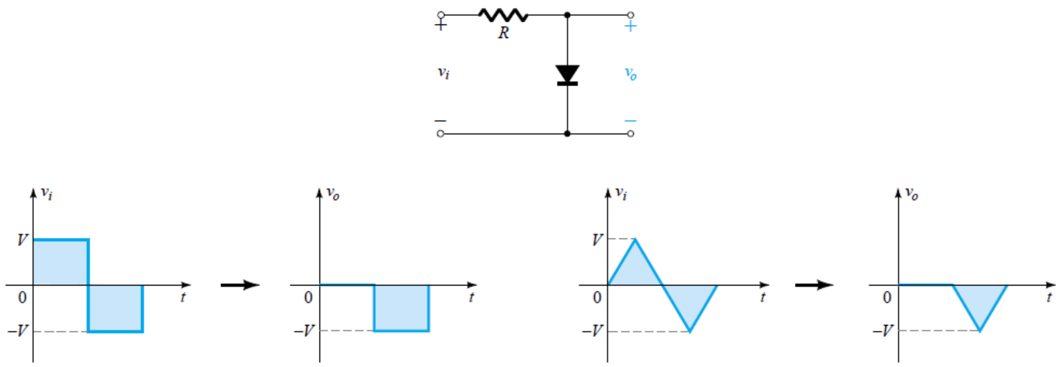


Fig 11.13 Response to a parallel clipper.

Example 11.3

Determine *vo*

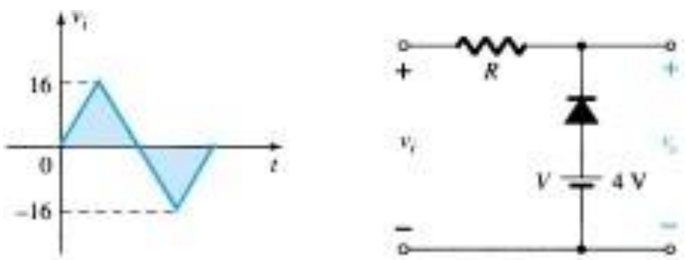


Fig 11.14 Applied signal and circuit for Example 11.2.

Solution

-The direction of the diode Strongly suggested that the diode on for the negative cycle

-The transition state *id*=0 and *vd*=0

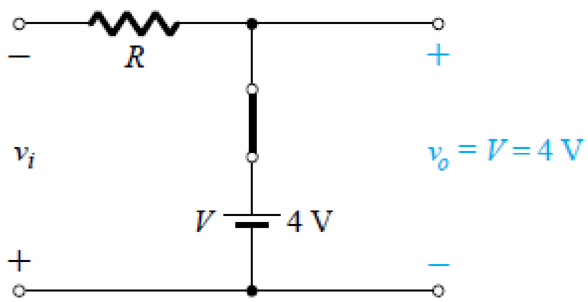


Fig 11.15 vo for the negative region of vi.

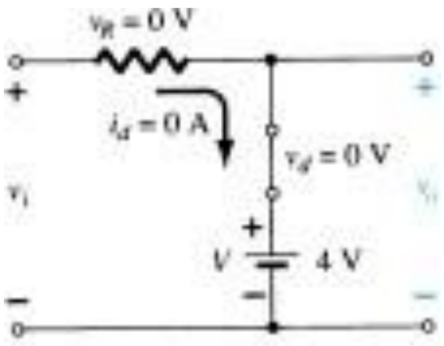


Fig 11.16 Determining the transition level for(vi<4) Diode on,

$$vi - idR - 4 = 0 \qquad vi = 4$$

For (*vi*>4) Diode off,

$$v_o = v_i \qquad v_o = 4V$$

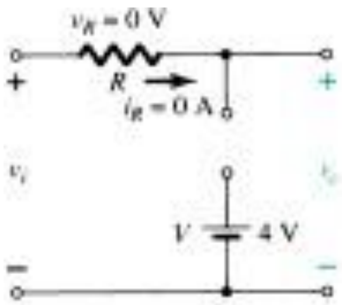


Fig 11.17 Determining vo for the open state of the diode.

-Sketching

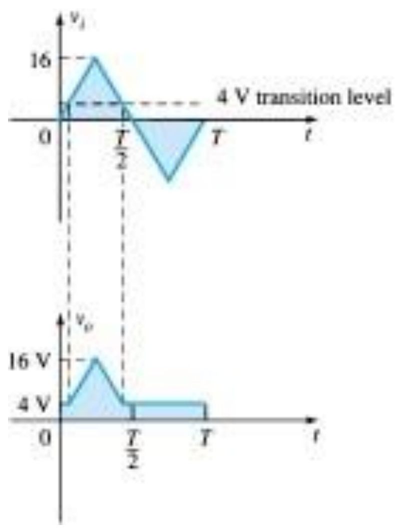


Fig 11.18 Sketching vo

Example

Repeat example using a silicon diode

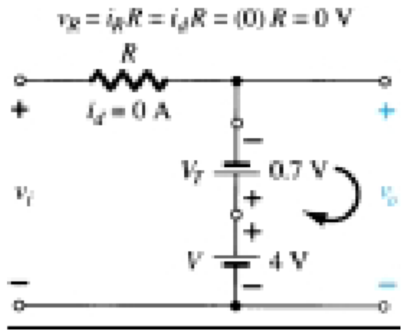


Fig 11.19 Determining the transition level

Solution

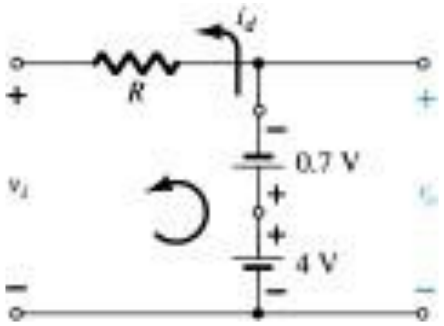
-The diode on for the negative cycle

-The transition state *id*=0 and *vd*=0.7V

Applying Kirchhoff's law

$$vi - idR + 0.7 - 4 = 0$$

$$vi = 4 - 0.7 = 3.3V$$



For (vi > 3.3V) Diode off, $v_o = v_i$

For (vi< 3.3V) Diode on, $v_o = 3.3V$

Fig 11.20 Determining *vo*

-Sketching

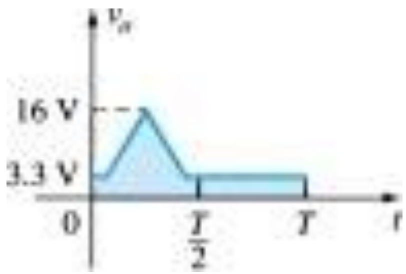


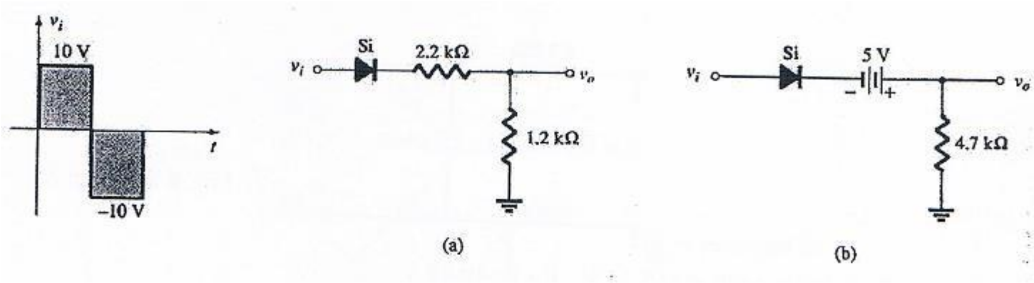
Fig 11.21 Sketching vo

Note:-Including the effect of V_T will complicate the analysis somewhat, but once the analysis is understood with the ideal diode the procedure including the effect of V_T will not be that difficult.

Problems

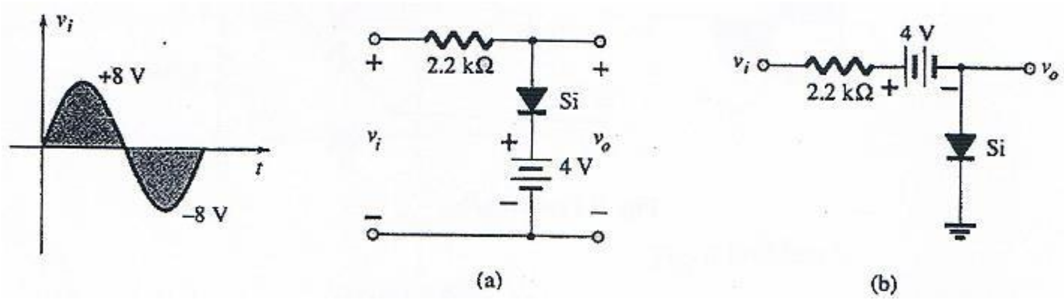
Q1: Sketch and determine v_o for configurations shown.

(Ans: positive pulse 3.28V, positive pulse 14.3V)



Q2: Sketch and determine v_o for configurations shown.

(Ans: clipped at 4.7V, positive clipped at 0.7V; negative-12V)



Q3: Sketch *iR* and *vo* for the network