الكلية	الهندسة
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المادة باللغة الانجليزية	Electronic Devices and Circuit Theory
المادة باللغة العربية	مكونات و دوائر إلكترونية
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اسم التدريسي	م.د. مصطفى عدنان حمود
عنوان المحاضرة باللغة الانجليزية	***Diode Application (* CLIPPERS*)***
عنوان المحاضرة باللغة العربية	
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Lecture 5

Diode Applications

5.1 CLIPPERS

Clippers are networks that employ diodes to "clip" away a portion of an input signal without distorting the remaining part of the applied waveform.

There are two general categories of clippers: series and parallel.

SERIES

The series configuration is defined as one where the diode is in series with the load. The response of the series configuration of Figure 1a to a variety of alternating waveforms is provided in Figure 1b. Although first introduced as a half-wave rectifier (for sinusoidal waveforms), there are no boundaries on the type of signals that can be applied to a clipper.

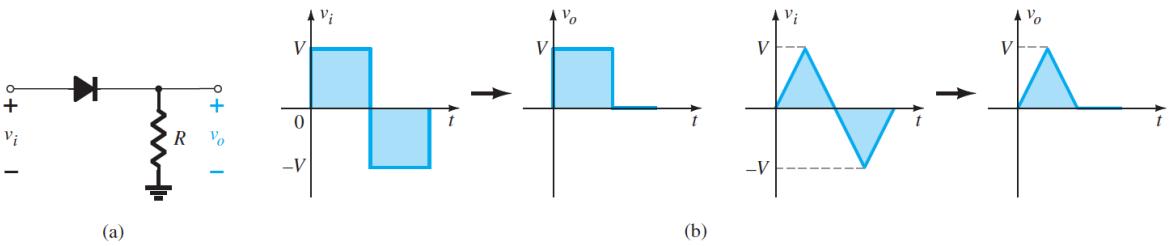


Figure 1: Series clipper.

The addition of a dc supply to the network as shown in Figure 2 can have a pronounced effect on the analysis of the series clipper configuration.

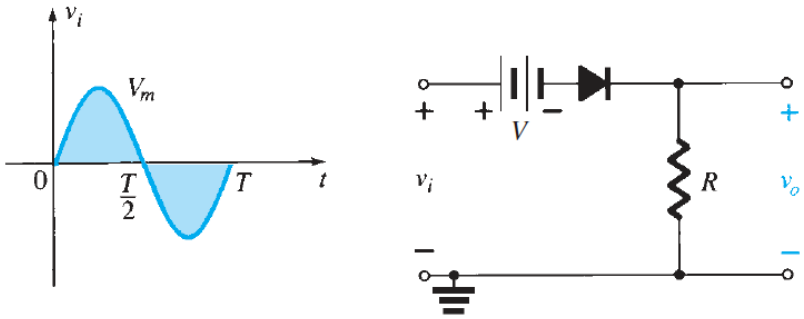


Figure 2: Series clipper with a dc supply.

EXAMPLE 2.18 Determine the output waveform for the sinusoidal input of Fig. 2.74.

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.

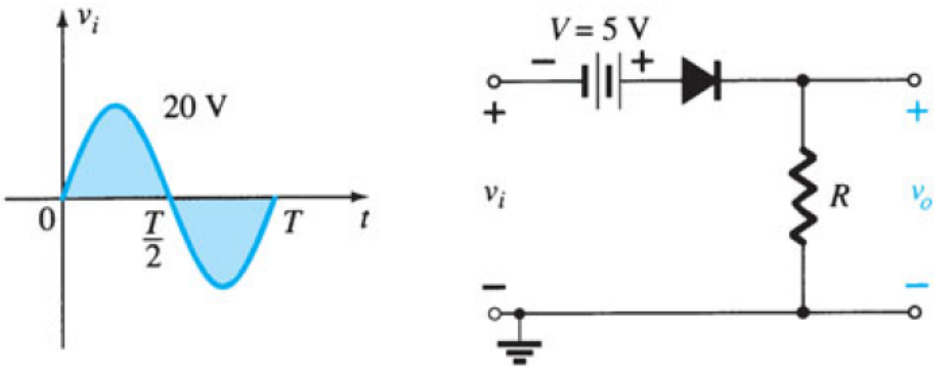


FIG. 2.74
Series clipper for Example 2.18.

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

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

or

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

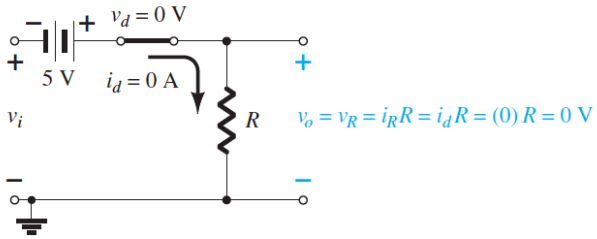


FIG. 2.75
Determining the transition level for the clipper of Fig. 2.74.

Step 4: In Fig. 2.76 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 0 V, as shown in the sketch of v_o. Using Fig. 2.76, 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:

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

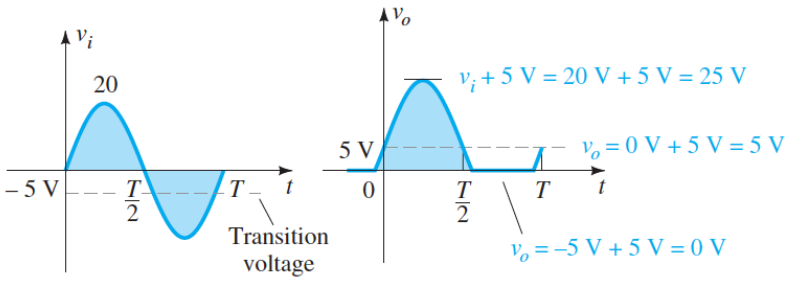


FIG. 2.76
Sketching v_o for Example 2.18.

The analysis of clipper networks with square-wave inputs is actually easier than with sinusoidal inputs because only two levels have to be considered. In other words, the network can be analyzed as if it had two dc level inputs with the resulting v_o plotted in the proper time frame. The next example demonstrates the procedure.

EXAMPLE 2.19 Find the output voltage for the network examined in Example 2.18 if the applied signal is the square wave of Fig. 2.77.

Solution: For $v_i = 20\text{ V}$ $(0 \rightarrow T/2)$ the network of Fig. 2.78 results. The diode is in the short-circuit state, and $v_o = 20\text{ V} + 5\text{ V} = 25\text{ V}$. For $v_i = -10\text{ V}$ the network of Fig. 2.79

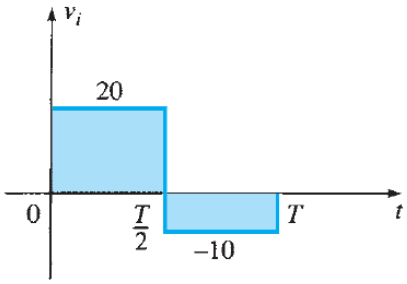


FIG. 2.77
Applied signal for Example 2.19.

results, placing the diode in the "off" state, and $v_o = i_R R = (0)R = 0\text{ V}$. The resulting output voltage appears in Fig. 2.80.

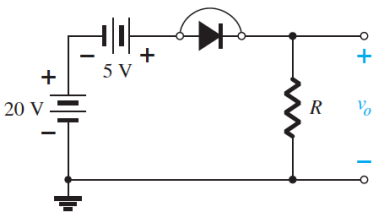


FIG. 2.78
v_o *at* $v_i = +20$ *V.*

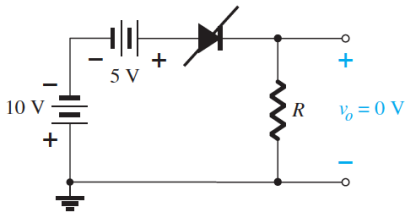


FIG. 2.79
v_o *at* $v_i = -10$ *V.*

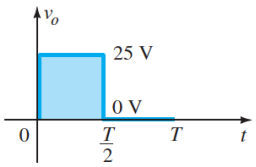


FIG. 2.80
Sketching v_o *for Example 2.19.*

Parallel

The parallel variety has the diode in a branch parallel to the load.

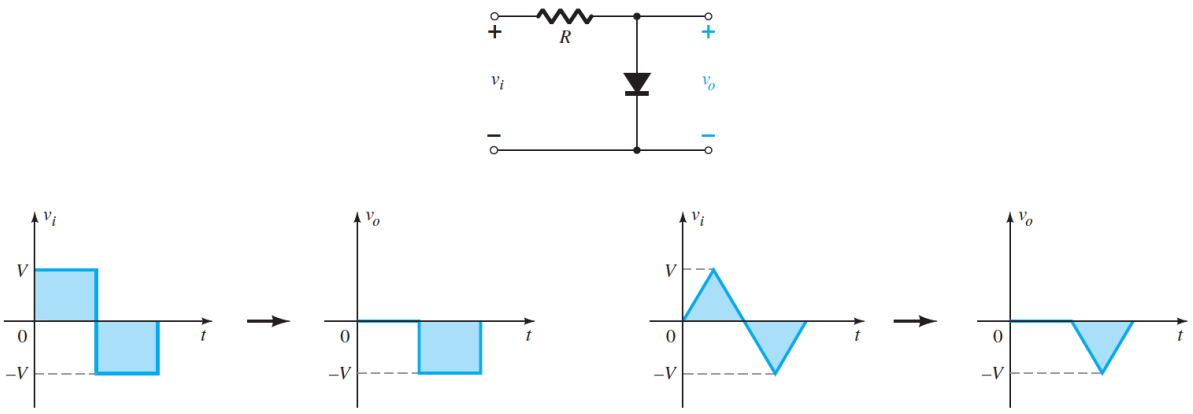


FIG. 2.81
Response to a parallel clipper.

EXAMPLE 2.20 Determine v_o for the network of Fig. 2.82.

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*.

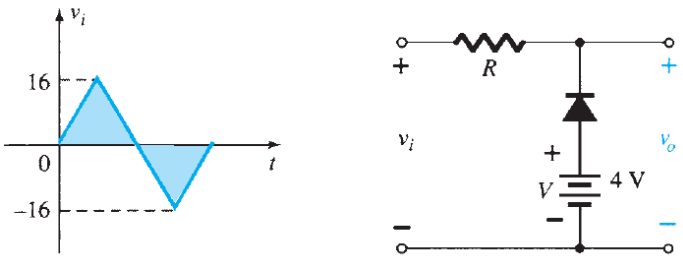


FIG. 2.82
Example 2.20.

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. In fact, it is interesting to note that since the output is directly across the series combination, when the diode is in its short-circuit state the output voltage will be directly across the 4-V dc supply, requiring that the output be fixed at 4 V. In other words, when the diode is on the output will be 4 V. Other than that, when the diode is an open circuit, the current through the series network will be 0 mA and the voltage drop across the resistor will be 0 V. That will result in $v_o = v_i$ whenever the diode is off.

Step 3: The transition level of the input voltage can be found from Fig. 2.83 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

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

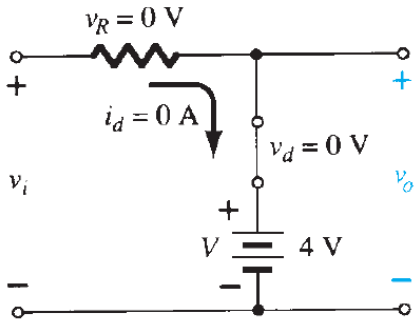


FIG. 2.83
Determining the transition level for Example 2.20.

Step 4: In Fig. 2.84 the transition level is drawn along with $v_o = 4$ V when the diode is on. For $v_i \geq 4$ V, $v_o = 4$ V, and the waveform is simply repeated on the output plot.

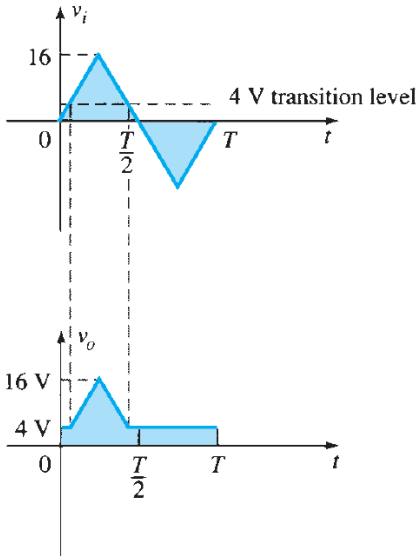
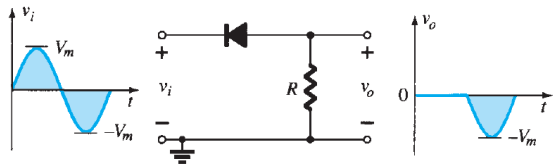


FIG. 2.84
Sketching v_o for Example 2.20.

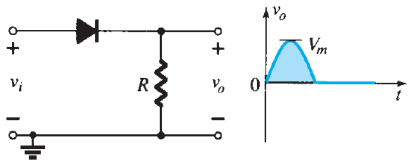
A variety of series and parallel clippers with the resulting output for the sinusoidal input are provided in Fig. 2.88. In particular, note the response of the last configuration, with its ability to clip off a positive and a negative section as determined by the magnitude of the dc supplies.

Simple Series Clippers (Ideal Diodes)

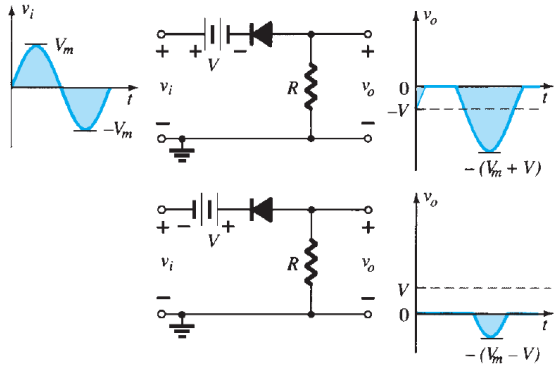
POSITIVE

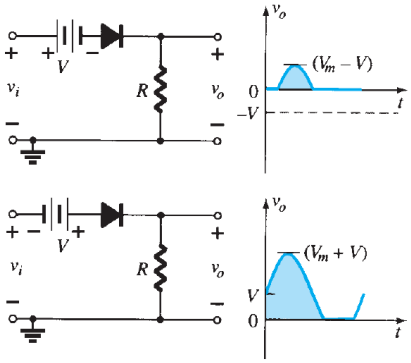


NEGATIVE

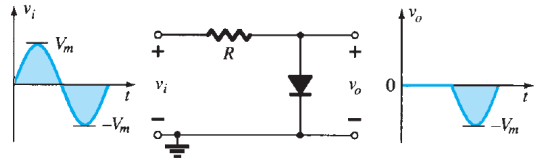


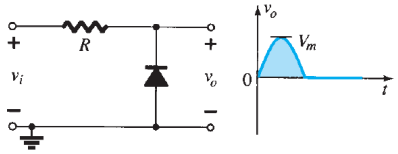
Biased Series Clippers (Ideal Diodes)



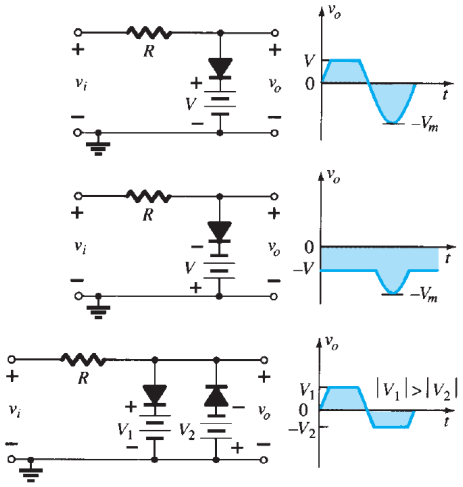


Simple Parallel Clippers (Ideal Diodes)





Biased Parallel Clippers (Ideal Diodes)



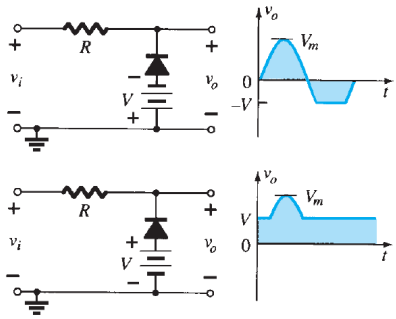


FIG. 2.88
Clipping circuits.

2.9 CLAMPERS

A clamper is a network constructed of a diode, a resistor, and a capacitor that shifts a waveform to a different dc level without changing the appearance of the applied signal.

The simplest of clamper networks is provided in Fig. 2.89 . It is important to note that the capacitor is connected directly between input and output signals and the resistor and the diode are connected in parallel with the output signal.

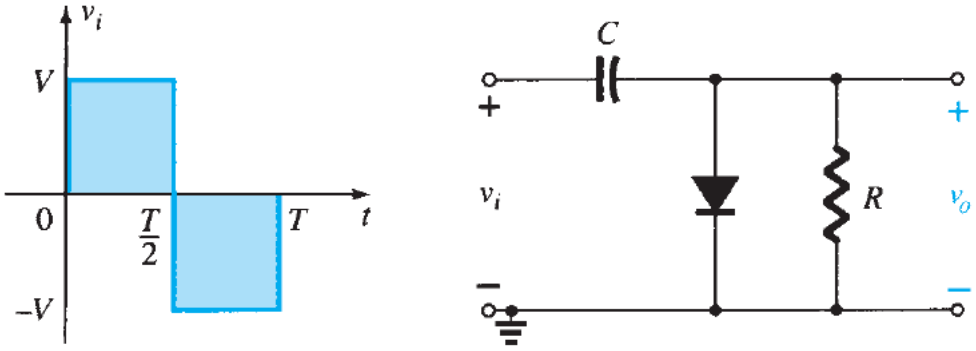


FIG. 2.89
Clamper.

Step 1: Start the analysis by examining the response of the portion of the input signal that will forward bias the diode.

Step 2: During the period that the diode is in the “on” state, assume that the capacitor will charge up instantaneously to a voltage level determined by the surrounding network.

For the network of Fig. 2.89 the diode will be forward biased for the positive portion of the applied signal. For the interval 0 to T/2 the network will appear as shown in Fig. 2.90. The short-circuit equivalent for the diode will result in v_o= 0 V for this time interval, as shown in the sketch of v_o in Fig. 2.92 .

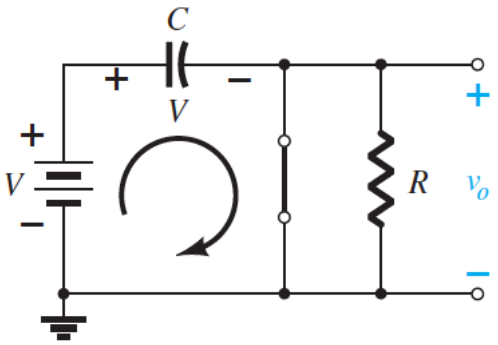


FIG. 2.90
Diode "on" and the capacitor charging to V volts.

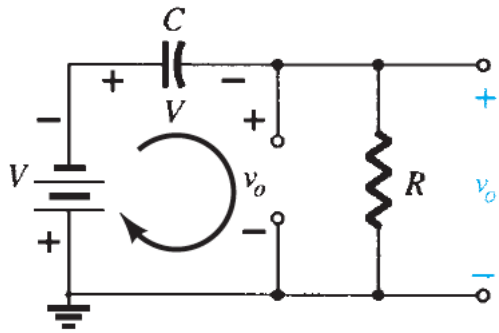


FIG. 2.91
Determining v_o with the diode "off."

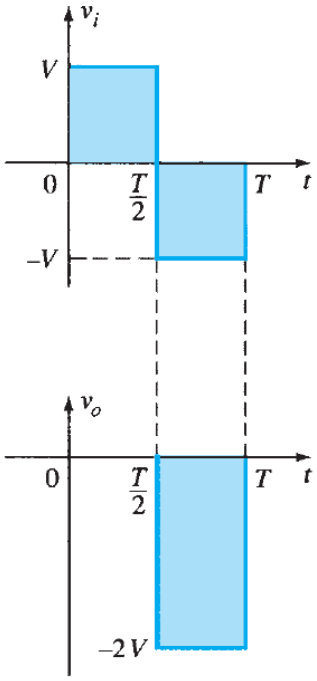


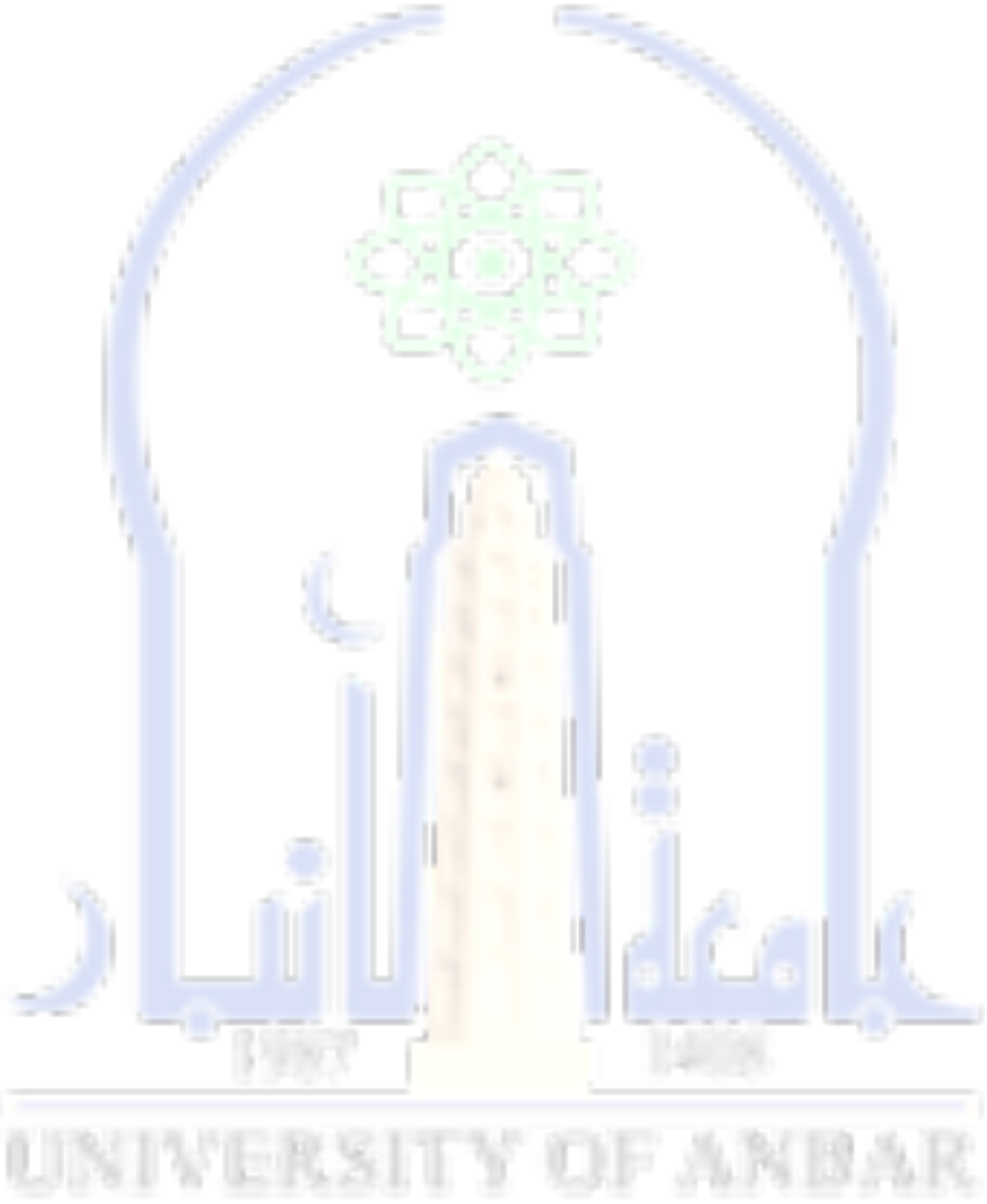
FIG. 2.92
Sketching v_o for the network of Fig. 2.91.

Step 3: Assume that during the period when the diode is in the "off" state the capacitor holds on to its established voltage level.

When the input switches to the - V state, the network will appear as shown in Fig. 2.91, with the open-circuit equivalent for the diode determined by the applied signal and stored voltage across the capacitor—both "pressuring" current through the diode from cathode to anode.

Applying Kirchhoff's voltage law around the input loop (Figure 2.91) results in

$$-V - V - v_o = 0$$
$$v_o = -2V$$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