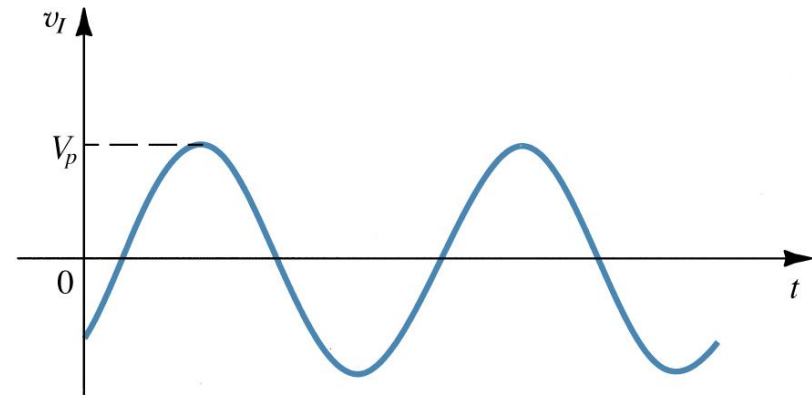
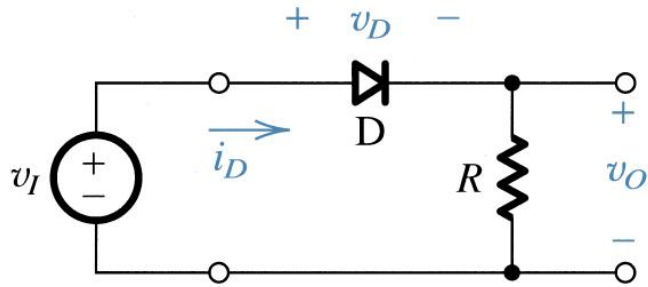


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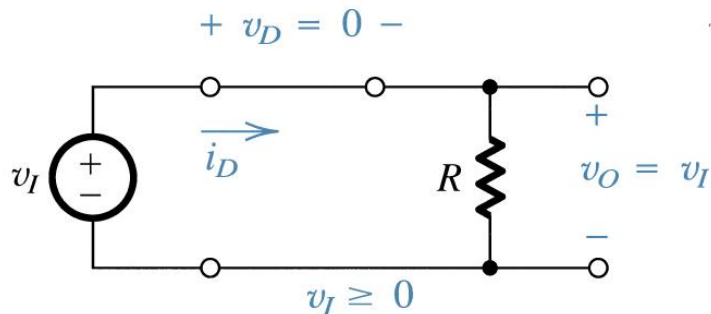
Analog Electronics

L3 Diode Applications 1
Instructor: Nasser Ismail

Large Signal Analysis (Sinusoidal Input)

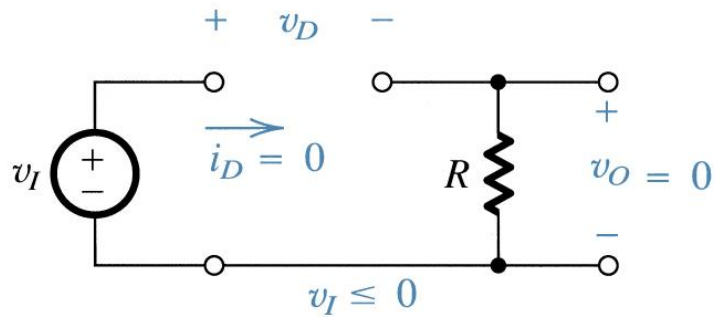


1) When $V_i(t) > 0$, diode is ON (Forward Biased) and it can be replaced by short circuit
 $\implies V_o(t) = V_i(t)$

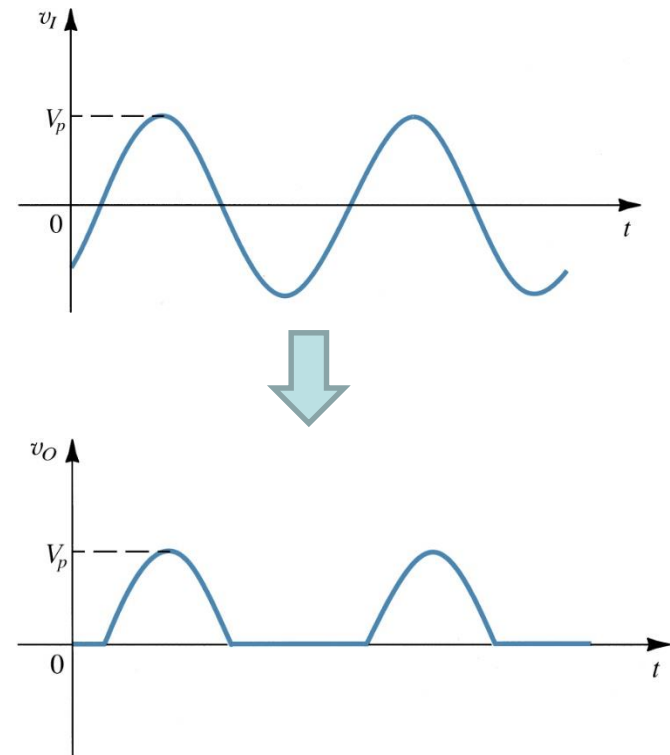


Large Signal Analysis (Sinusoidal Input)

2) When $V_i(t) < 0$, diode is OFF (Reverse Biased) and it can be replaced by open circuit
 $\implies V_o(t)=0$

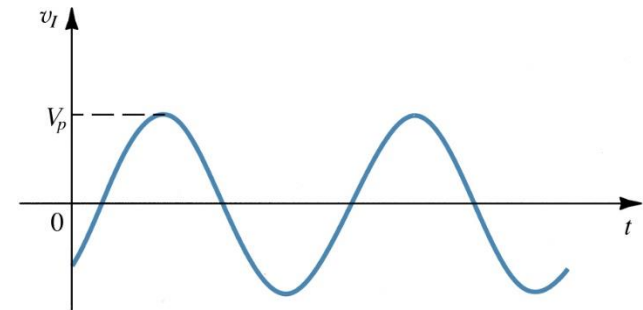
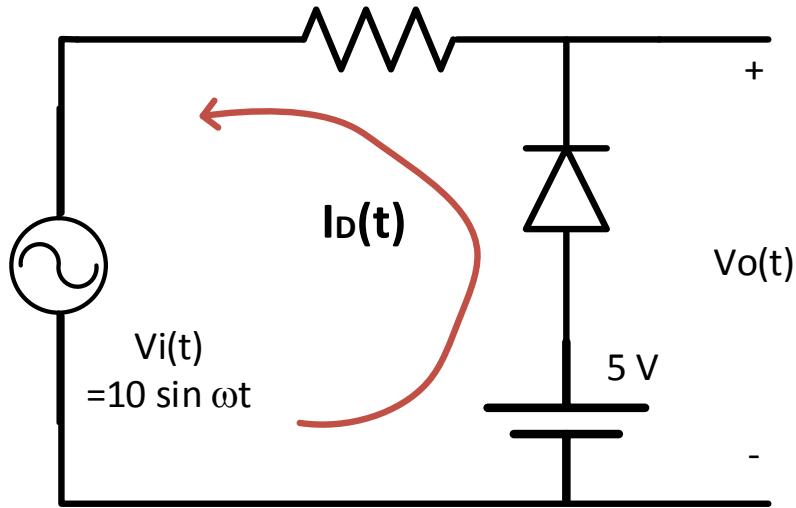


3) Total $V_o(t)$ waveform for ideal diode and simplified diode model is shown

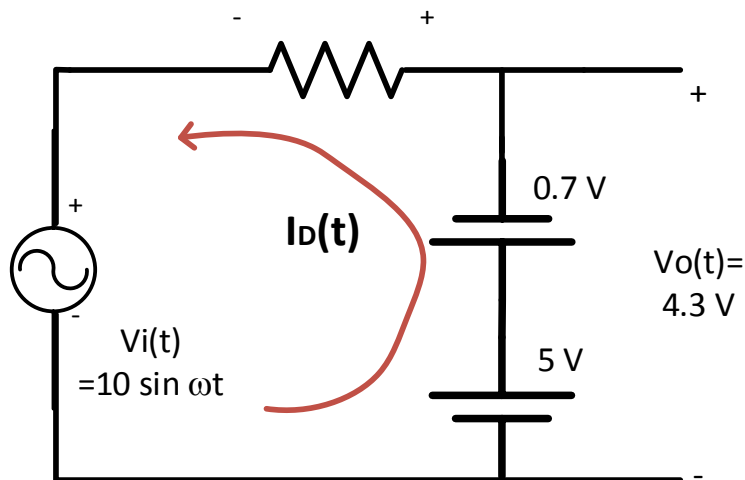


Limiters (=Clipping circuits) (1)

Example: Calculate and sketch $V_o(t)$ using simplified diode model



1) Assume diode is ON, so we replace it by 0.7 V and $i_D(t)$ must be > 0

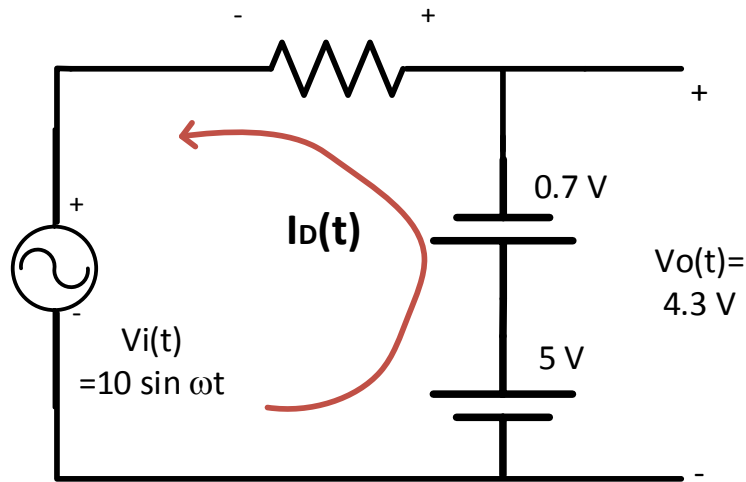


$$5V - 0.7V - i_D(t) \cdot R - V_i(t) = 0$$

$$i_D(t) \cdot R = 4.3V - V_i(t)$$

$$i_D(t) = \frac{4.3V - V_i(t)}{R} > 0$$

Limiters (=Clipping circuits) (2)

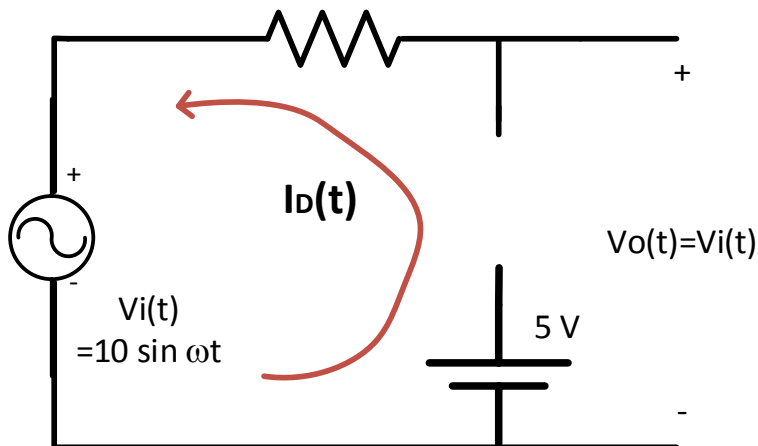


$$\therefore 4.3\text{V} - V_i(t) > 0$$

$$\Rightarrow V_i(t) < 4.3\text{V}$$

when $V_i(t) < 4.3\text{ V}$ diode is ON and
 $V_o(t) = 4.3\text{ V}$

2) Otherwise, When $V_i(t)$ is $> 4.3\text{ V}$, Diode will be off and it is replaced by open circuit



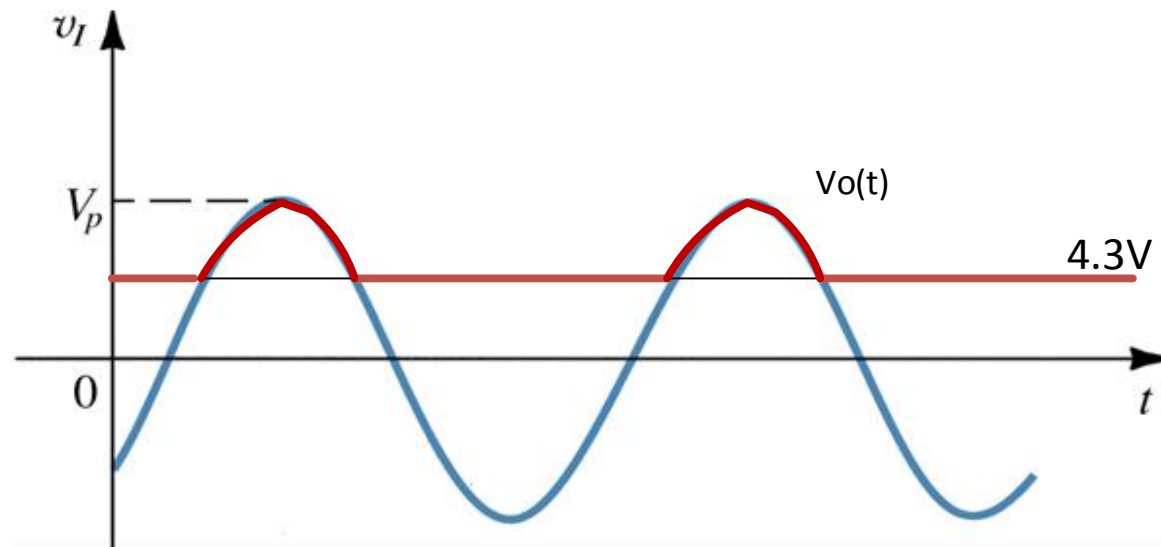
$$\Rightarrow V_i(t) > 4.3\text{V}$$

$$V_o(t) = V_i(t)$$

Limiters (=Clipping circuits) (3)

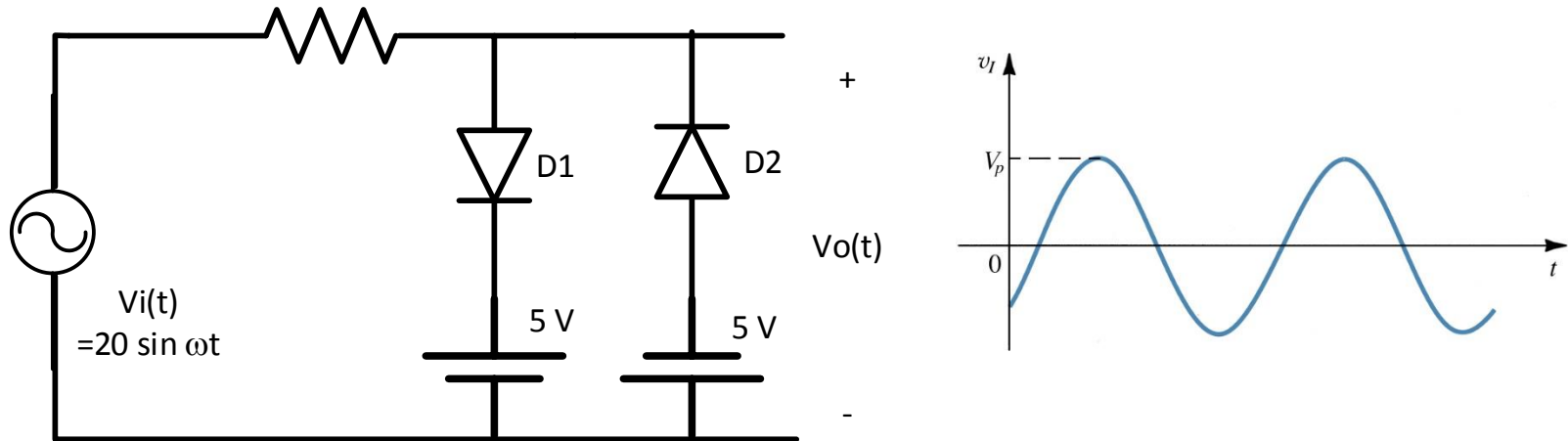
when $V_i(t) < 4.3V$, diode is ON & $V_o(t) = 4.3V$

when $V_i(t) > 4.3V$, diode is off & $V_o(t) = V_i(t)$



Circuit Containing Two diodes

Example: Calculate and sketch $V_o(t)$ using simplified diode model

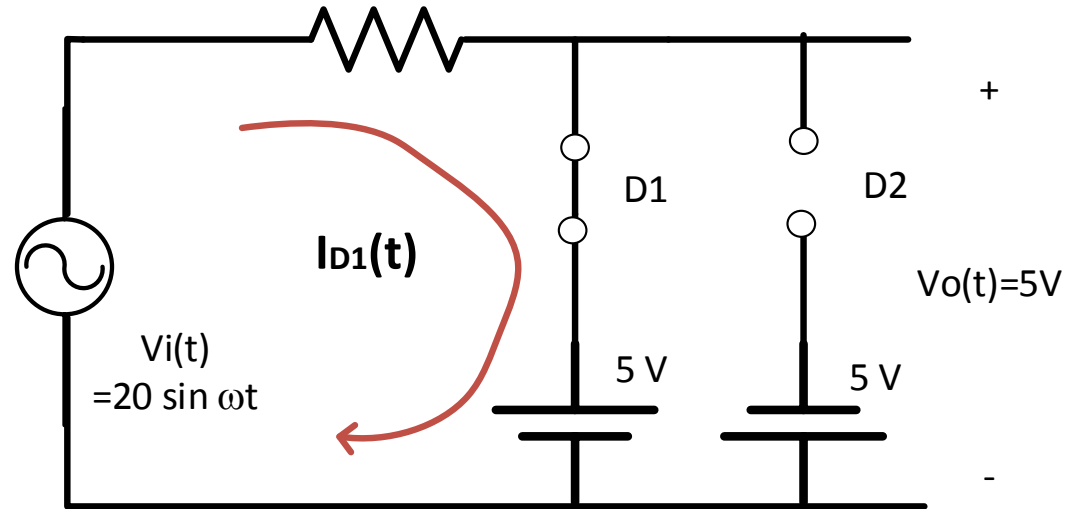


Since the circuit contains two diodes, each of them can be either On or Off, then there is 4 possible combinations for the states of D_1 and D_2

- 1) Assume D1 is ON and D2 is OFF

$$i_{D1}(t) > 0$$

$$i_{D1}(t) = \frac{V_i(t) - 5}{R} > 0$$

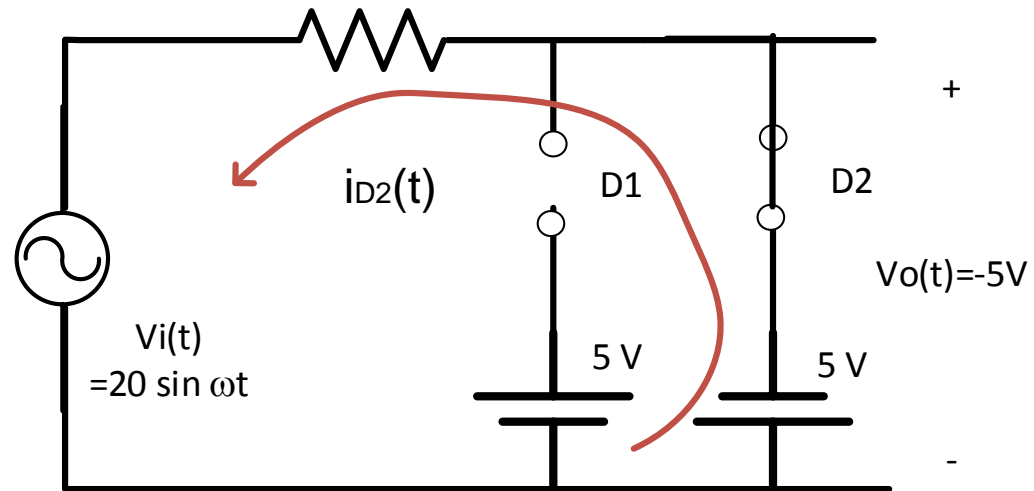


when $V_i(t) > 5V$, $V_o(t) = 5V$

2) Assume D2 is ON and D1 is OFF

$$i_{D2}(t) > 0$$

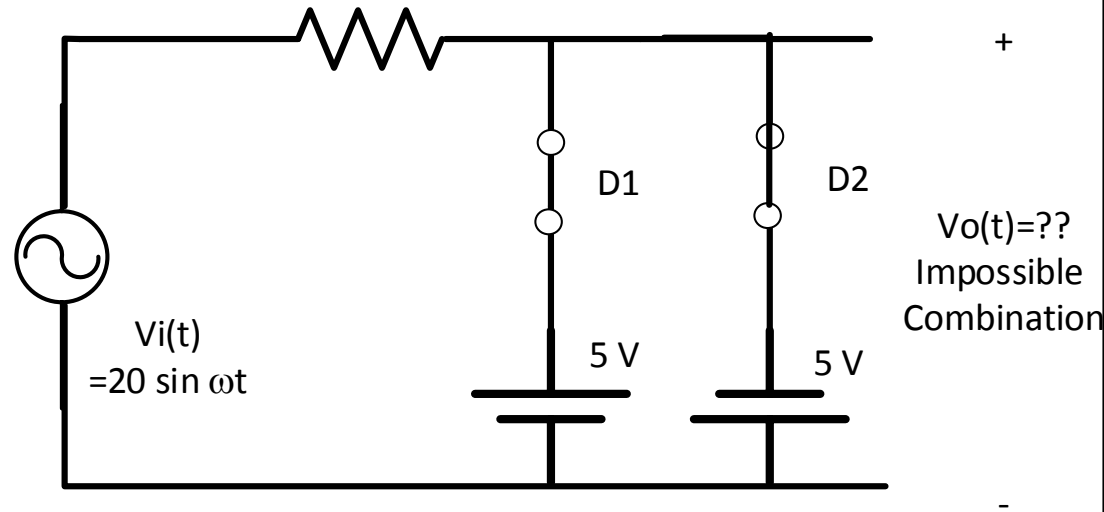
$$i_{D2}(t) = \frac{-V_i(t) - 5}{R} > 0$$



when $V_i(t) < -5V$, $V_o(t) = -5V$

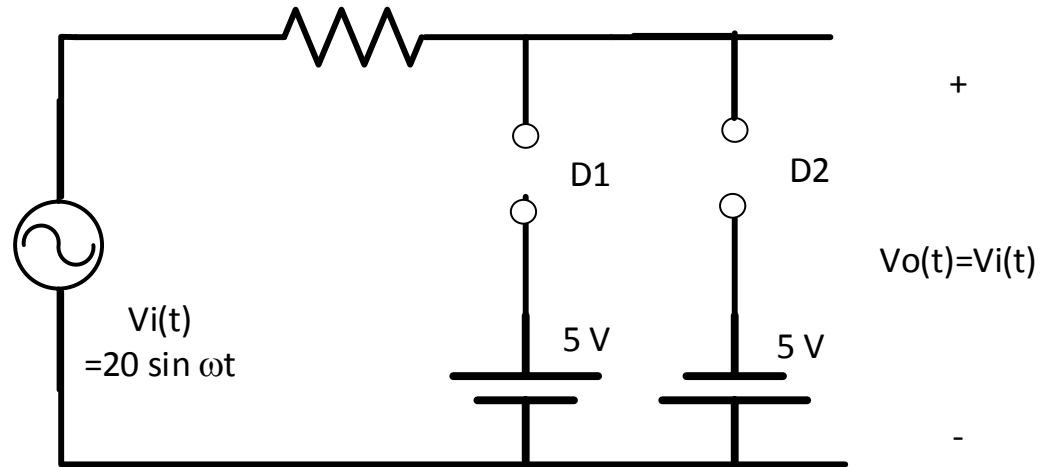
3) Assume D1 & D2 are ON

This invalid configuration and impossible to occur



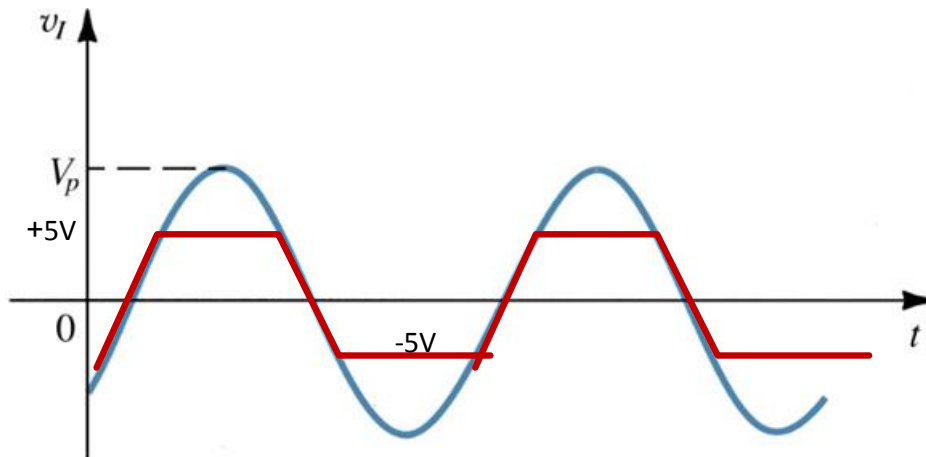
4) Assume D1 & D2 are both OFF

$$V_o(t) = V_i(t)$$

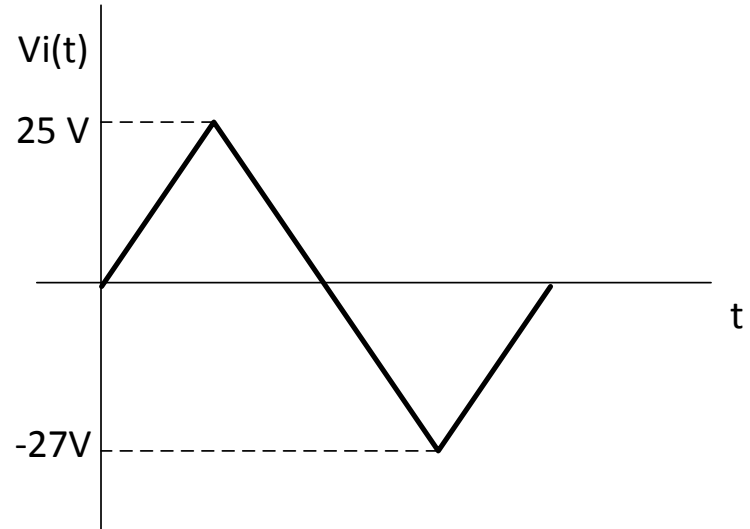
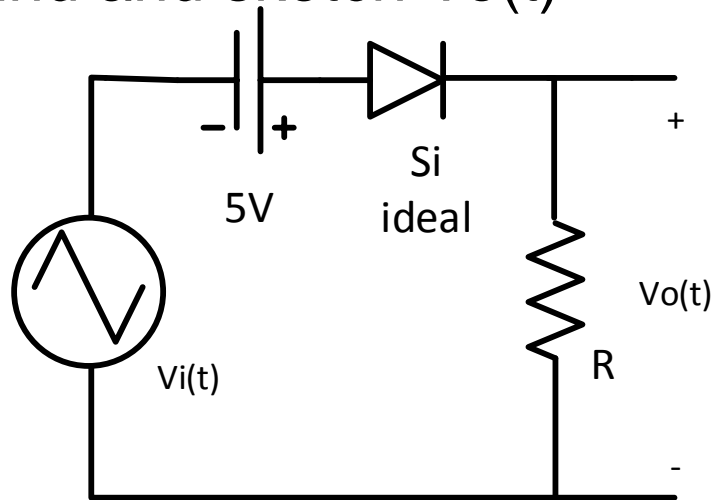


This occurs for the remaining part of the input voltage waveform:

$$-5V < V_i(t) < 5V$$

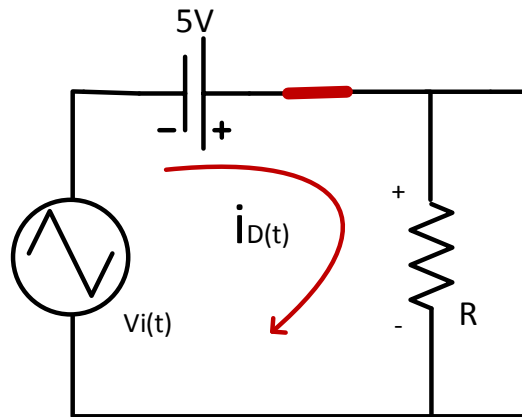


Find and sketch $V_o(t)$



Solution:

1) Assume diode is ON, so we replace it by short and $i_D(t)$ must be > 0



$$5V - i_D(t) \cdot R + V_i(t) = 0$$

$$i_D(t) \cdot R = 5V + V_i(t)$$

$$i_D(t) = \frac{5V + V_i(t)}{R} > 0$$

$$\therefore V_i(t) > -5V$$

$$\Rightarrow V_o(t) = V_i(t) + 5$$

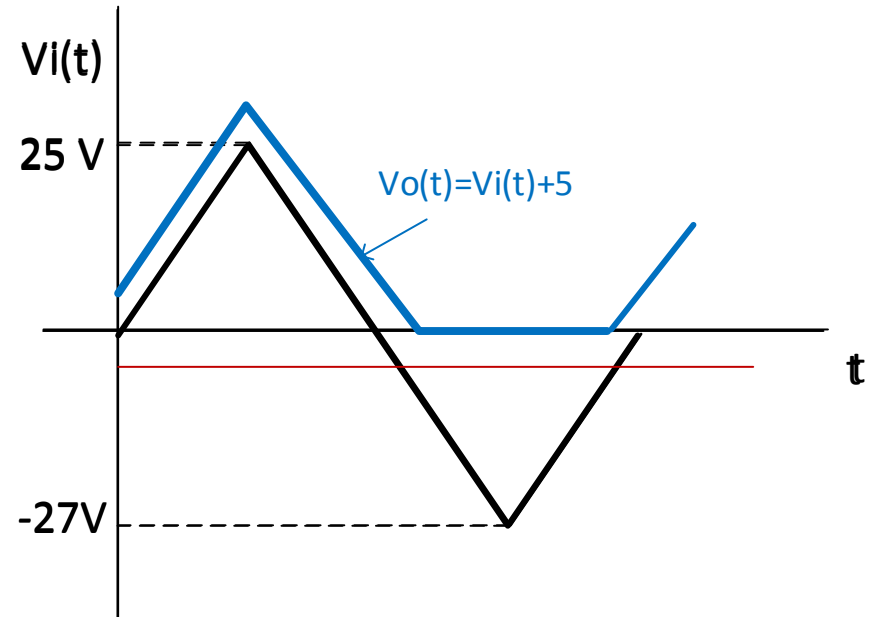
2) Otherwise

For $V_i(t) < -5 \text{ V}$

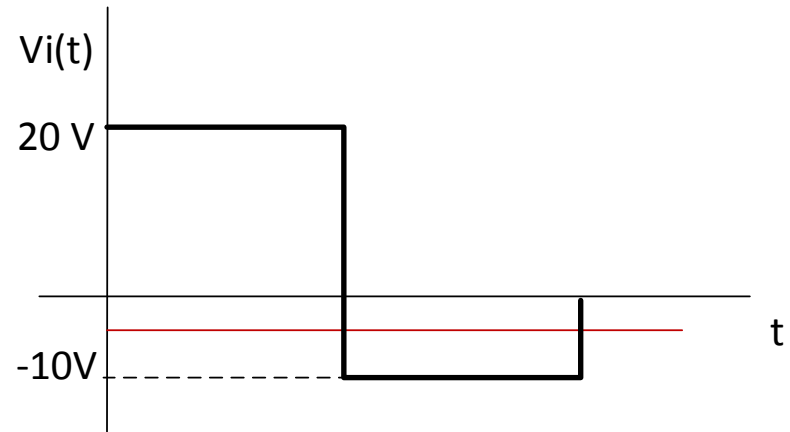
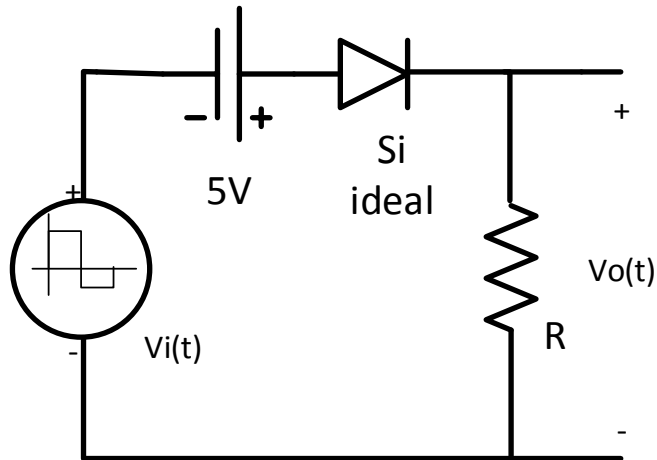
Diode is OFF

$$\Rightarrow i_D(t) = 0$$

$$V_o(t) = 0$$



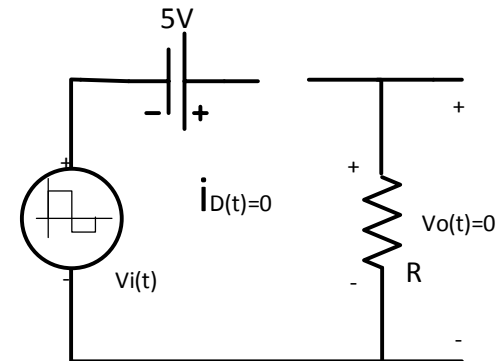
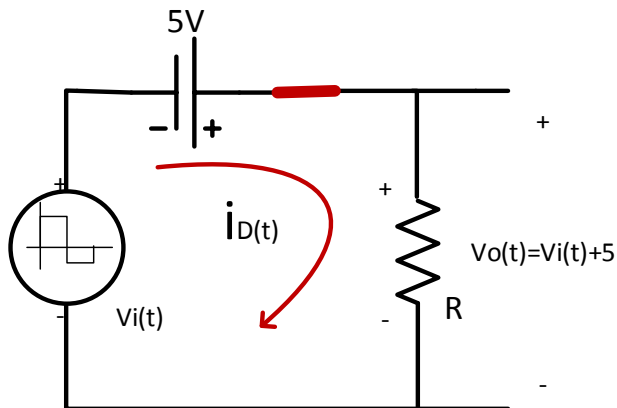
Find and sketch $V_o(t)$

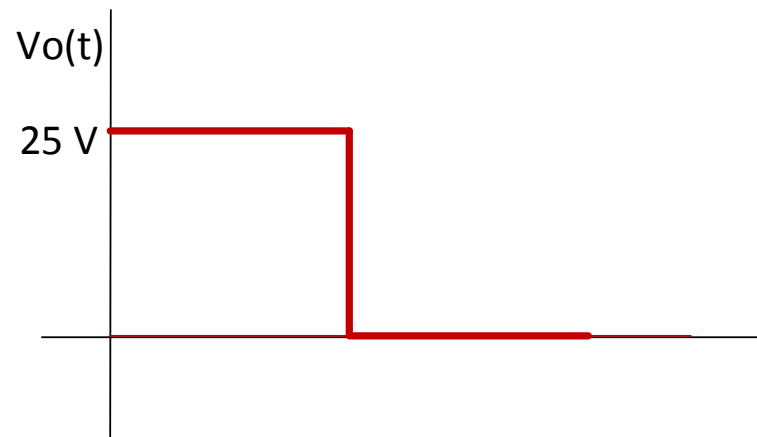
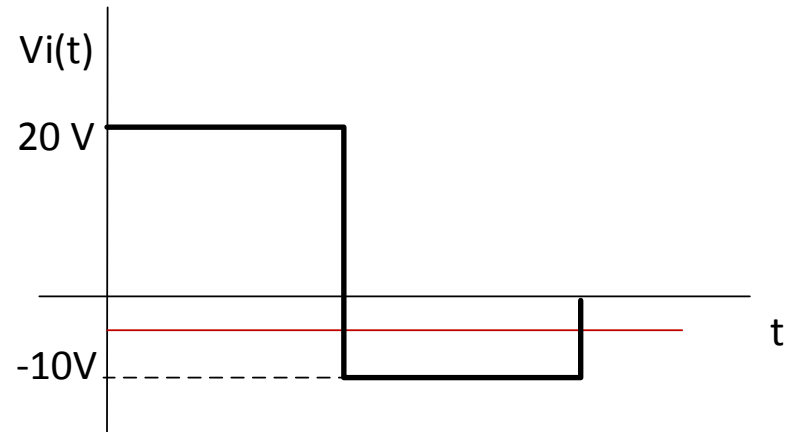
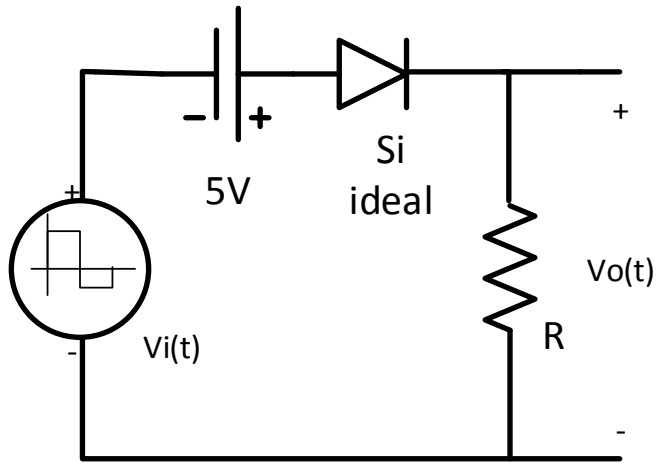


Solution:

1) When $V_i(t)=20\text{V}$, Diode is ON and $V_o(t)=20+5=25\text{ V}$

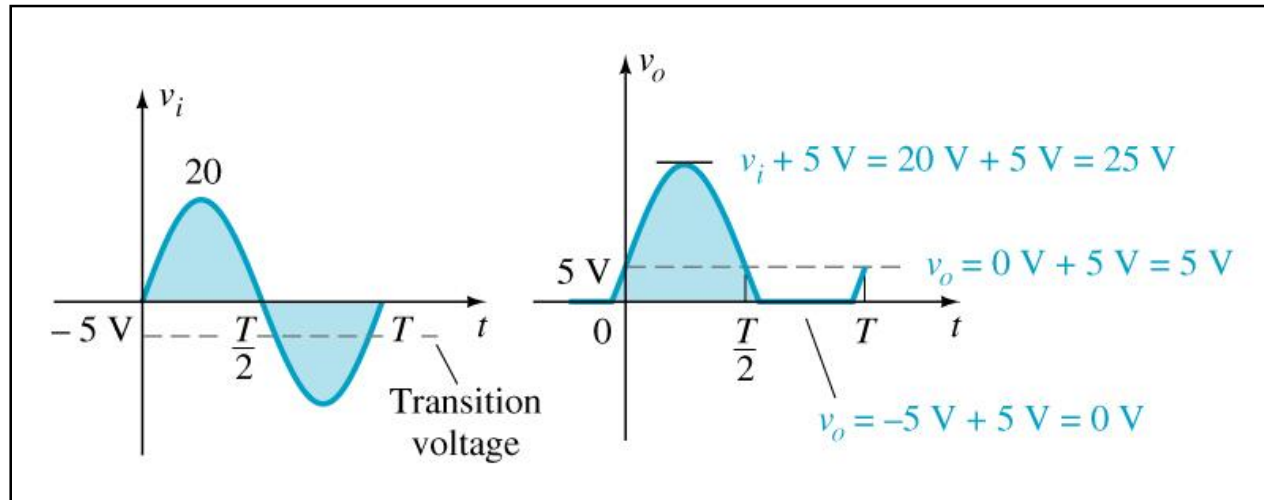
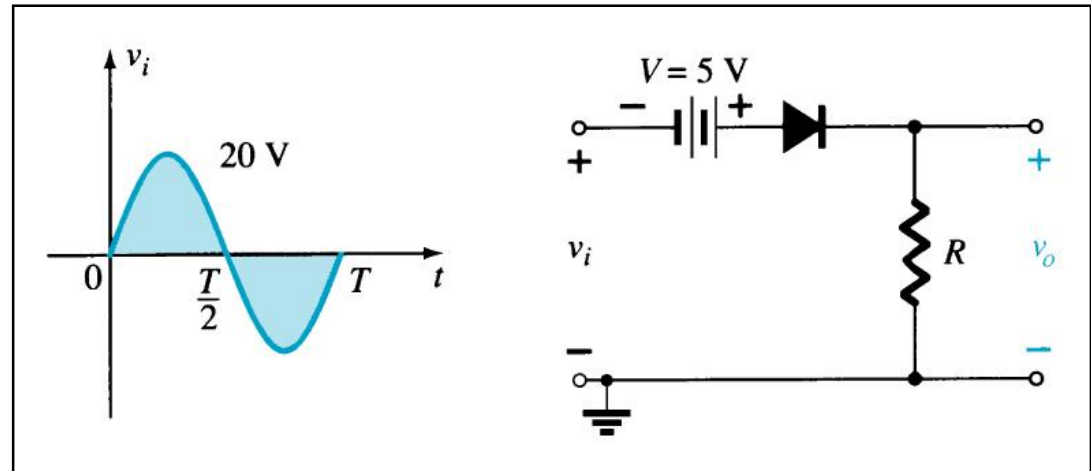
2) When $V_i(t)=-10\text{ V}$, Diode is OFF and $V_o(t)=0$





Biased Clippers

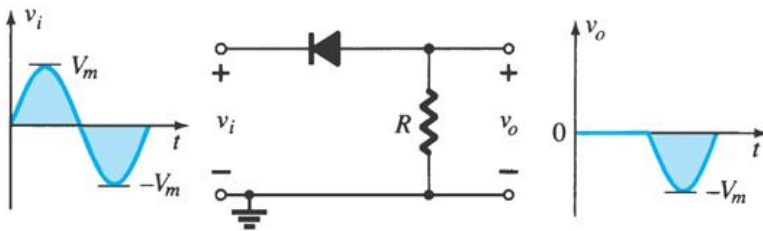
Adding a DC source in series with the clipping diode changes the effective forward bias of the diode.



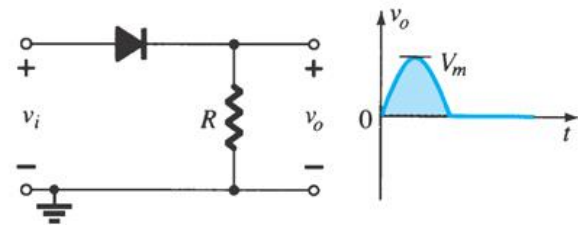
Summary of Clipper Circuits

Simple Series Clippers (Ideal Diodes)

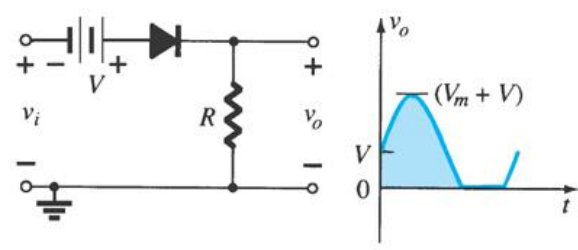
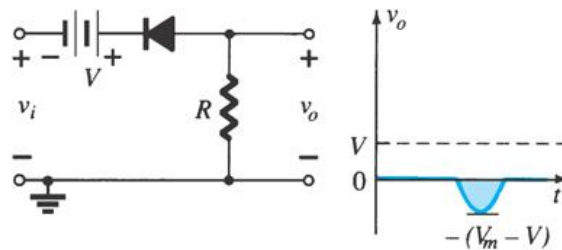
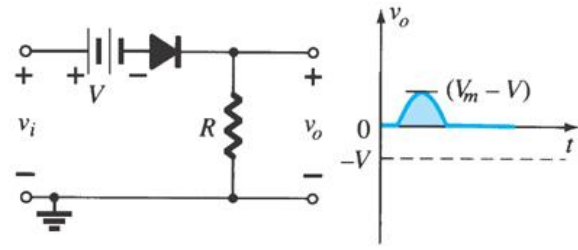
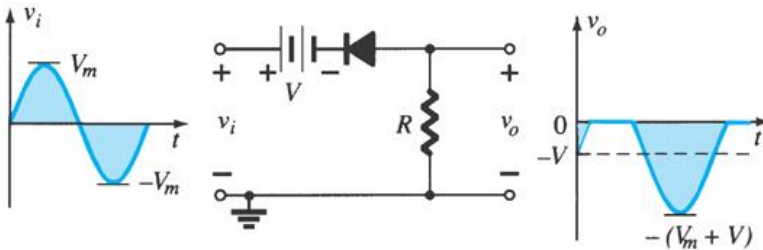
POSITIVE



NEGATIVE

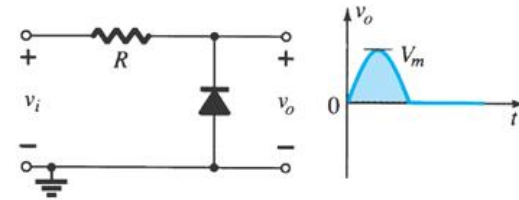
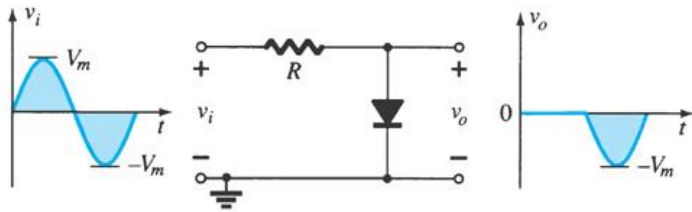


Biased Series Clippers (Ideal Diodes)

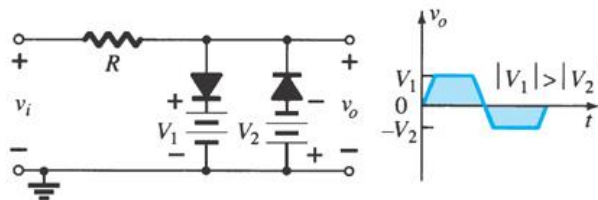
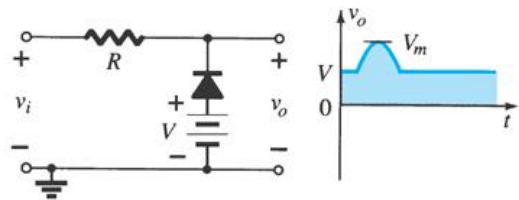
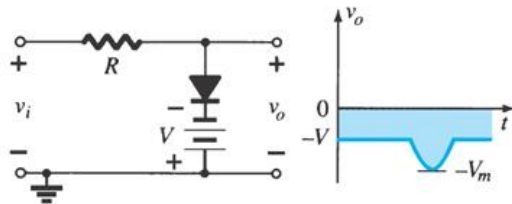
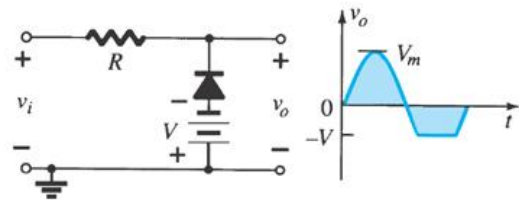
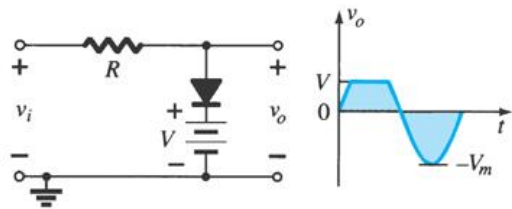


Summary of Clipper Circuits

Simple Parallel Clippers (Ideal Diodes)



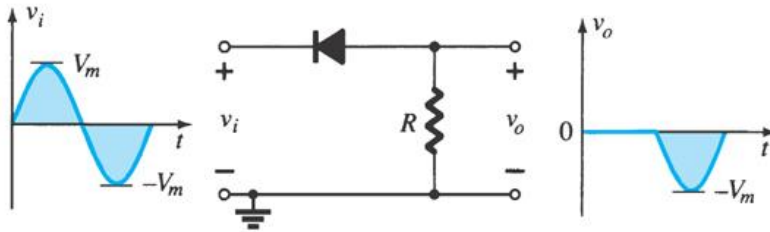
Biased Parallel Clippers (Ideal Diodes)



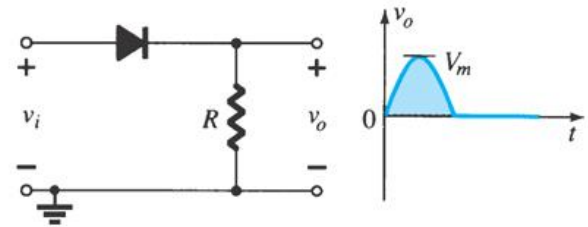
Summary of Clipper Circuits

Simple Series Clippers (Ideal Diodes)

POSITIVE



NEGATIVE



Biased Series Clippers (Ideal Diodes)

