Clampers

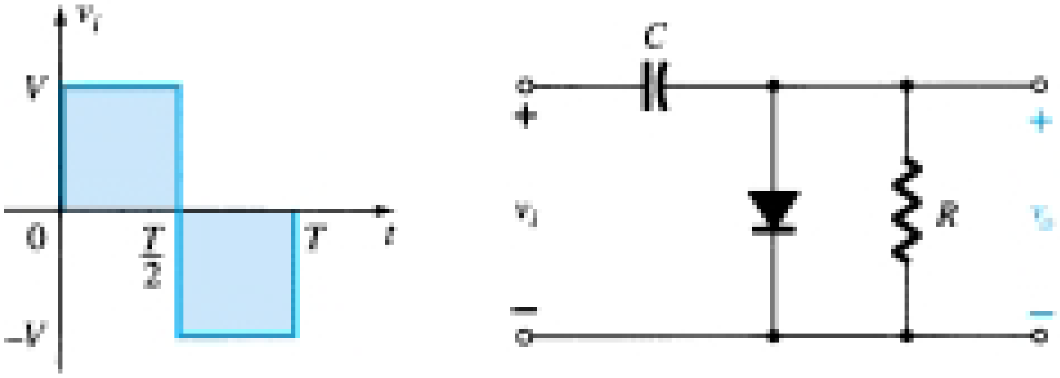


Fig. 12.1 Clamper.

The clamping network is one that will clamp a signal to a different dc level. It must have a capacitor a diode and resistance but it can also employ dc supply to introduce additional shift.

The magnitude of R and C must be chosen because the time constant τ,

$$\tau = RC$$

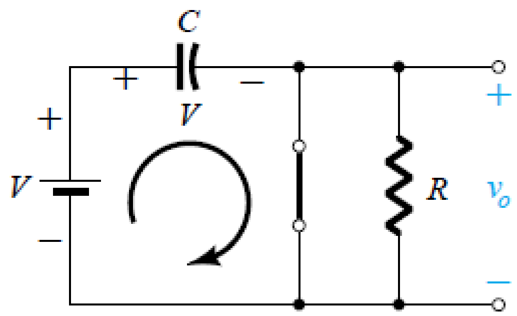


Fig. 12.2 not Diode "on" and the capacitor charging to V volts.

And the capacitor will fully charge or discharge in 5τ, τ must be large enough to ensure that the voltage a cross capacitor does discharge significantly during the interval the diode off.

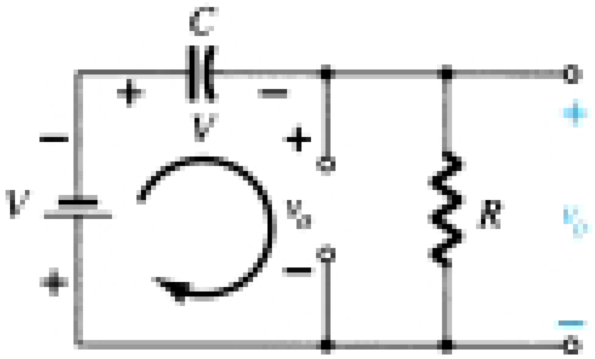


Fig.12.3 Determining vo with the diode "off."

During the positive half cycle the network will appear as shown with the diode in on state, τ is very small that the capacitor will charge very quickly *vo=0.*

During the negative half cycle the network will appear as shown, diode off, τ is large, the capacitor holds during the period

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

$$v_o = -2V$$

The following steps may be helpful to analysis clampers.

- Start analysis by the part of input signal that will forward bias the diode
- During the period assume that the capacitor will charge to voltage level determined by the network (*vc*, *vo*)
- Assume that during the diode **OFF** the capacitor will hold to its established voltage level.
- Keep in mind the general rule that the total swing of the output must match the swing of input signal.

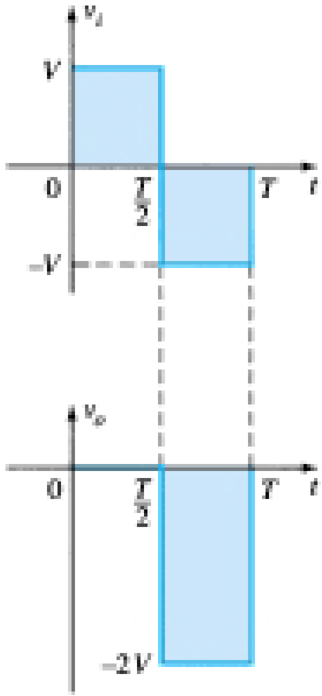


Fig. 12.4 Sketching vo

<u>Example</u>

Determine *vo*

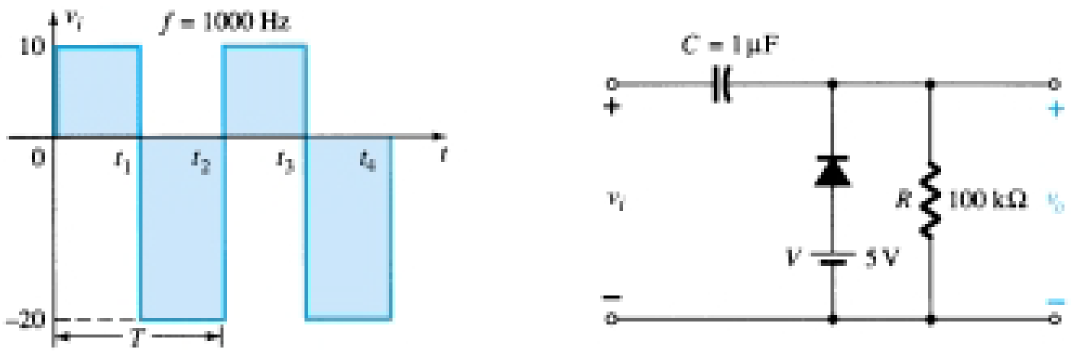


Fig 12.5 Applied signal and network for Example 12.1.

<u>Solution</u>

$$T = \frac{1}{f} = \frac{1}{1000} = 10^{-3} s$$ Half time-period=

$$\frac{T}{2} = 0.5 \times 10^{-3} s$$

-Begin with forward bias, 2nd half Period, the network will appear as shown vo=5V

$$20+5-vc=0 \qquad vc=25V$$

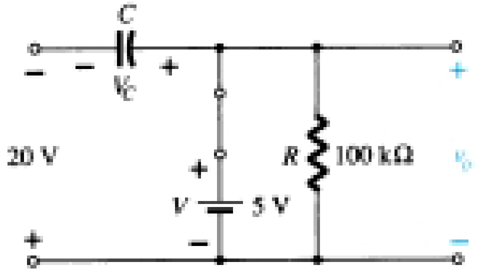


Fig 12.6 Determining vo and VC with the diode in the "on" state.

-During the positive half cycle Diode reverse bias

$$10+25-vo=0$$

$$vo=35V$$

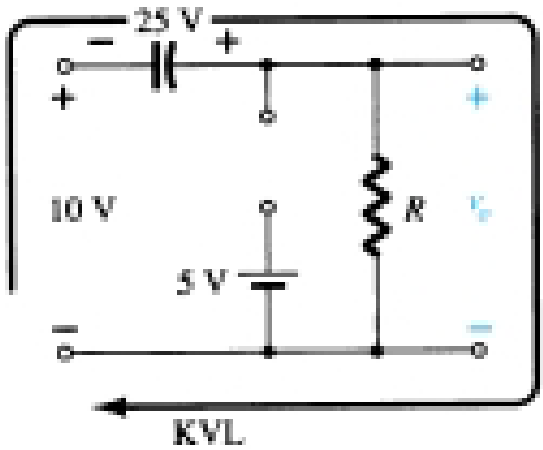


Fig 12.7 Determining vo with the diode in the "off" state

The output swing of 30V match the swing of input signal.

Time constant of the discharge network

$$\tau = RC = (100k)(0.1\mu) = 0.01s = 10ms$$

The total discharge times

$$5\tau = 50ms$$

Half time-period=*T/2*=0.5×10^{-3}s

It's a good approximation that the capacitor will hold its voltage during the discharge period.

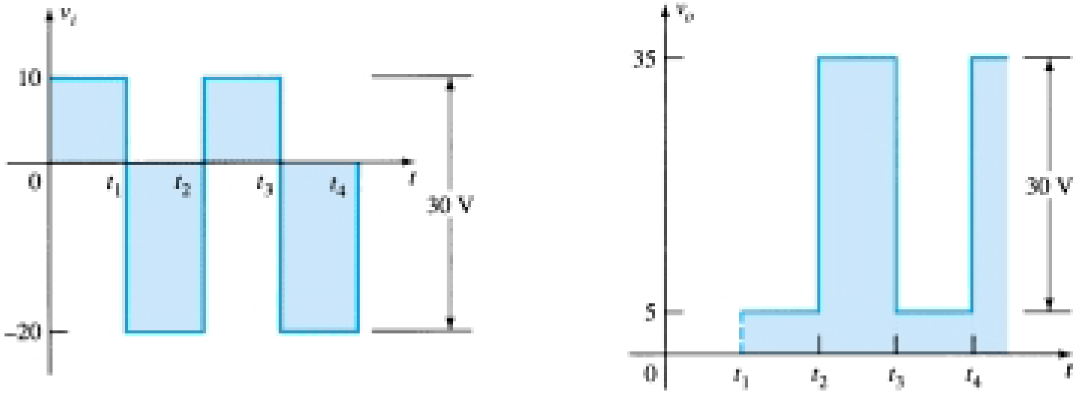


Fig 12.8 vi and vo for the clamper

Example

Repeat example using a silicon diode

Solution

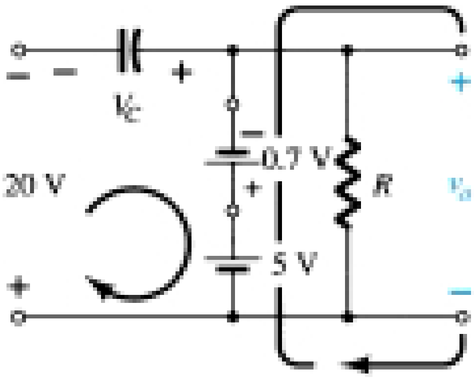


Fig 12.9 Determining vo and V_C with the diode in the "on" state.

For short circuit state

5-0.7-vo=0

vo=4.3V

for input section

$$-20 - vc + 0.7 - 5 = 0 \qquad\qquad vc = 24.3V$$

-For open circuit state Diode reverse bias

$$10 - 24.3 - vo = 0 \qquad vo = 34.3V$$

The output swing of 30V match the swing of input signal.

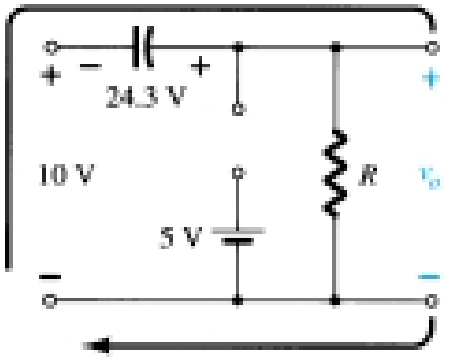


Fig 12.10 Determining vo with the diode in the "off" state.

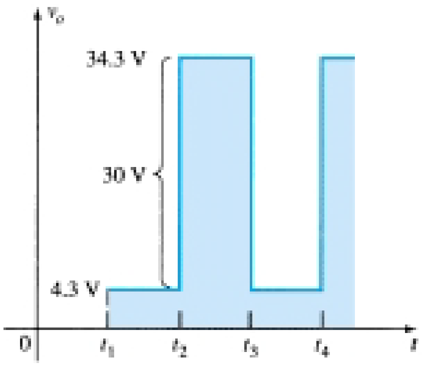


Fig 12.11 vo for the clamper

Note: -

For sinusoidal signal one approach to the analysis of clamping networks is to replace the sinusoidal signal by a square wave of the same peak value.

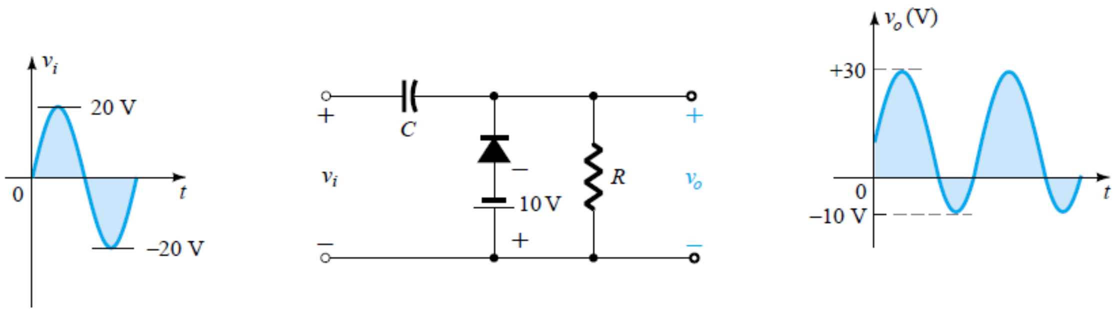
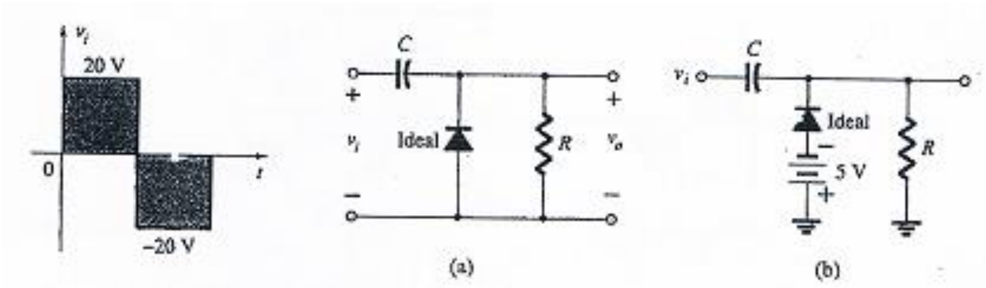


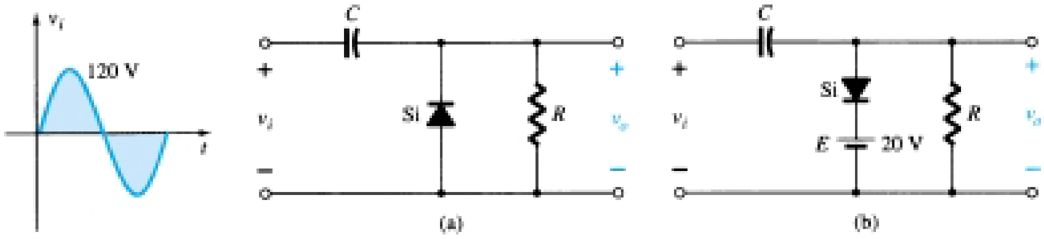
Fig 12.12 Clamping network with a sinusoidal input.

<u>Problems</u>

Q1: Sketch and determine v_o for configurations shown.



Q2: Sketch *vo* for each network of Figure for the input shown. Would it be a good approximation to consider the diode to be ideal for both configurations? Why?



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Q3. For the network of Figure:

(a) Calculate 5.

(b) Compare 5 to half the period of the applied signal.

(c) Sketch *vo*.