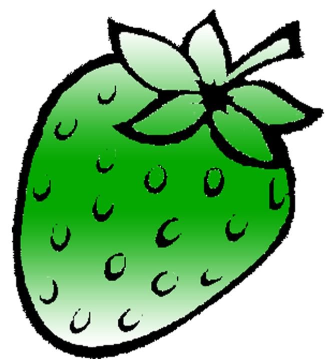
STRAWBERRY



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Unit 2-Applications of diode

Contents

Clippers

- Clippers, limiters or clipping circuits make use of non-linear properties of diode, that is the diode conduct the current in forward direction and does not conduct in reverse direction.

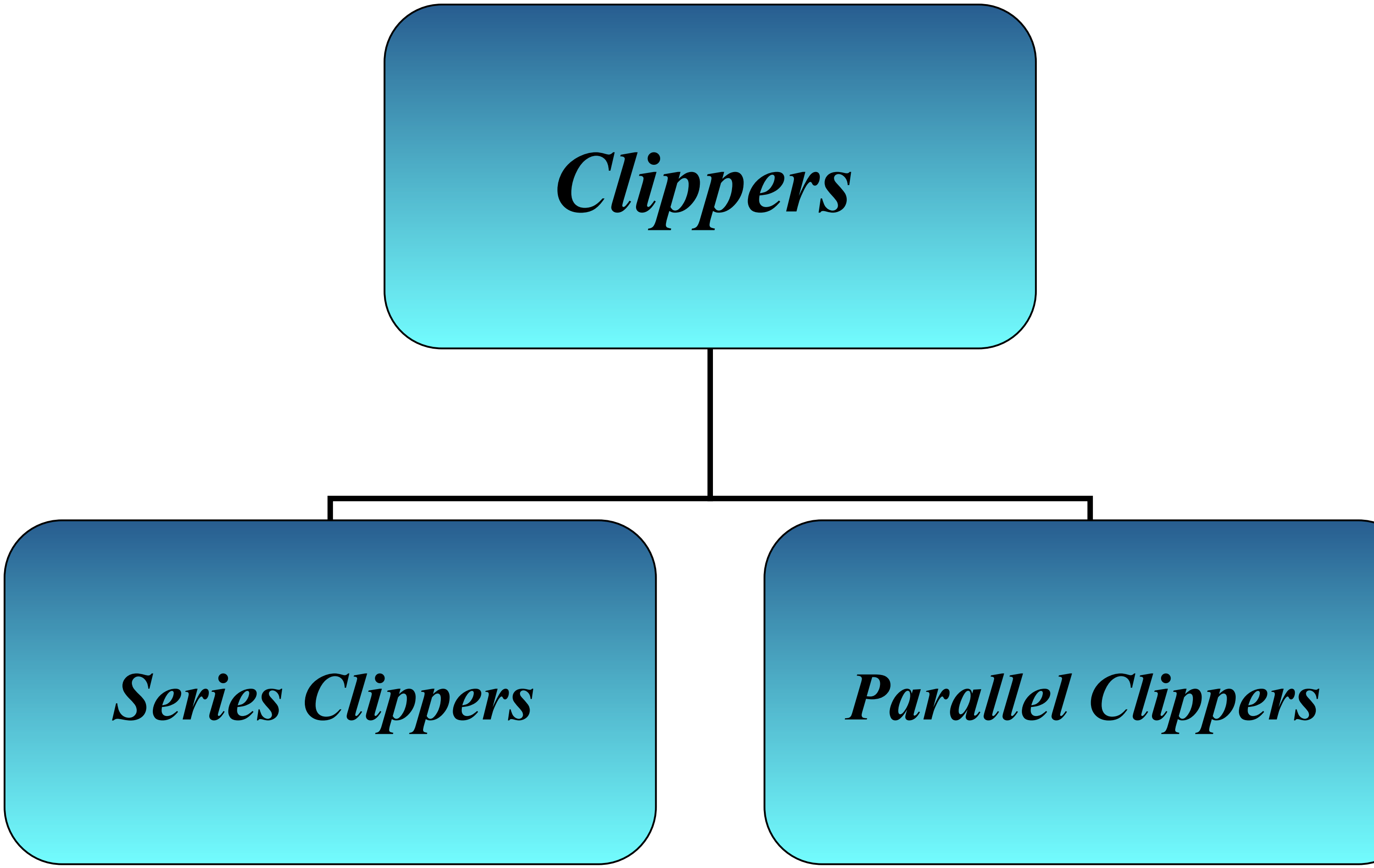
Basic operating Principle:

- These circuits are primarily are wave shaping circuits.
- They clip or remove certain portion of ac voltage applied to the input of circuit.

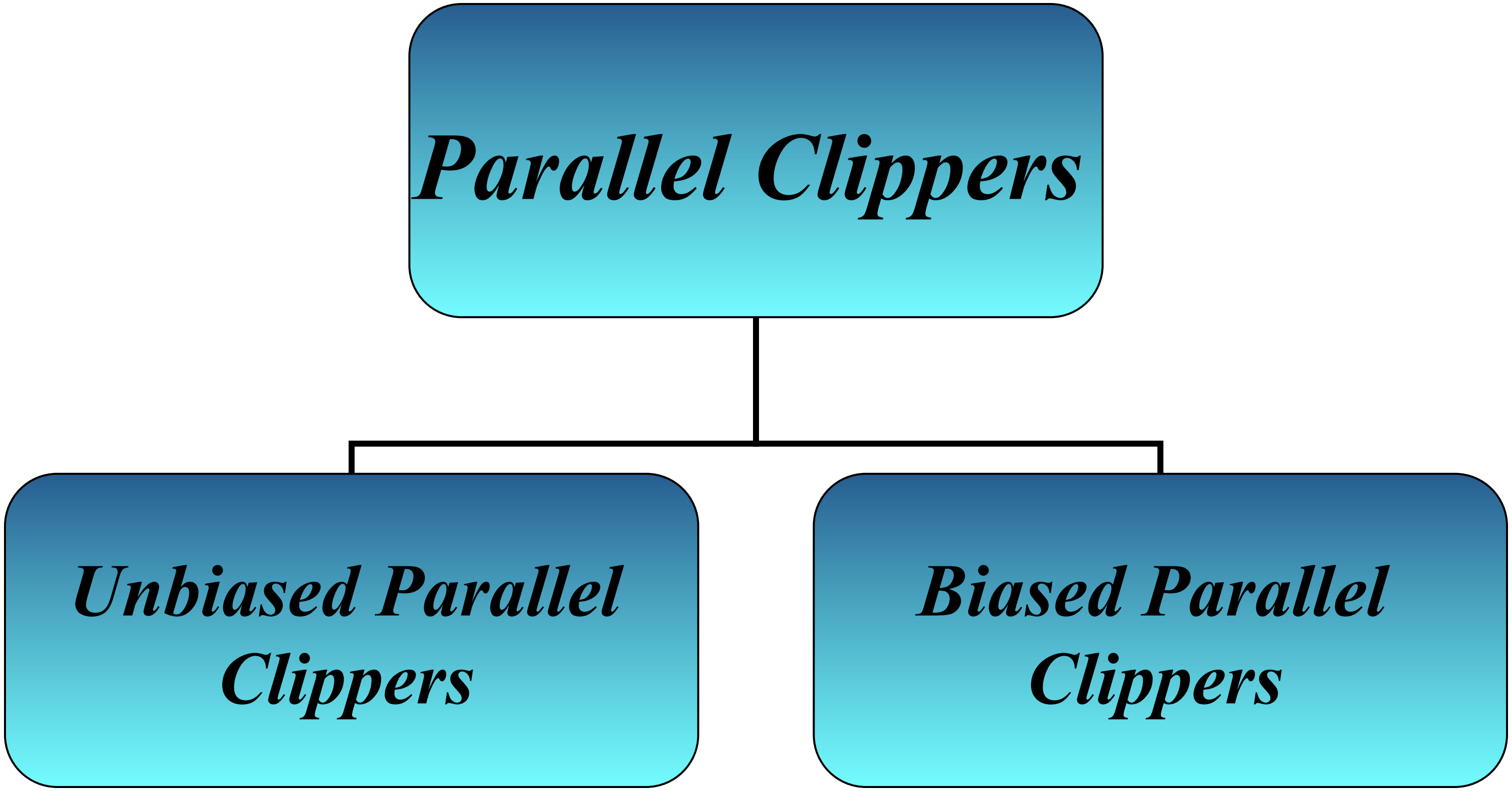
Applications of Clippers:

- They need to clip the voltage above or below a certain pre-determined voltage level arises in the television, digital computers, radar, and many other electronic circuits.

Types of Clippers



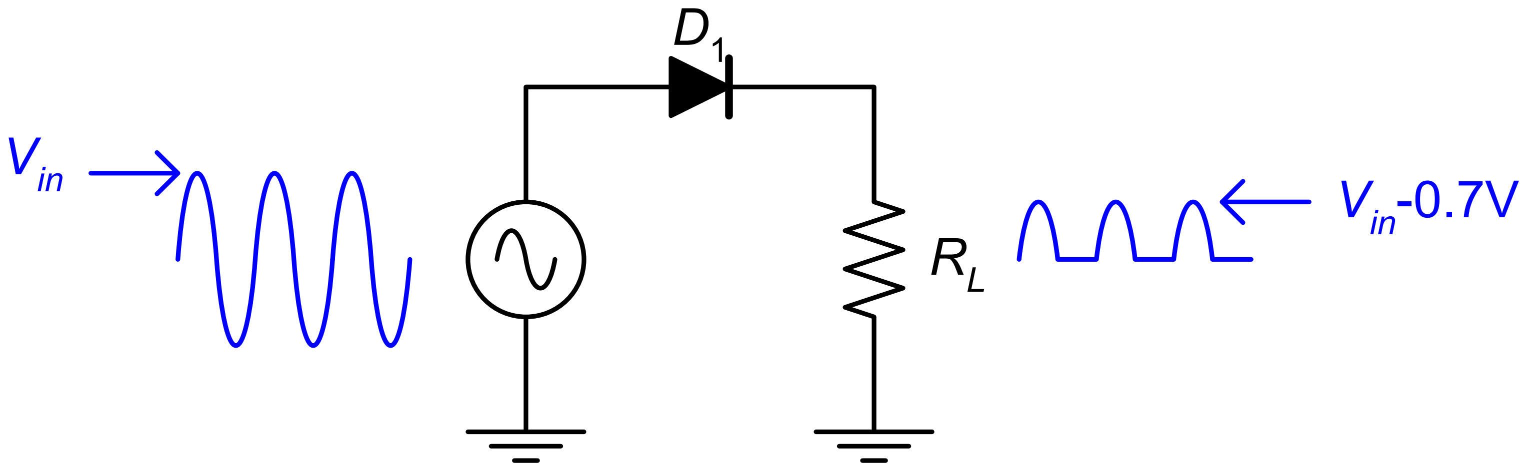
Further Classification:



Further Classification (Cont..) :

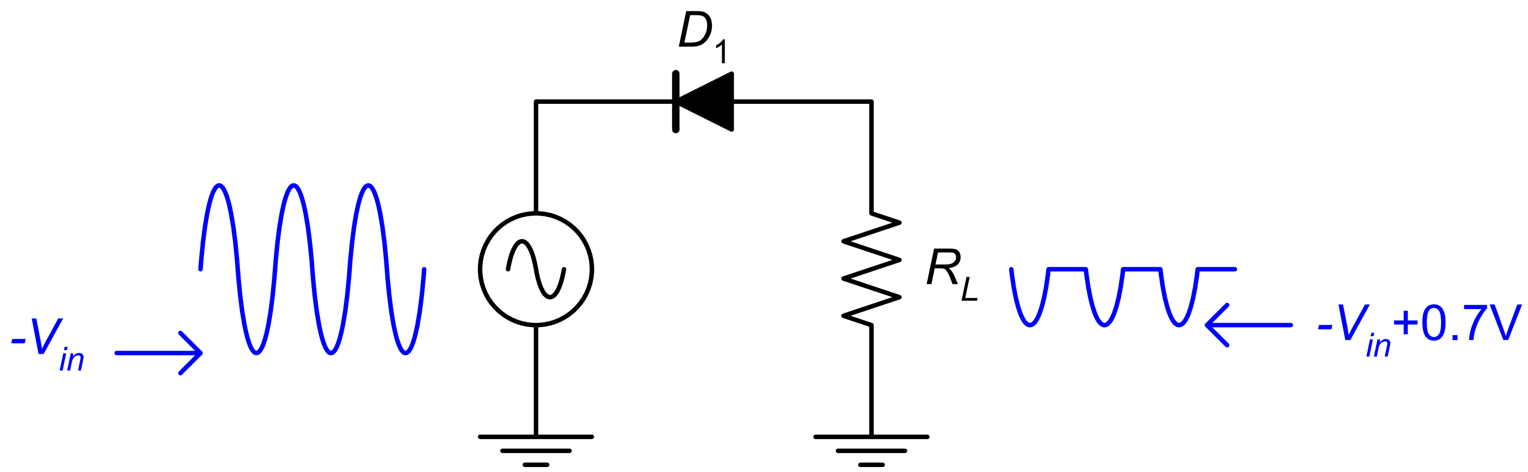
- ***Series Clippers***
  - ***Unbiased Series Clippers***
  - ***Biased Series Clippers***

Series Clipper (limiter) circuits. (practical diode)



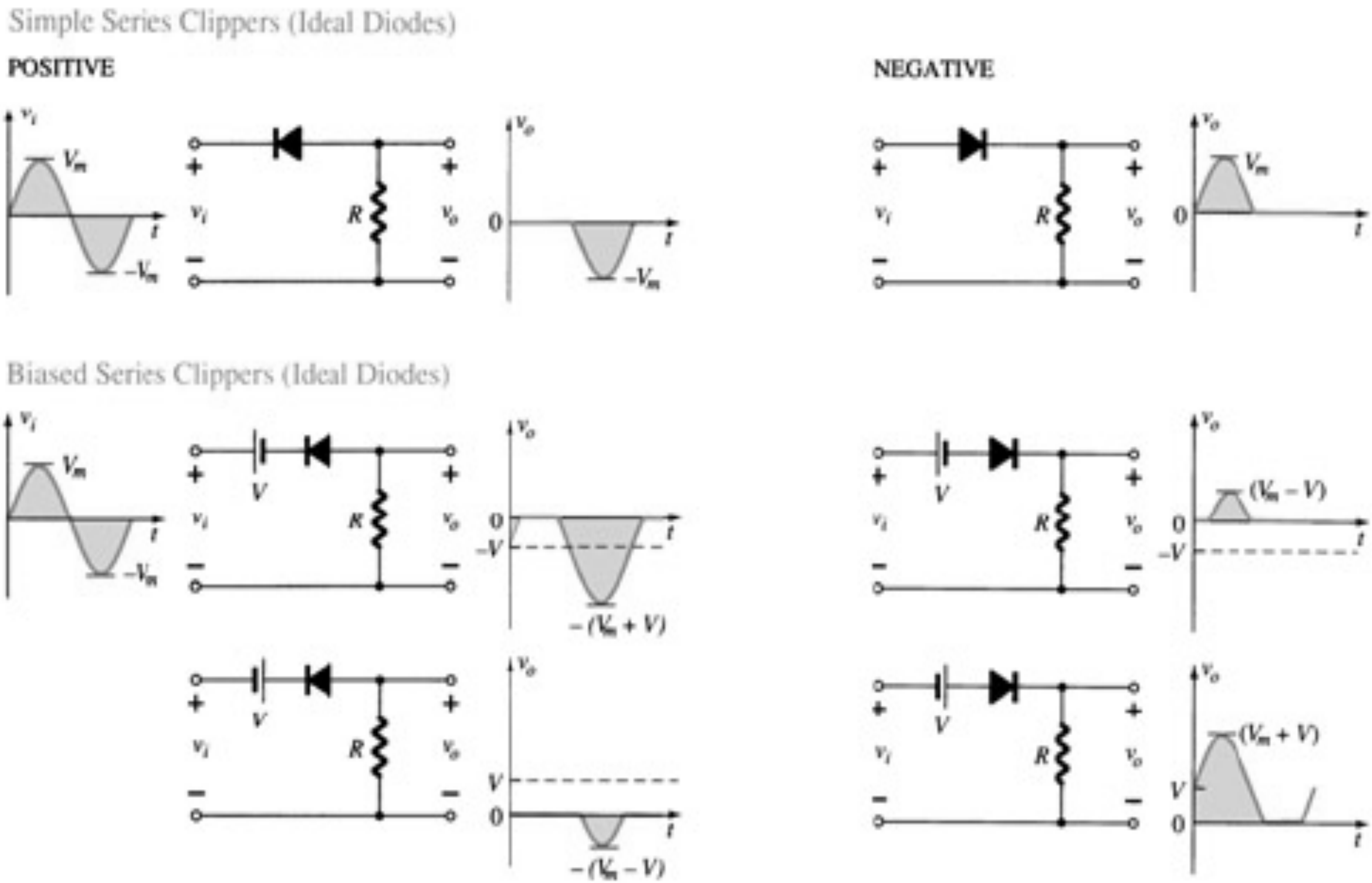
Negative series clipper.

Series Clipper circuits. (Practical diode)

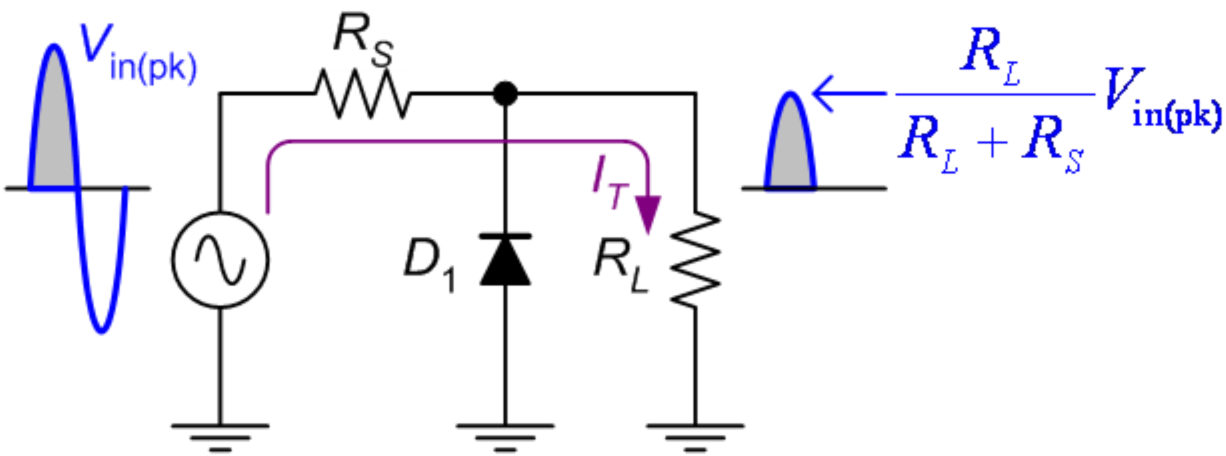


Positive series clipper.

Series Clipper Circuit Summary

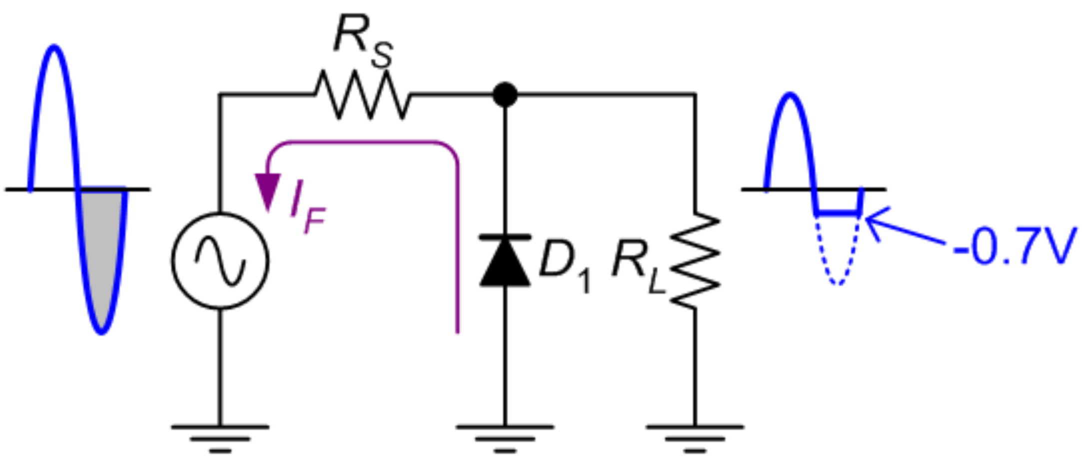


Parallel Negative Clipper circuits. (ideal diode)

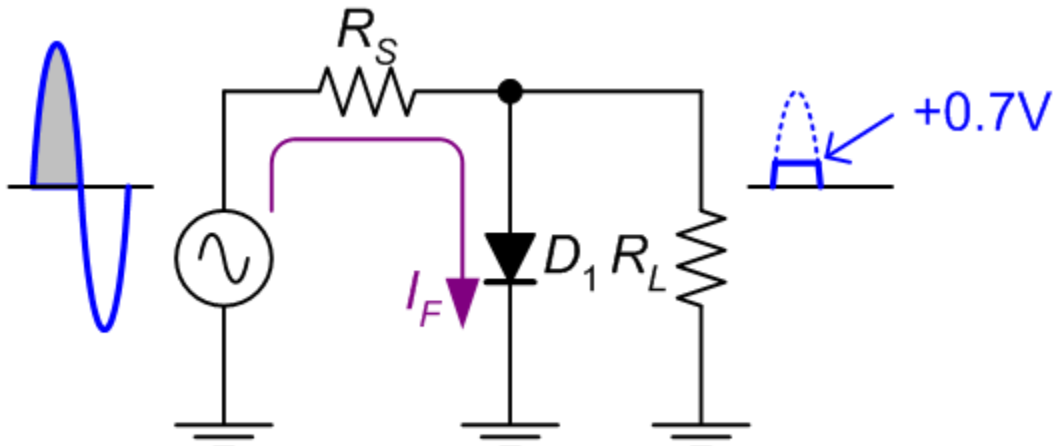


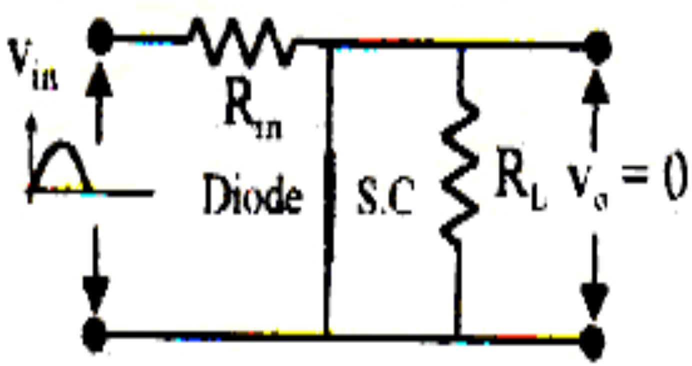
Negative shunt clipper.

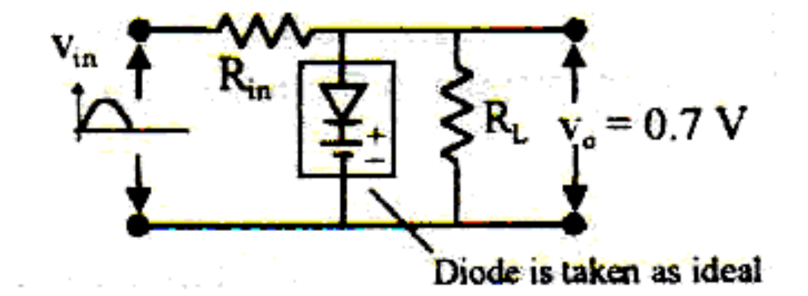
Parallel Negative Clipper circuits. (Practical diode)



Parallel Positive Clipper circuits.



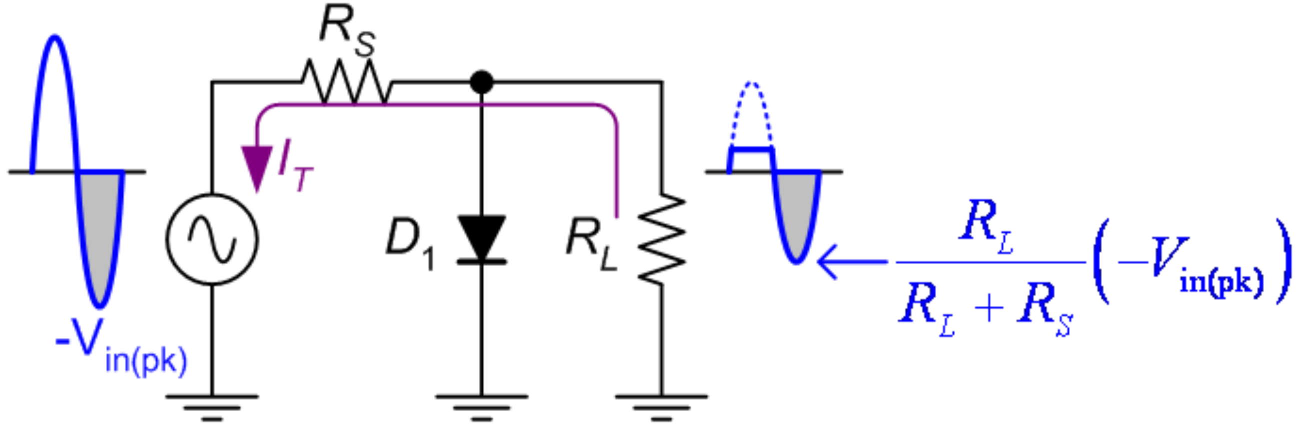


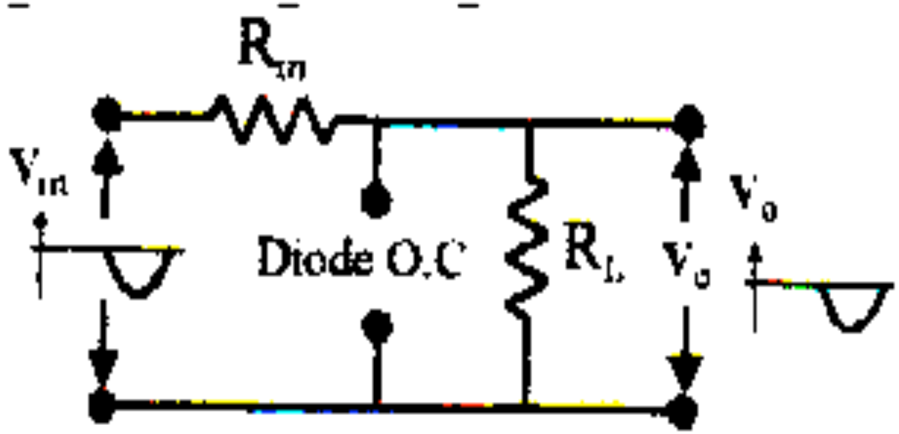


Ideal Diode

Practical Diode

Positive shunt clipper.





So, output voltage can be found by using VDR.

$V_o = V_{in} R_L/(R_{in}+R_L)$

Where $V_{in} = -V_m$.

Since, $R_L \gg R_{in}$.

So, R_{in} can be neglected in comparison to R_L.

Biased parallel clipper

Parallel Clippers

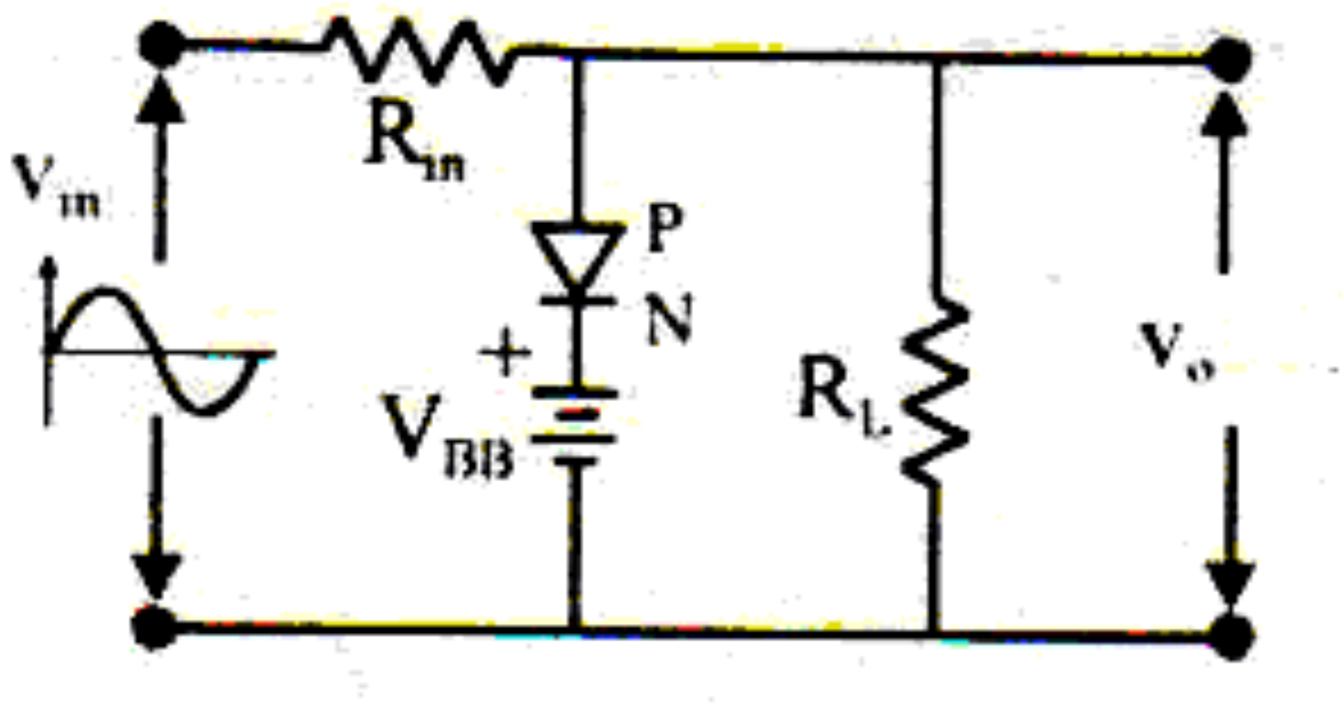
Biased Parallel Clipper:

- In parallel biased clipper, there is a battery connected in series with diode

Parallel Positive Clippers

Analysis of biased parallel clipper:

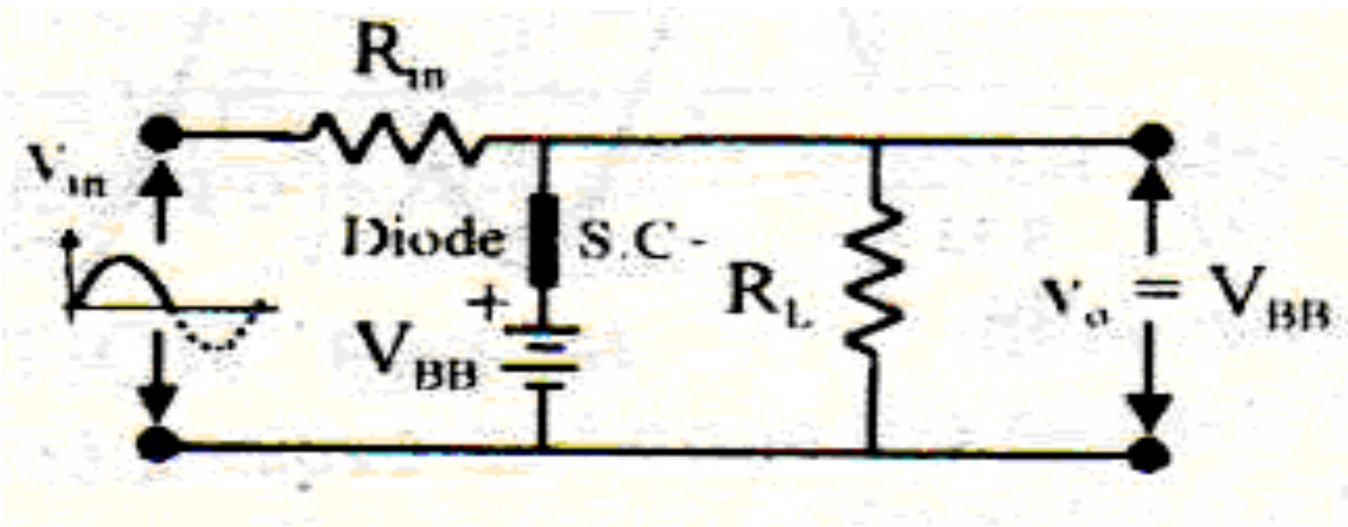
Ideal Diode:



Parallel Clippers

Analysis of biased parallel clipper:

<u>Ideal Diode:</u>

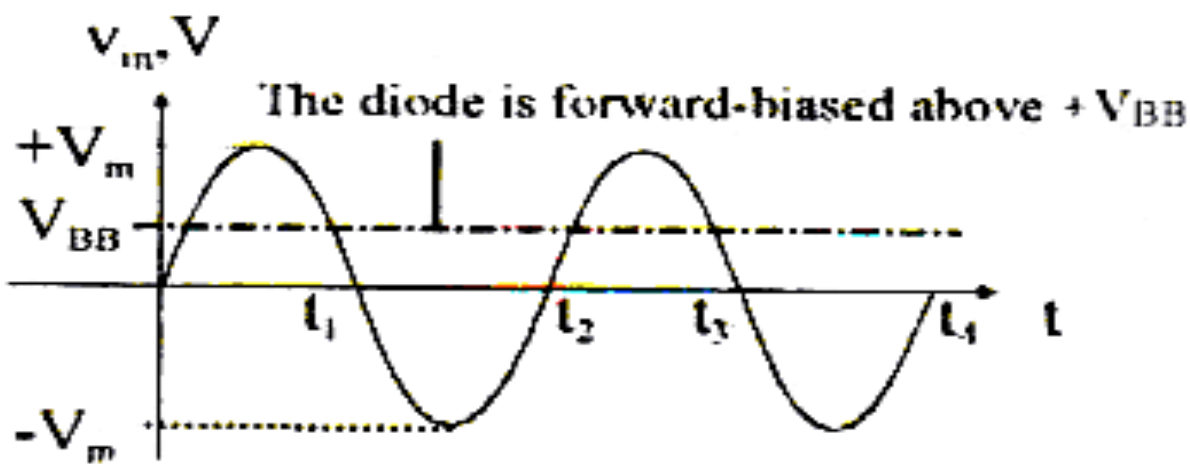


During positive half cycle

Parallel Clippers

Analysis of biased parallel clipper:

<u>Ideal Diode:</u>

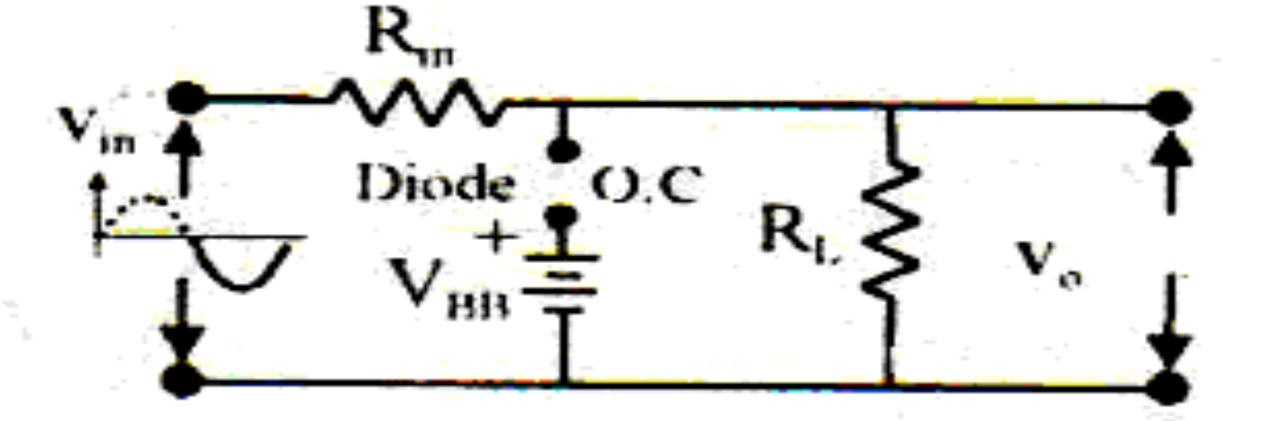


Output waveform during negative half cycle

Parallel Clippers

Analysis of biased parallel clipper:

Ideal Diode:

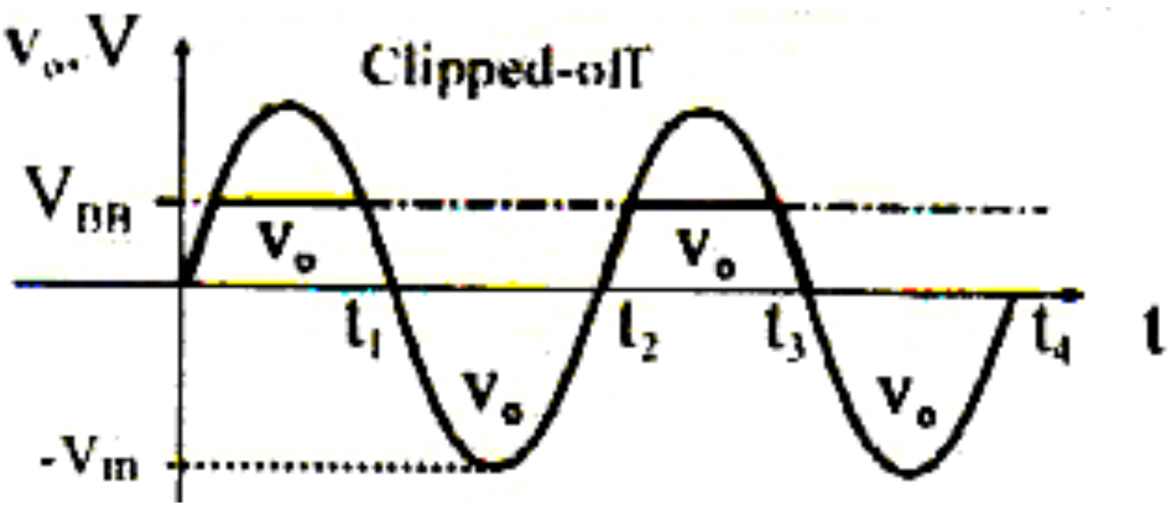


During the negative half cycle

Parallel Clippers

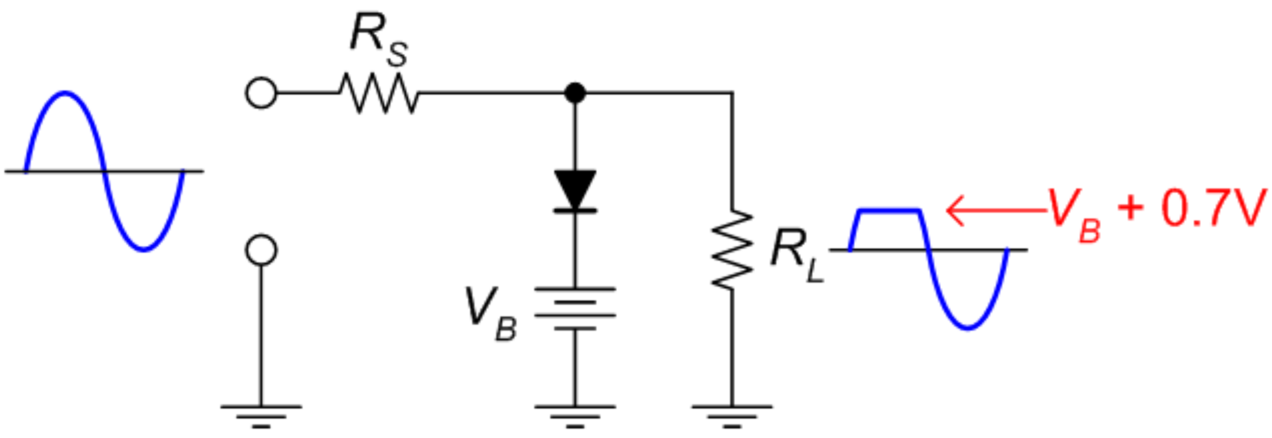
Analysis of biased parallel clipper:

Ideal Diode:

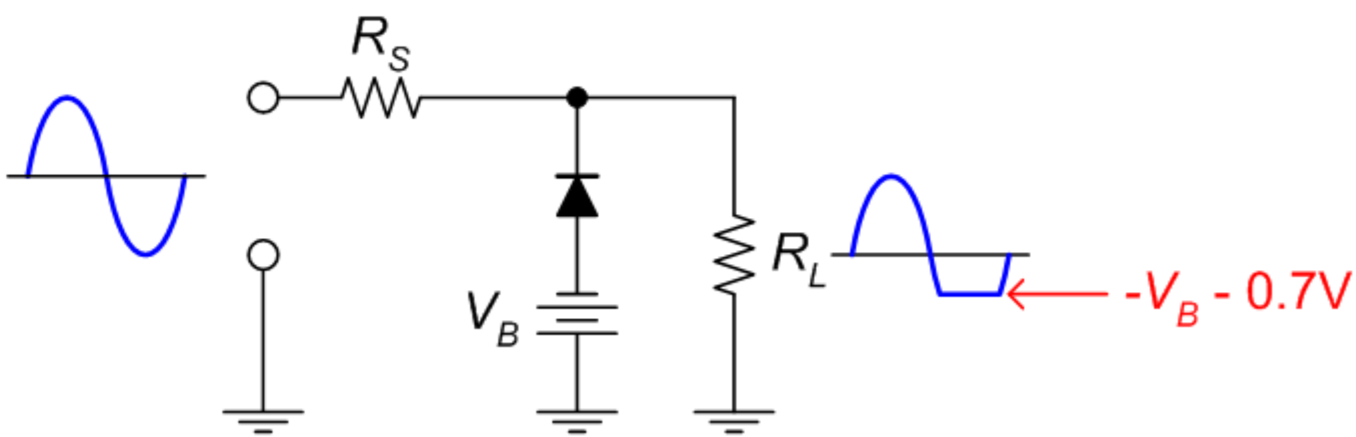


Output waveform during negative half cycle

Biased Positive Shunt Clipper circuits.



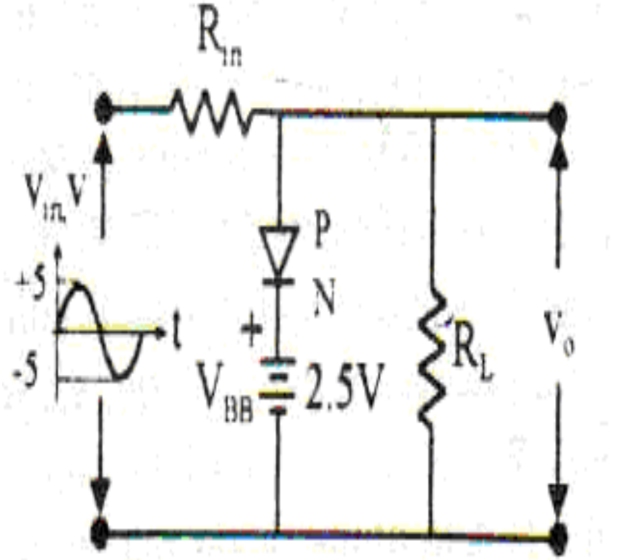
Biased Negative Shunt Clipper circuits.

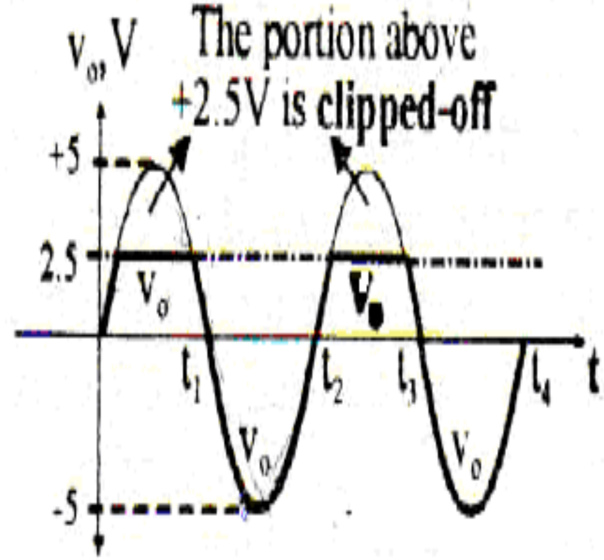


Design Problems

Parallel Clippers

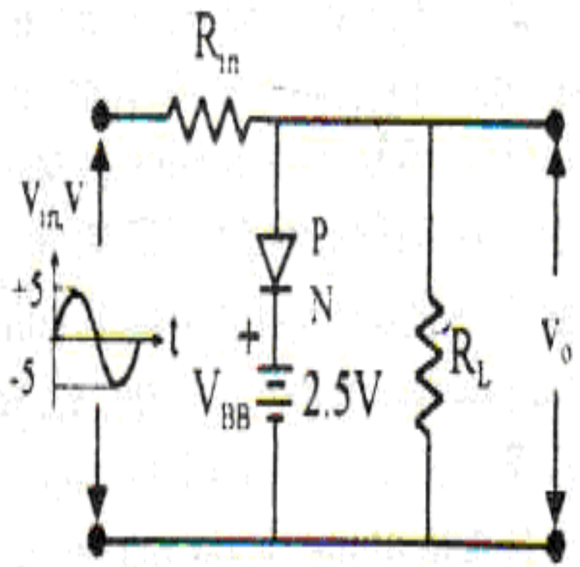
Draw the output waveform for the given clipper circuit (ideal Diode)

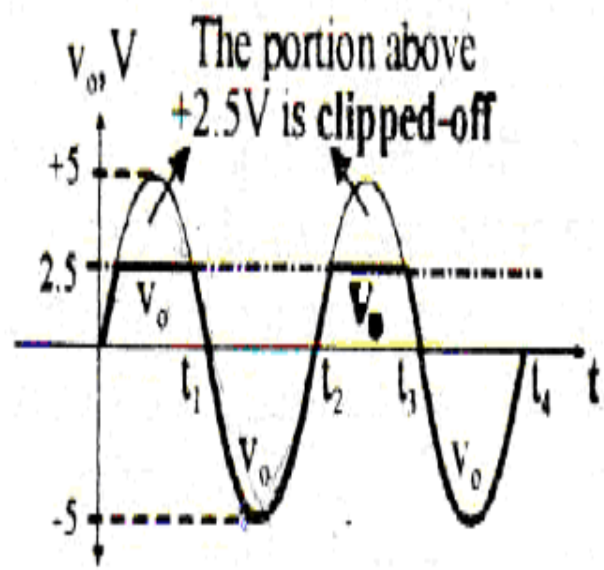




When , **Vin > VBB** (i.e. Vin>2.5V) , Diode D conducts and **Vo = 2.5V**

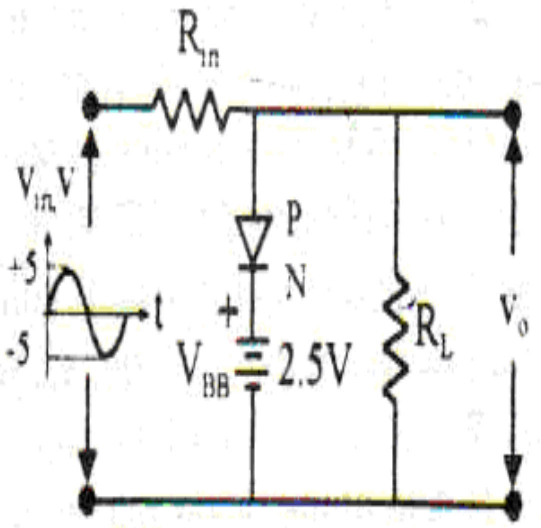
When , **Vin <VBB** , i.e.Vin < 2.5, Diode D is OFF and **Vo = Vin**

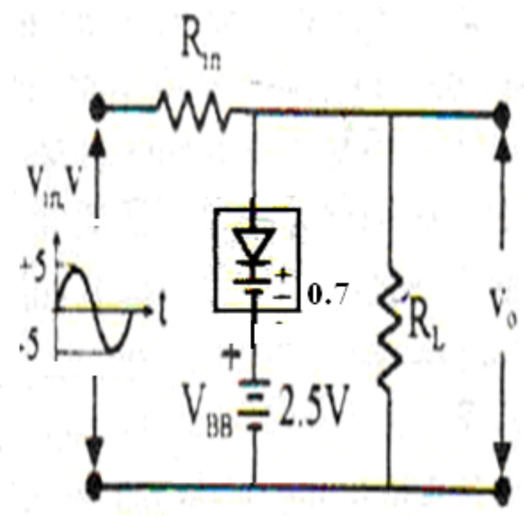


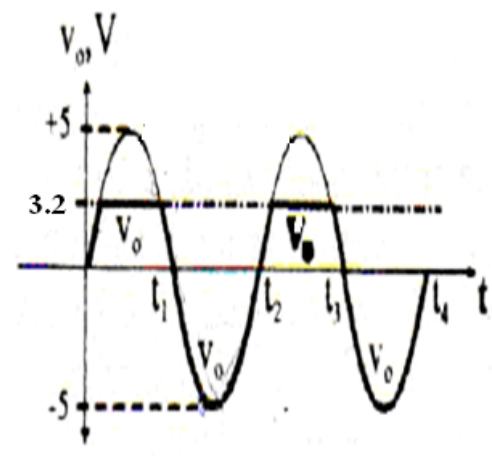


Non ideal diode

<u>Draw the output waveform for the given clipper circuit (non-ideal Diode)</u>

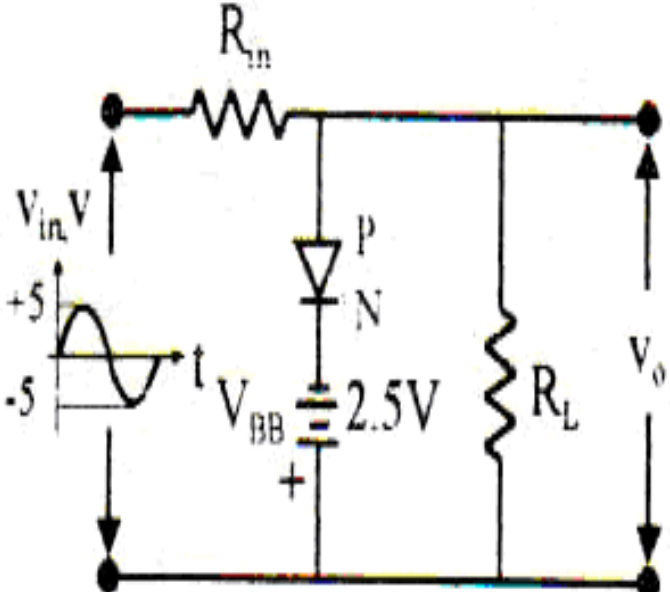


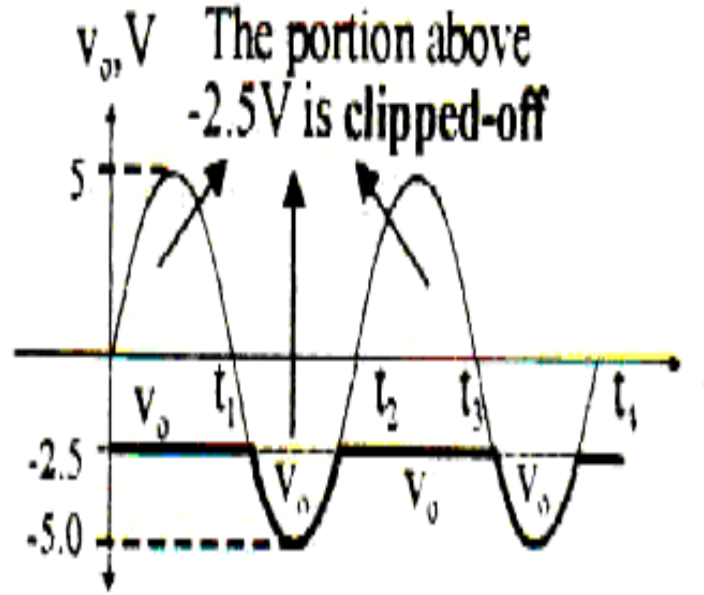




Parallel Clippers

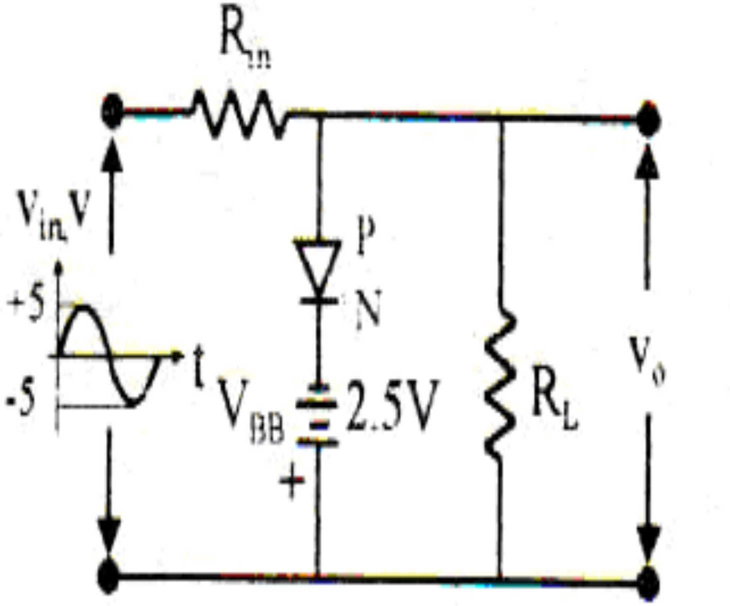
<u>Draw the output waveform for the circuit shown. (ideal diode)</u>

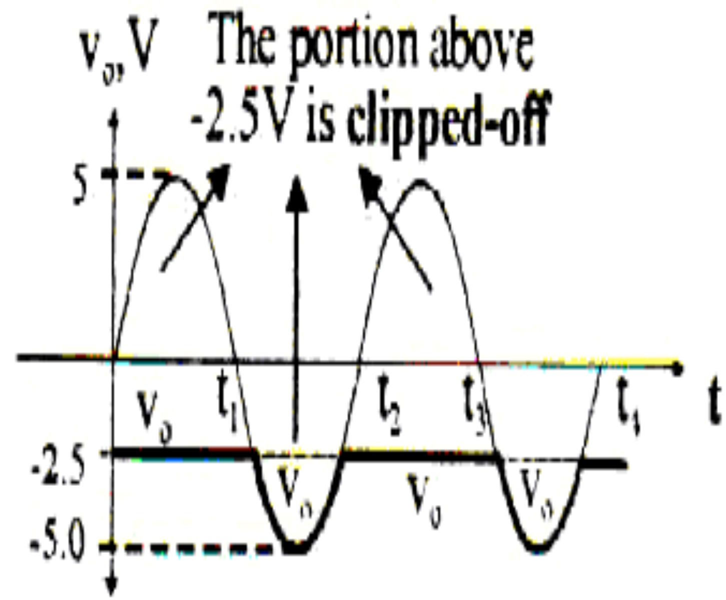




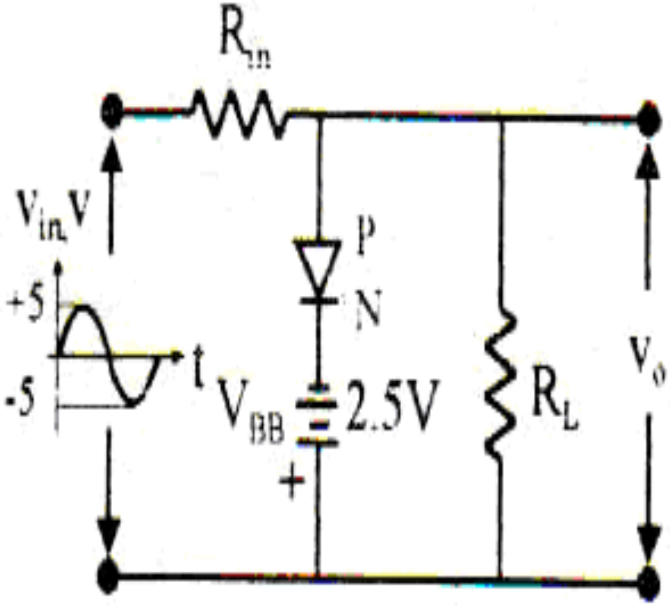
Parallel Clippers

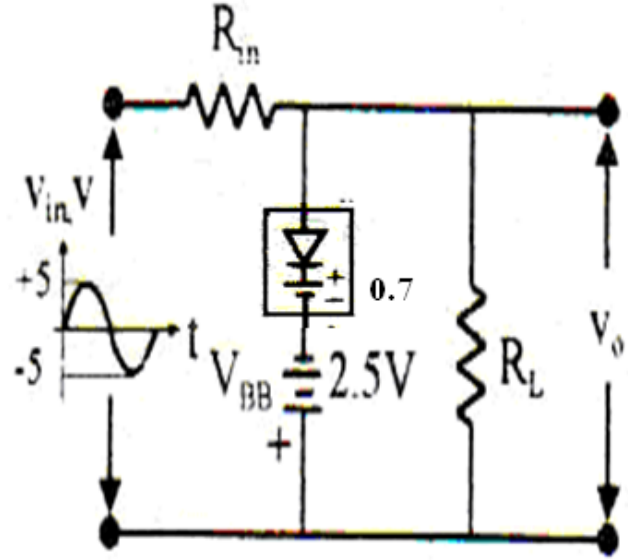
When , **Vin < VBB** , i.e. Vin<-2.5 , Diode D is OFF and **Vo=Vin**
When, **Vin ≥ VBB**, i.e. Vin ≥ -2.5, Diode D is ON and
Vo=VBB= -2.5V

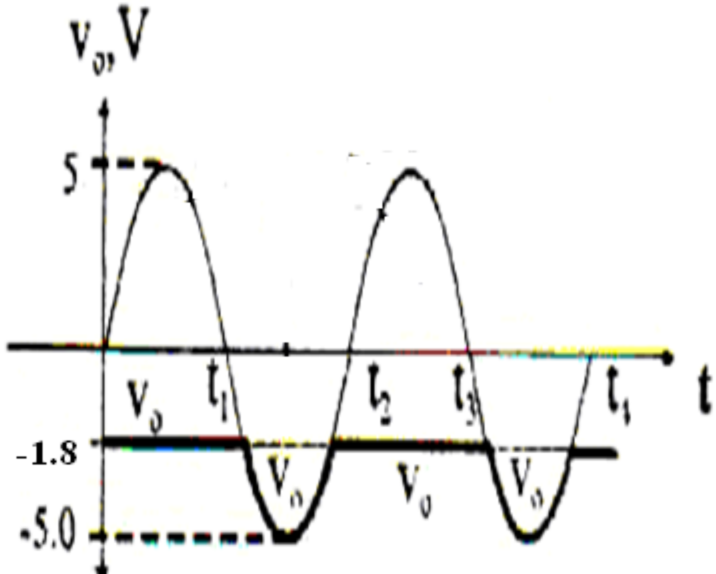




Non- Ideal diode

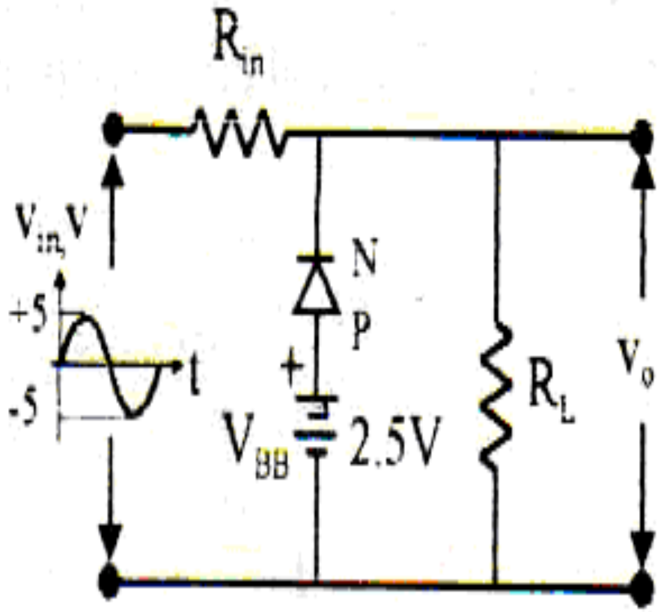


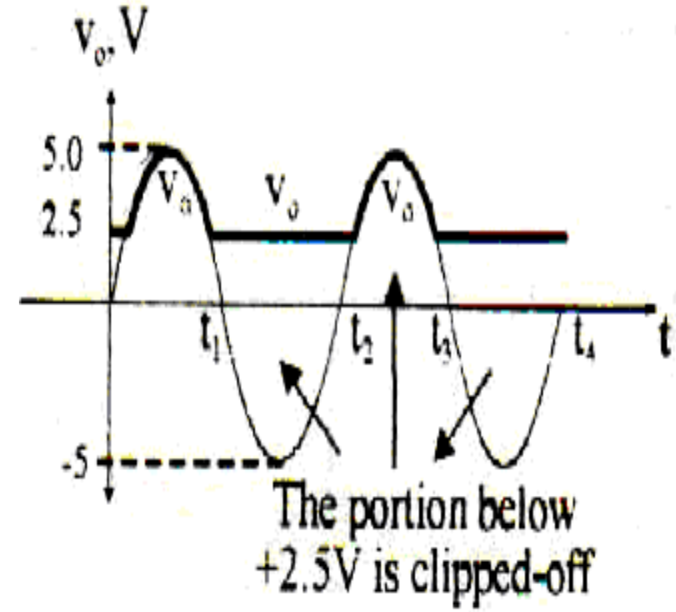




Parallel Clippers

Case 3: ideal diode

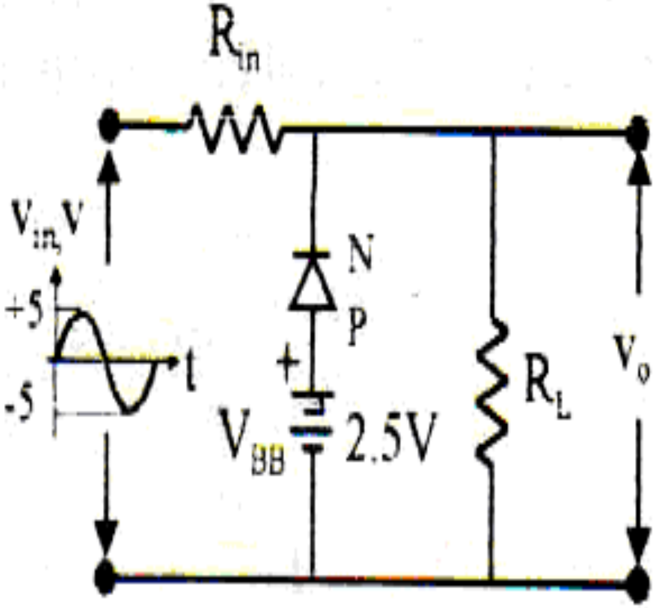


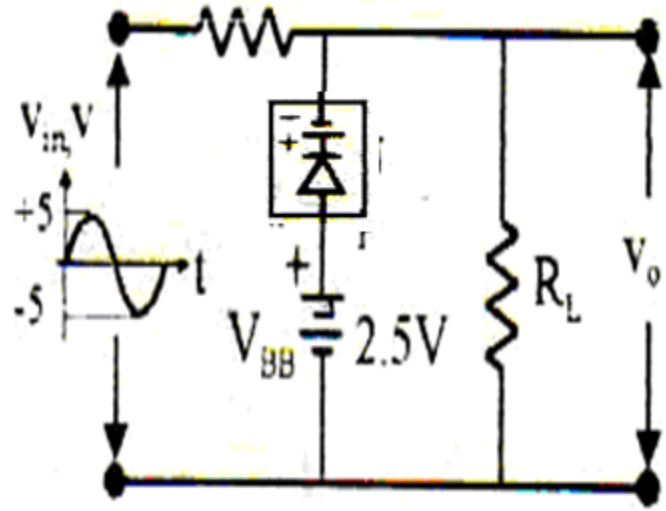


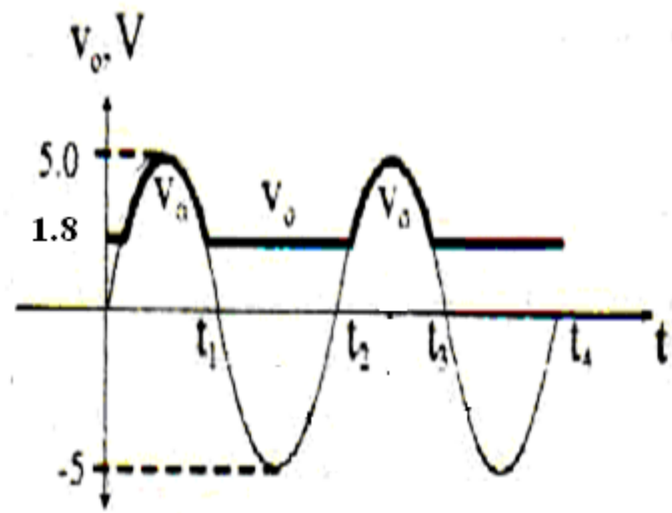
When , **Vin >VBB**, i.e. Vin> 2.5, D is OFF , **Vo =Vin**

When, **Vin ≤VBB**,i.e. Vin ≤ 2.5,D is ON ,**Vo=VBB=2.5V**

Nonideal diode

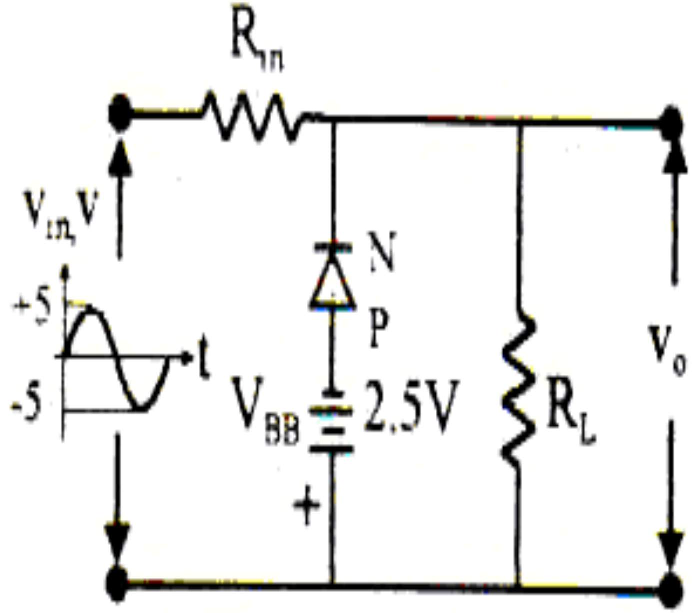


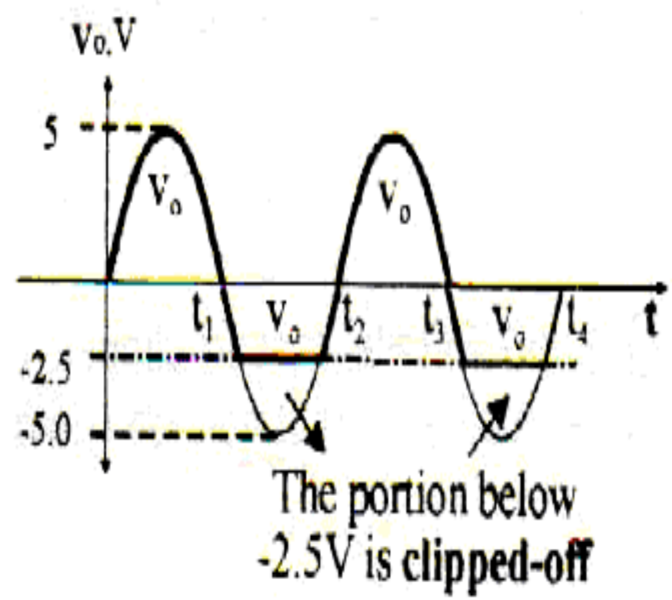




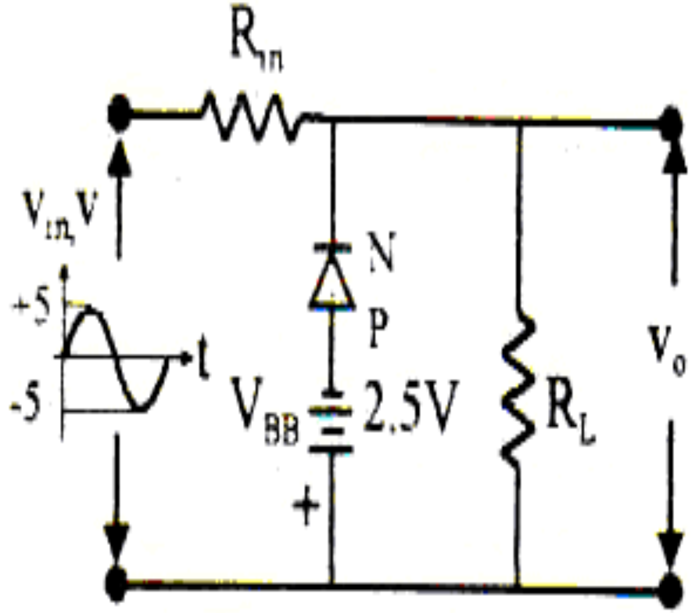
Parallel Clippers

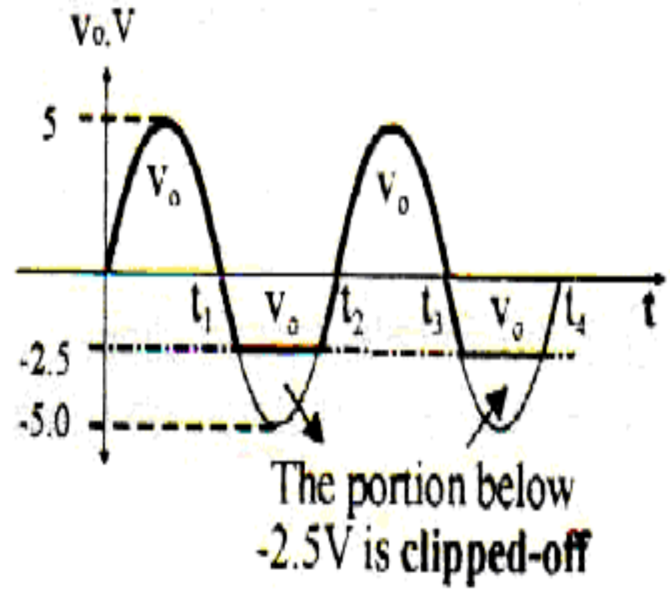
Case 4:





Parallel Clippers





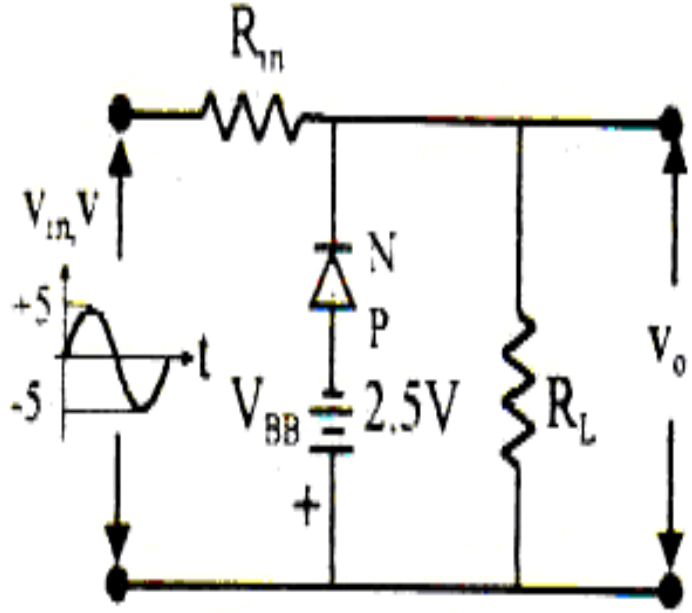
Vo=Vin …..for Vin >VBB

i.e. Vin> -2.5

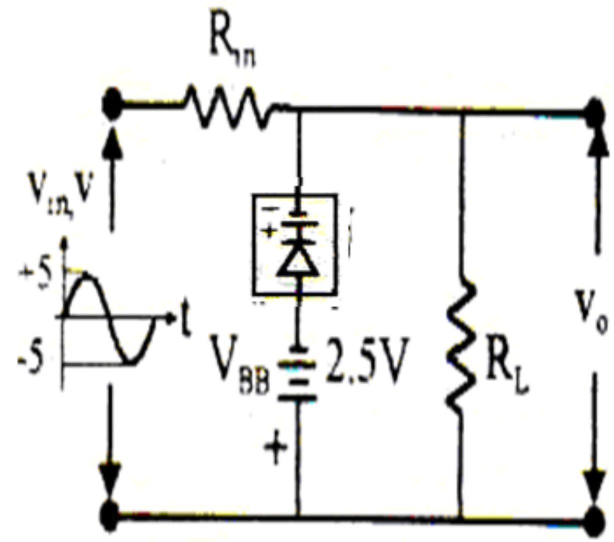
Vo=VBB= -2.5V …..for Vin ≤VBB

i.e. Vin ≤ -2.5

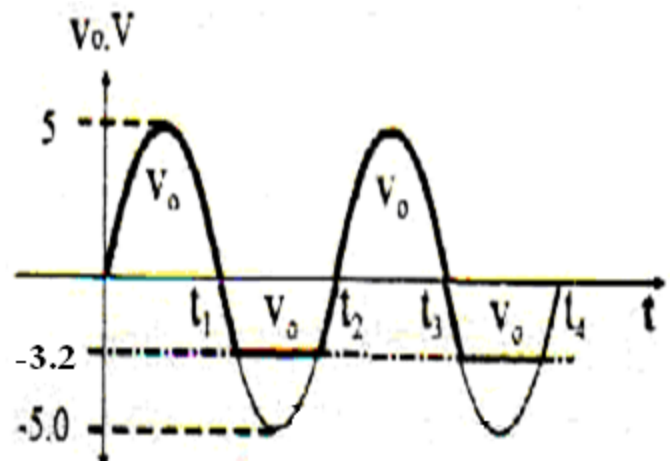
Non ideal



R_{in}
V_{in}, V
+5
-5
t
N
P
V_{BB}
2.5V
+
R_L
V_o



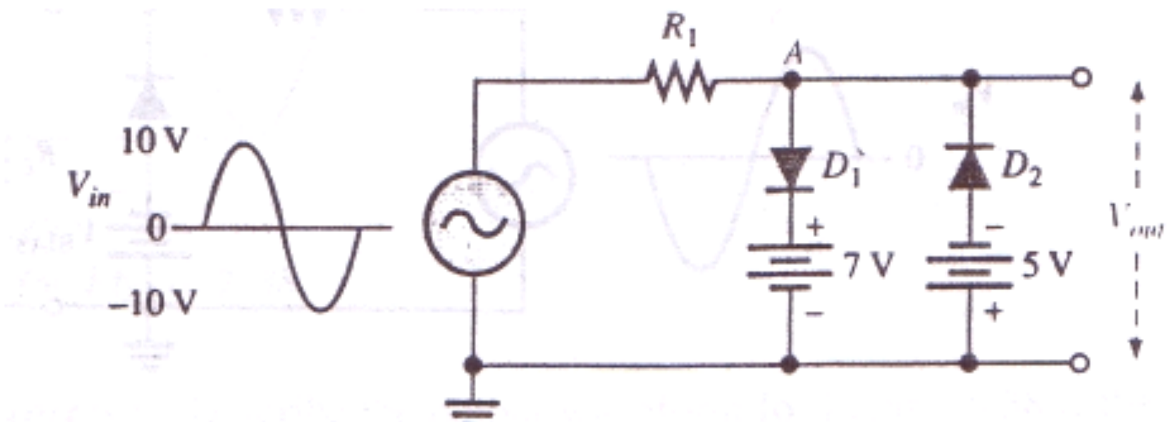
R_{in}
V_{in}, V
+5
-5
t
V_{BB}
2.5V
+
R_L
V_o



V_o, V
5
V_o
V_o
t_1
V_o
t_2
t_3
V_o
t_4
t
-3.2
-5.0

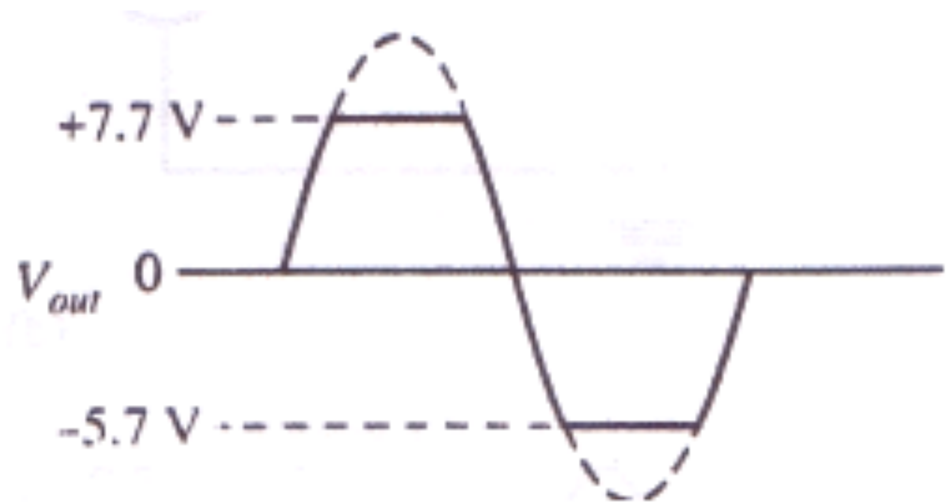
Two Sided Clipper

- Determine the output voltage waveform (Assume non-ideal diodes)



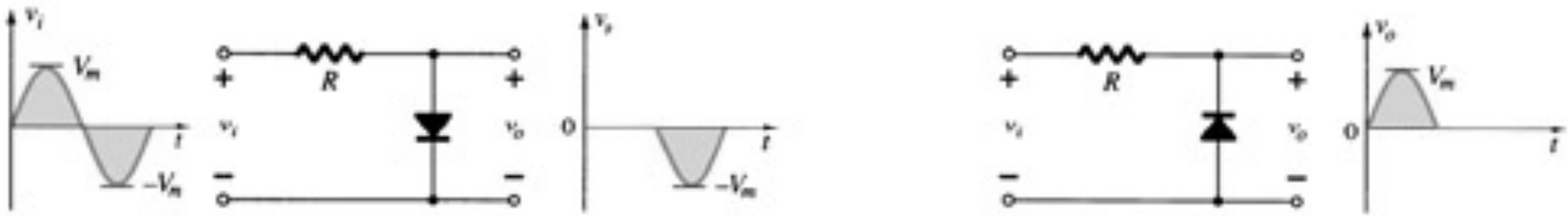
Solution

- When the voltage at point A reaches +7.7 V, diode D1 conducts and limits the waveform to +7.7 V Diode D2 does not conduct until the voltage reaches -5.7 V Therefore, positive voltages above +7.7 V and negative voltages below -5.7 V are clipped off.

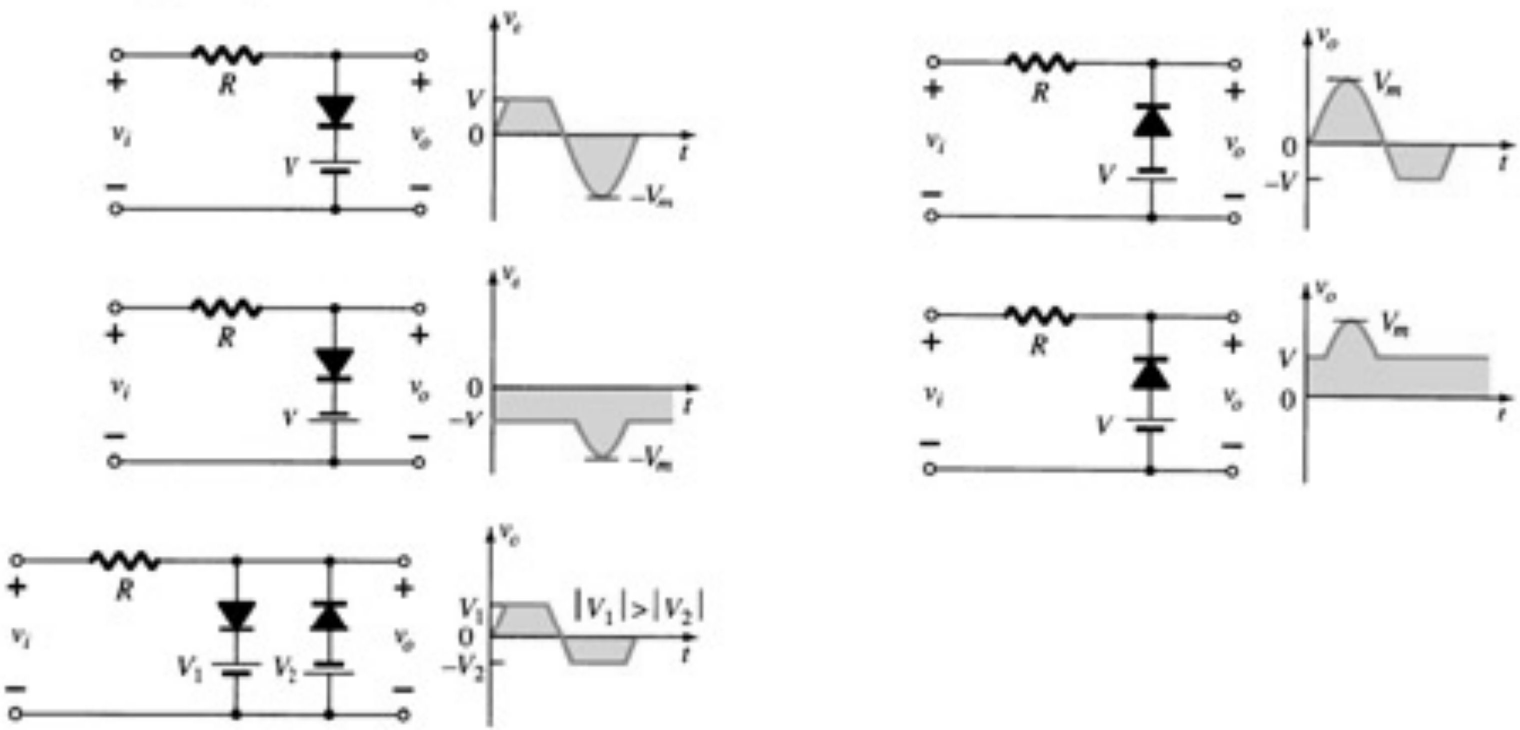


Parallel Clipper Circuit Summary

Simple Parallel Clippers (Ideal Diodes)

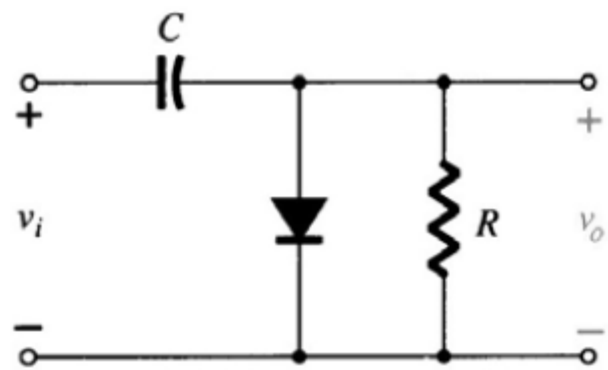


Biased Parallel Clippers (Ideal Diodes)



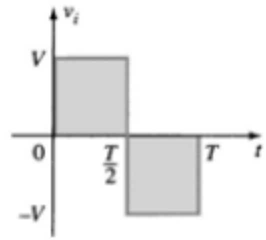
Clamper

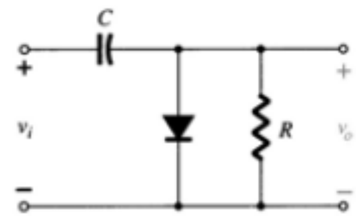
A diode in conjunction with a capacitor can be used to "Clamp" an AC signal to a specified DC level.

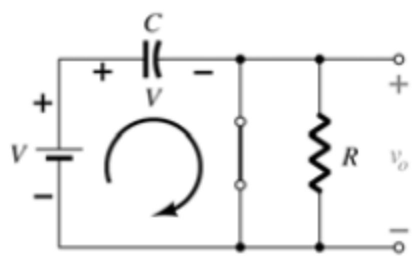


Shifts the signal in the direction of the diode arrow.

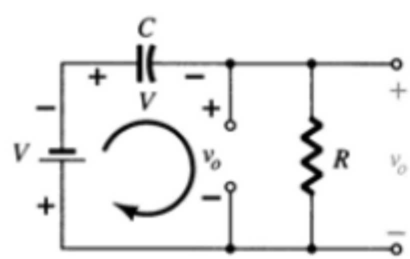
Working of Clamper



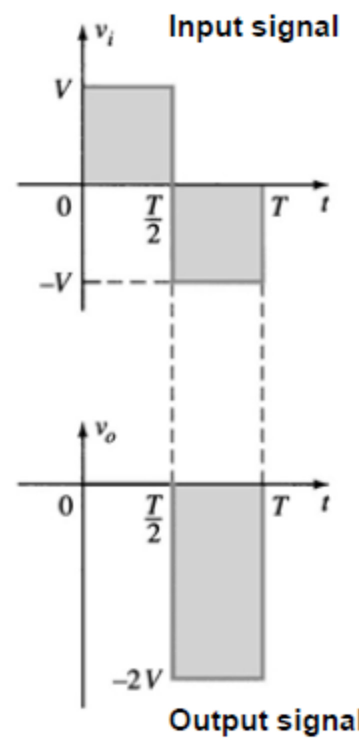




Diode "on" and the capacitor charging to V volts



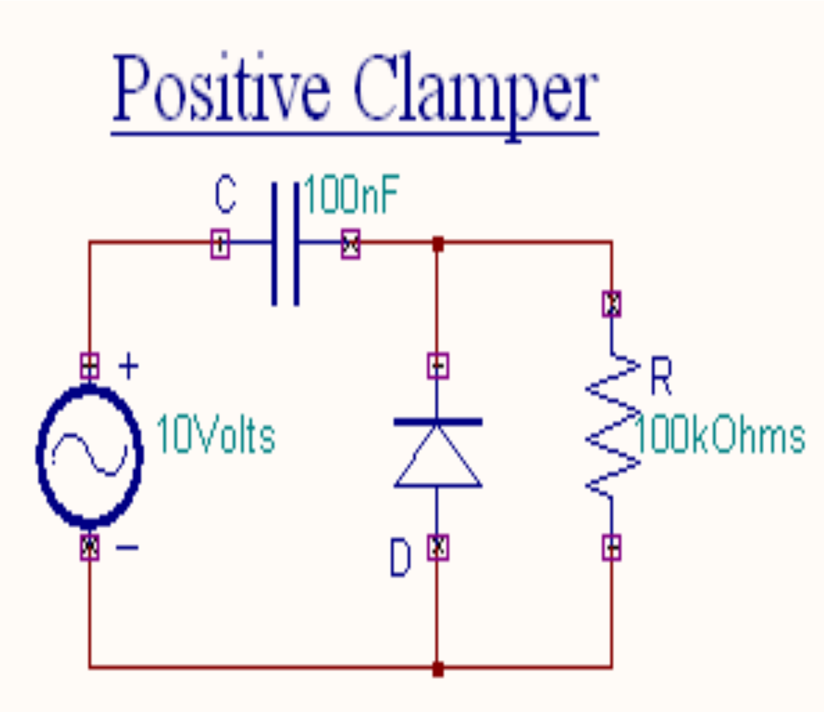
Determine v_o with the diode "off."



Diode :- Clamper

Positive Clamper

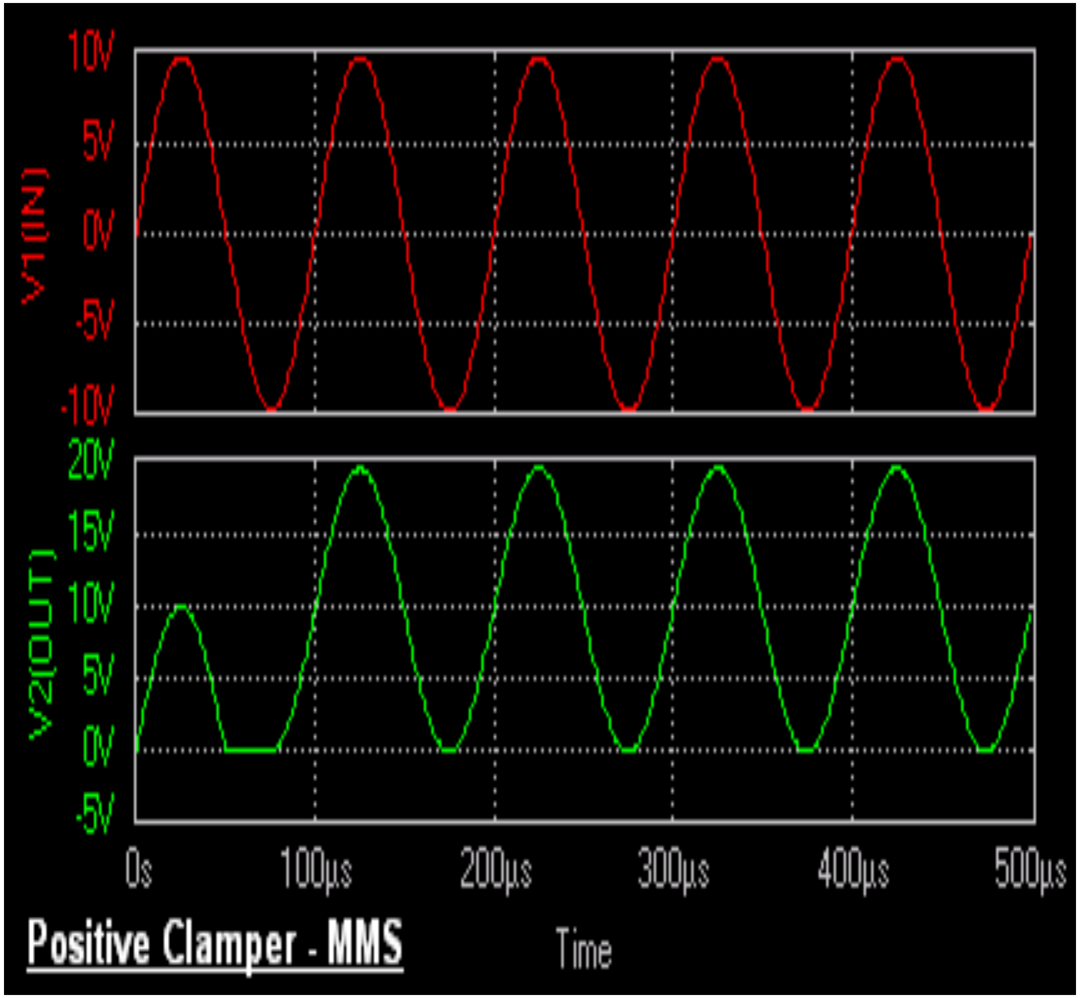
During the negative half cycle of the input signal, the diode conducts and acts like a short circuit. The output voltage $V_o \Rightarrow 0$ volts . The capacitor is charged to the peak value of input voltage V_m. and it behaves like a battery. During the positive half of the input signal, the diode does not conduct and acts as an open circuit. Hence the output voltage $V_o \Rightarrow V_m + V_m$ This gives a positively clamped voltage.

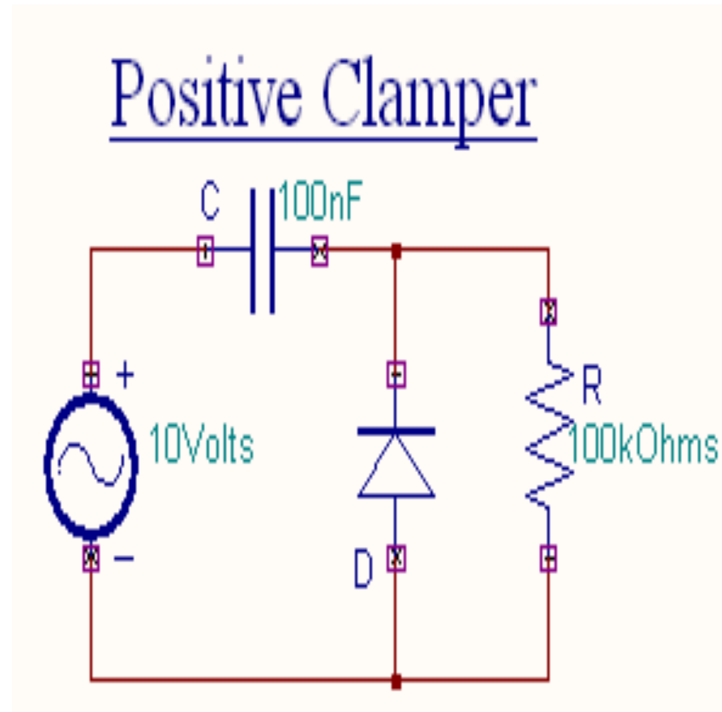


$$V_o \Rightarrow V_m + V_m = 2\,V_m$$

Diode :- Clamper

Positive Clamper

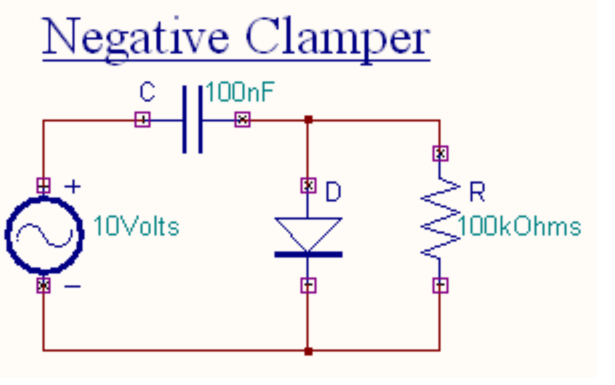




Diode :- Clamper

Negative Clamper

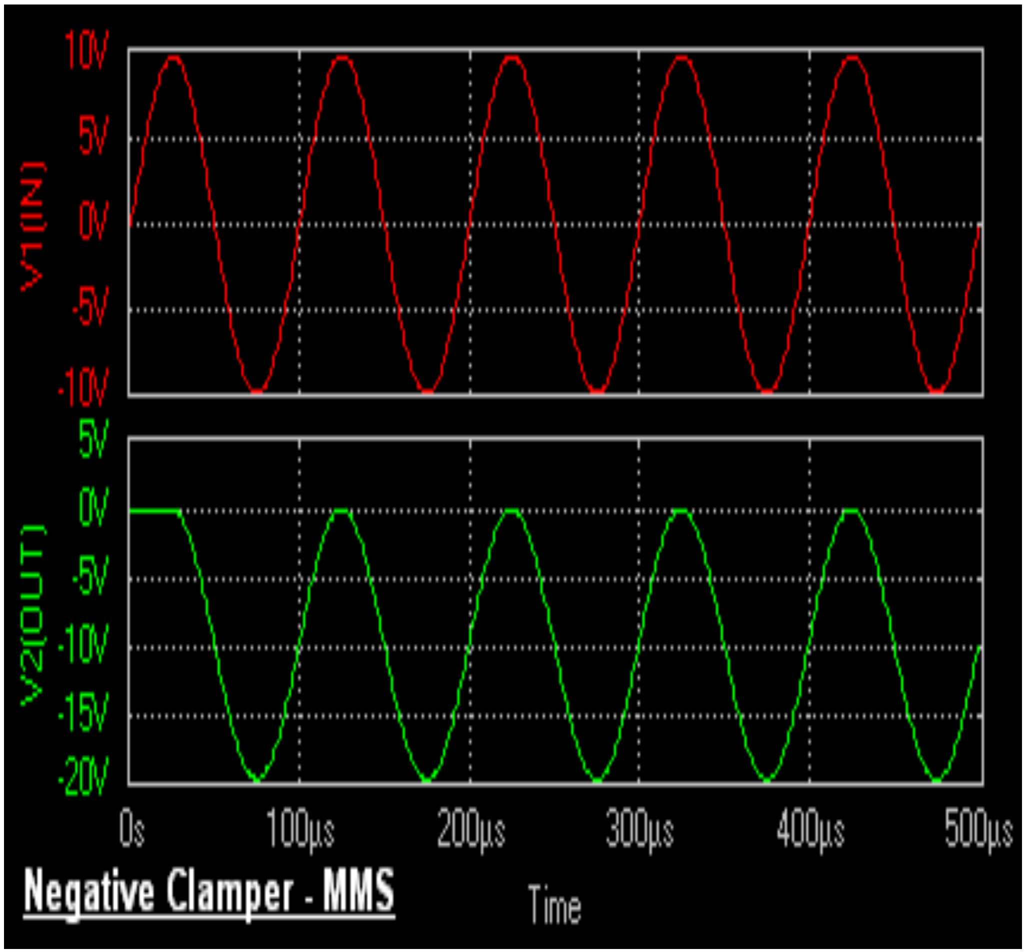
During the positive half cycle the diode conducts and acts like a short circuit. The capacitor charges to peak value of input voltage V_m. During this interval the output *Vo* which is taken across the short circuit will be zero During the negative half cycle, the diode is open. The output voltage can be found by applying KVL.

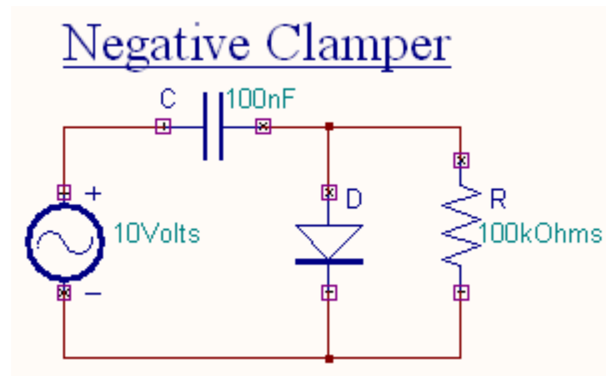


$$-V_m - V_m - V_o = 0 \qquad V_o = -2V_m$$

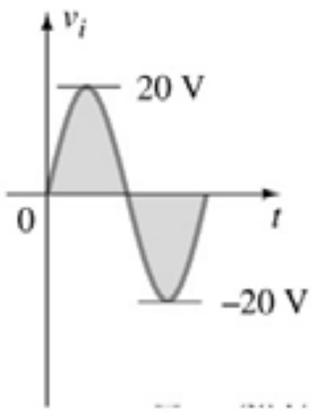
Diode :- Clamper

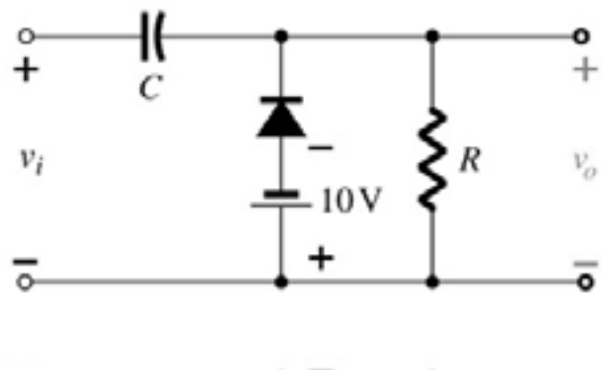
Negative Clamper

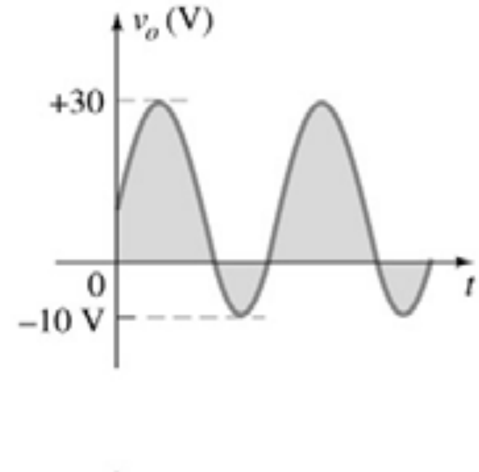




Diode :- Biased Clamper

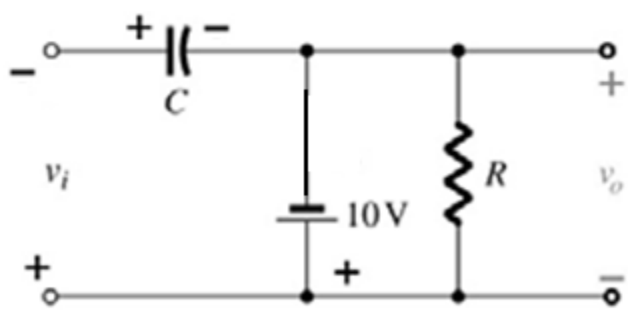






When Vin < -10V

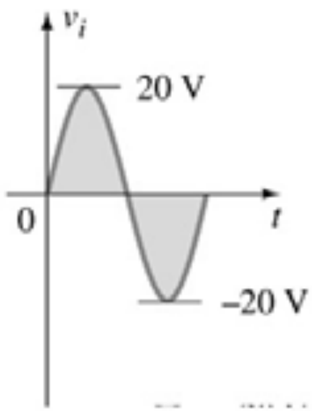
D is ON   Vo = -10V   C charges

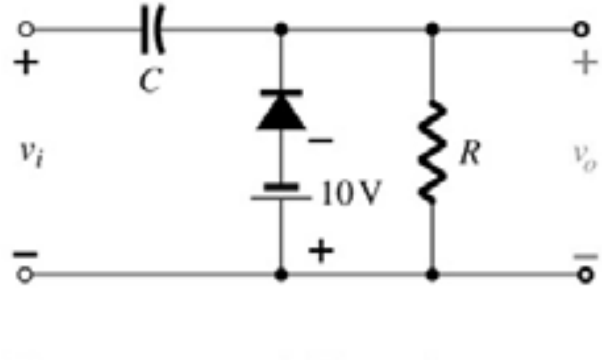


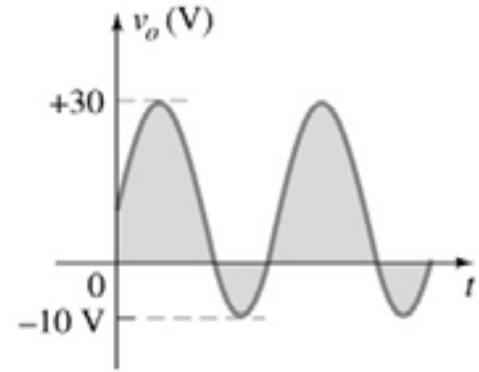
Vc is obtained by applying KVL

-20-Vc+10 = 0 , Vc = -10V

Diode :- Clamper

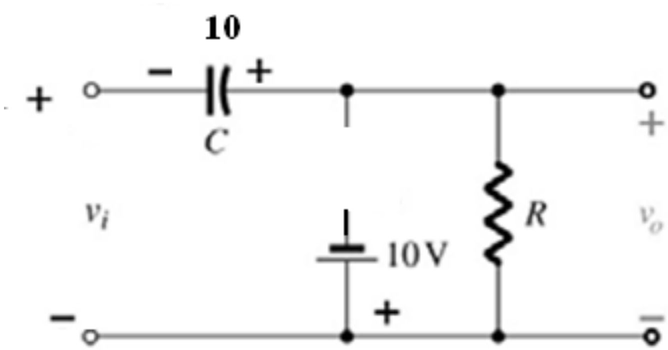






When Vin > -10V

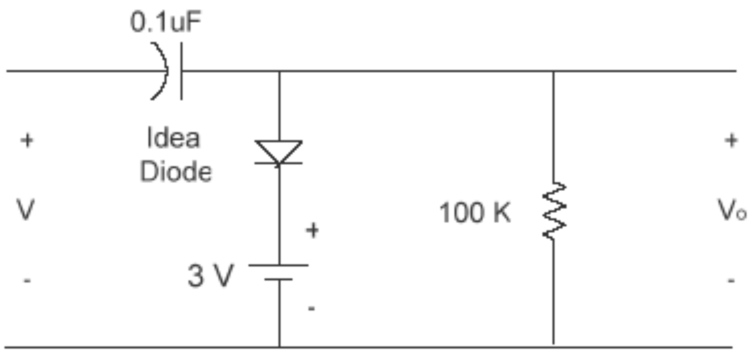
D is OFF Vo = Vi +10V

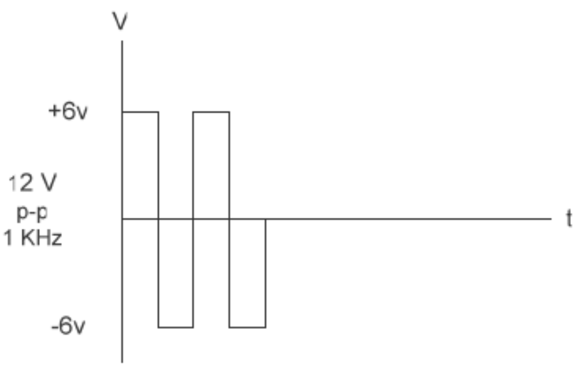


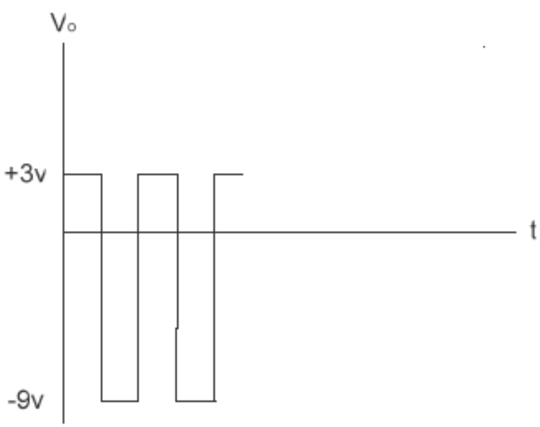
Vo is obtained by applying KVL

Vi+10 -Vo= 0 , V0 = Vi+10

Problem





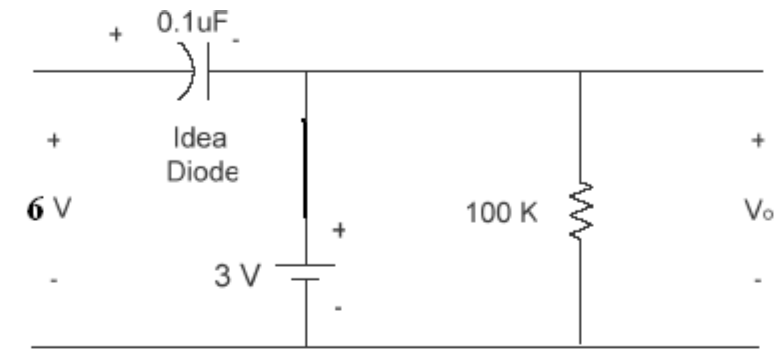


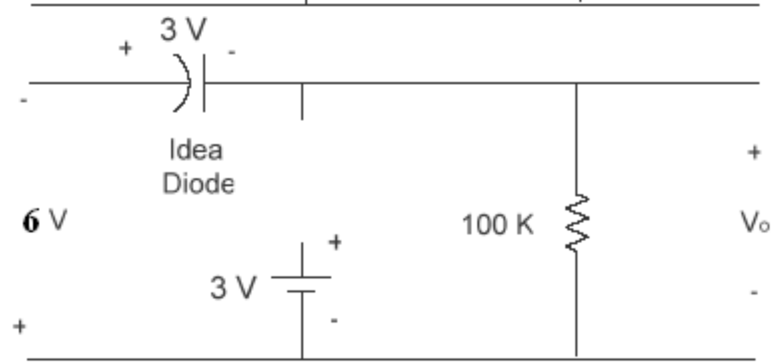
When Vin = +6V

D is ON , Vo = +3V

C charges to = +3 V

+6 – Vc -3 =0



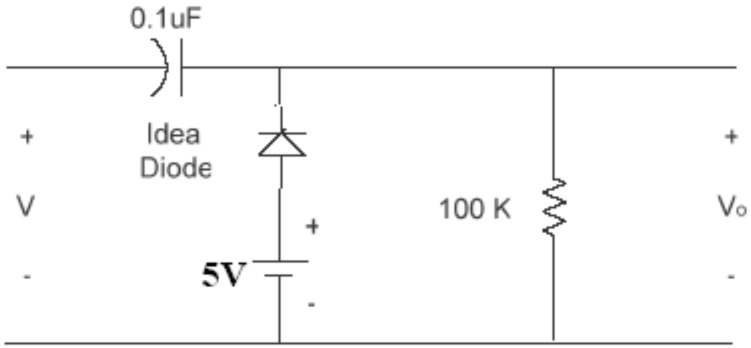


When Vin = -6V

D is OFF , Vo = -9V

-6-3-Vo =0

Problem

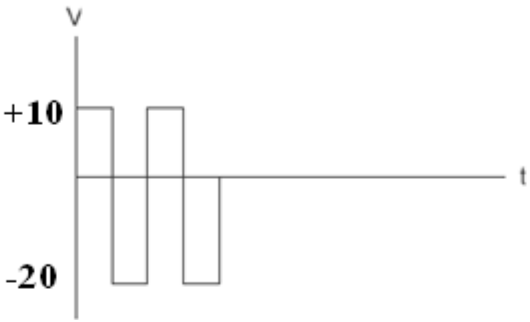


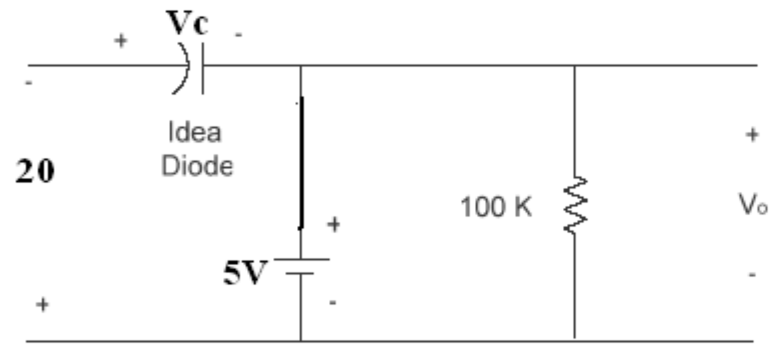
When Vin = -20V

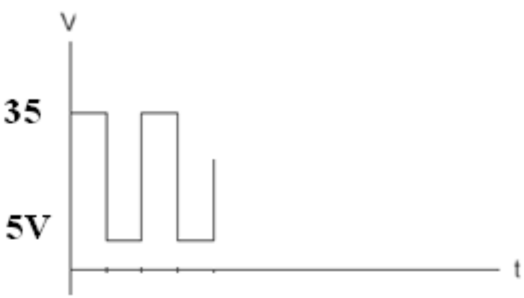
D is ON , Vo = +5V

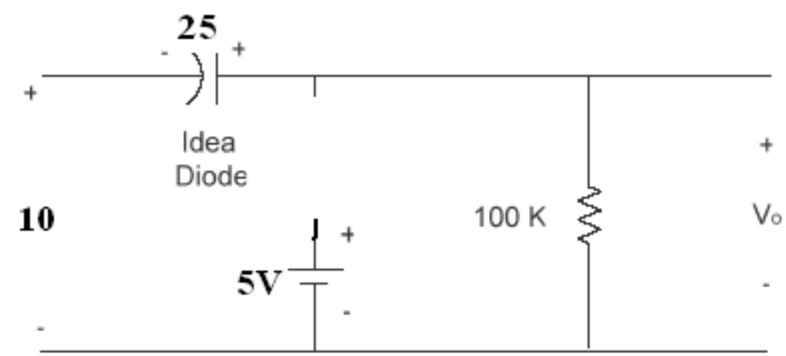
C charges to = -25 V

-20-Vc-5=0









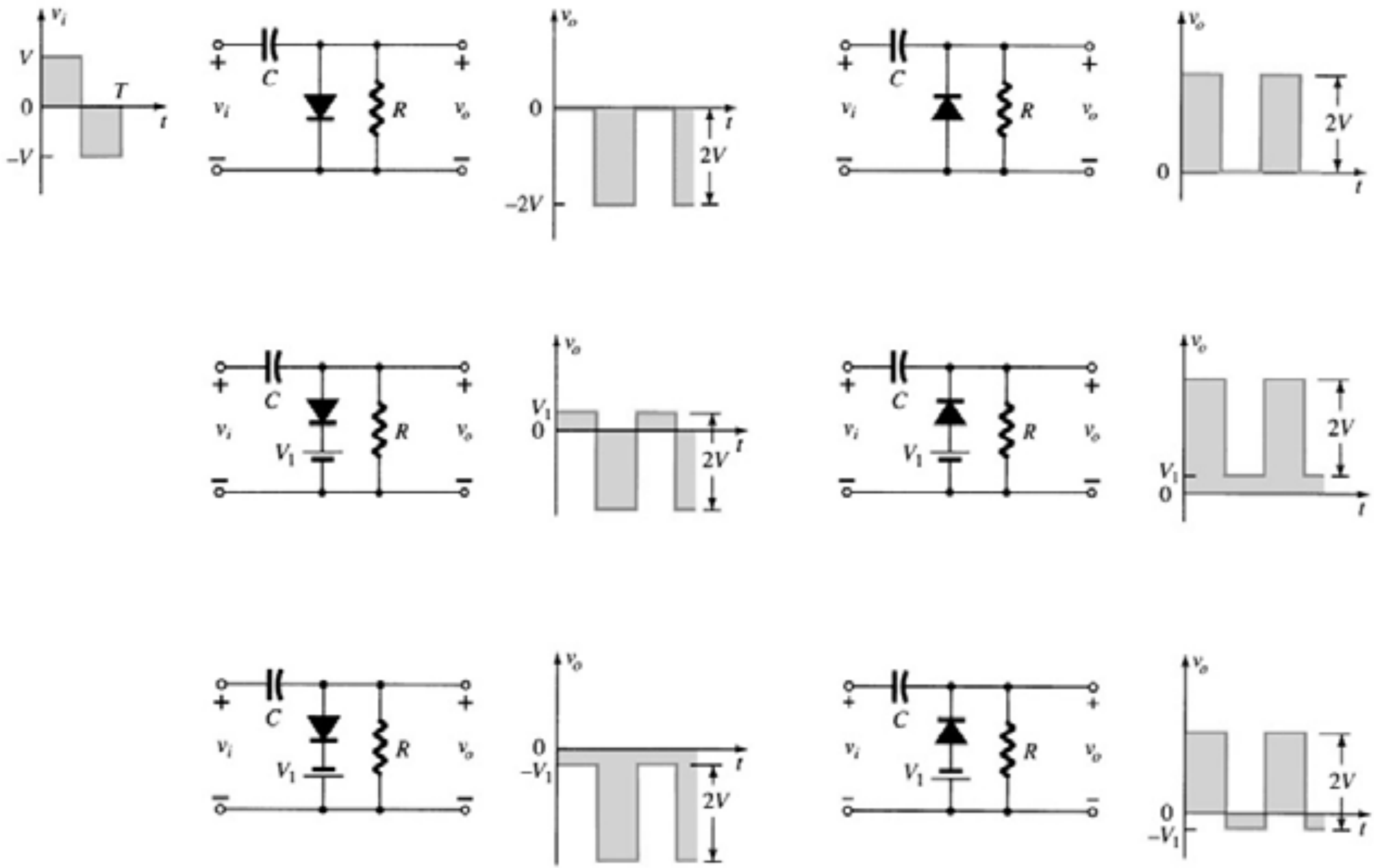
When Vin = +10V

D is OFF , Vo =35V

10+25-Vo=0

Summary of Voltage Clamper

Clamping Networks



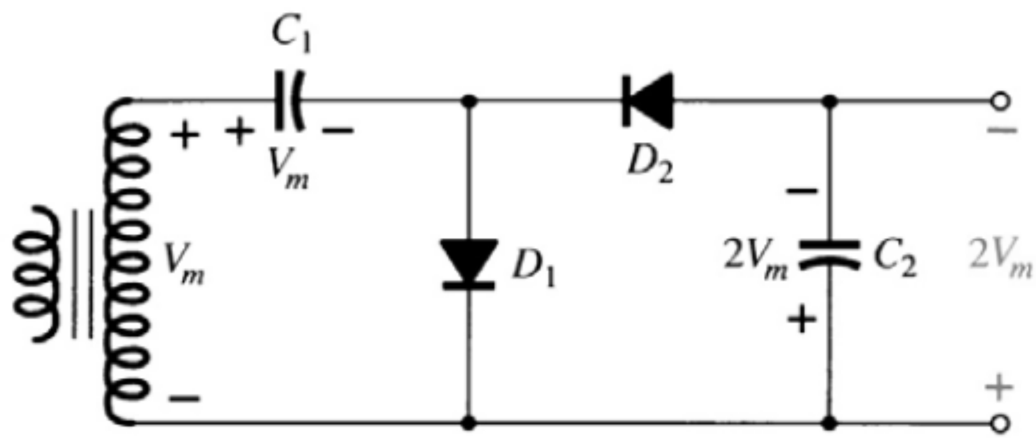
Voltage Multiplier Circuits

Voltage multiplier circuits use a combination of diodes and capacitors to step up the output voltage of rectifier circuits.

- Voltage Doubler
- Voltage Tripler
- Voltage Quadrupler

Voltage Doubler

Half Wave Voltage Doubler

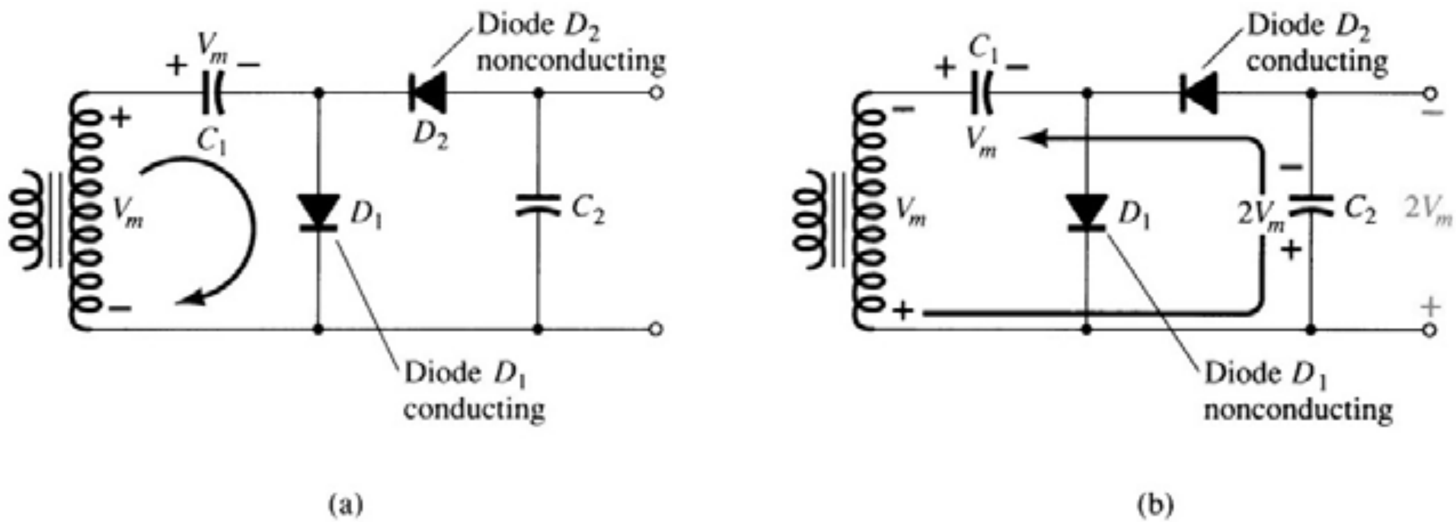


This half-wave voltage doubler's output can be calculated as

$$V_{out} = V_{C2} = 2Vm$$

Vm = peak secondary voltage of the transformer.

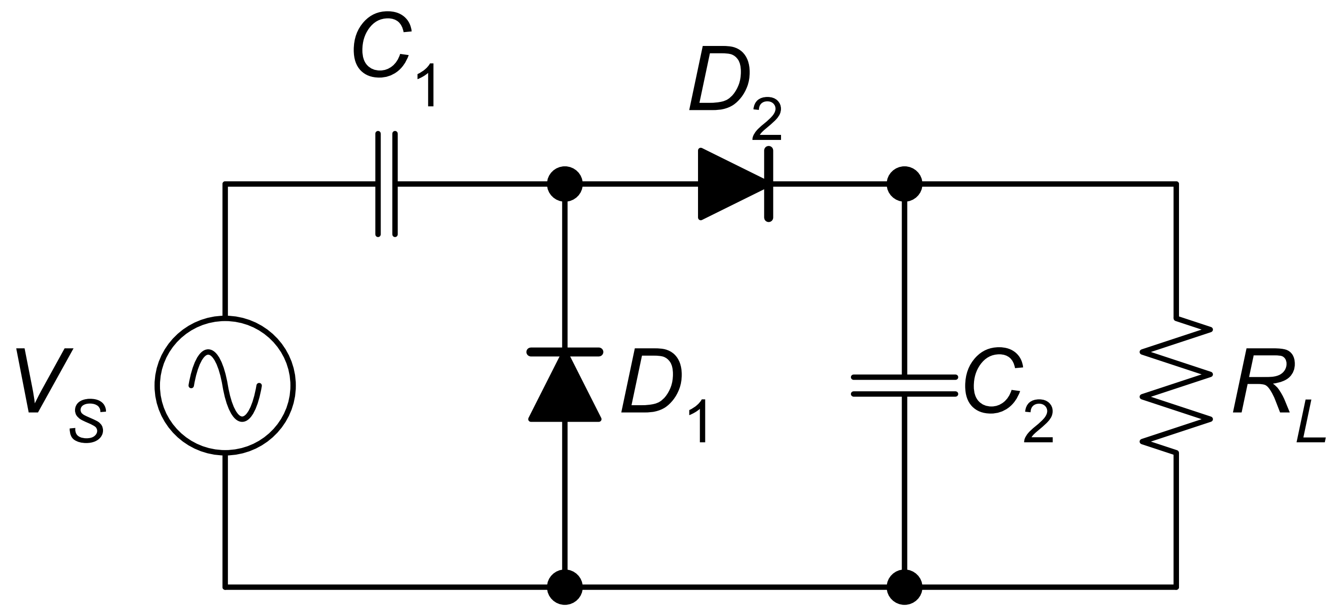
Operation of a Voltage Doubler Circuit



The 1st capacitor charges up to Vm during the positive half of the cycle, then the 2nd capacitor charges up to Vm in the same polarity as the 1st capacitor,
finally the output is the sum of the voltages across both capacitors:

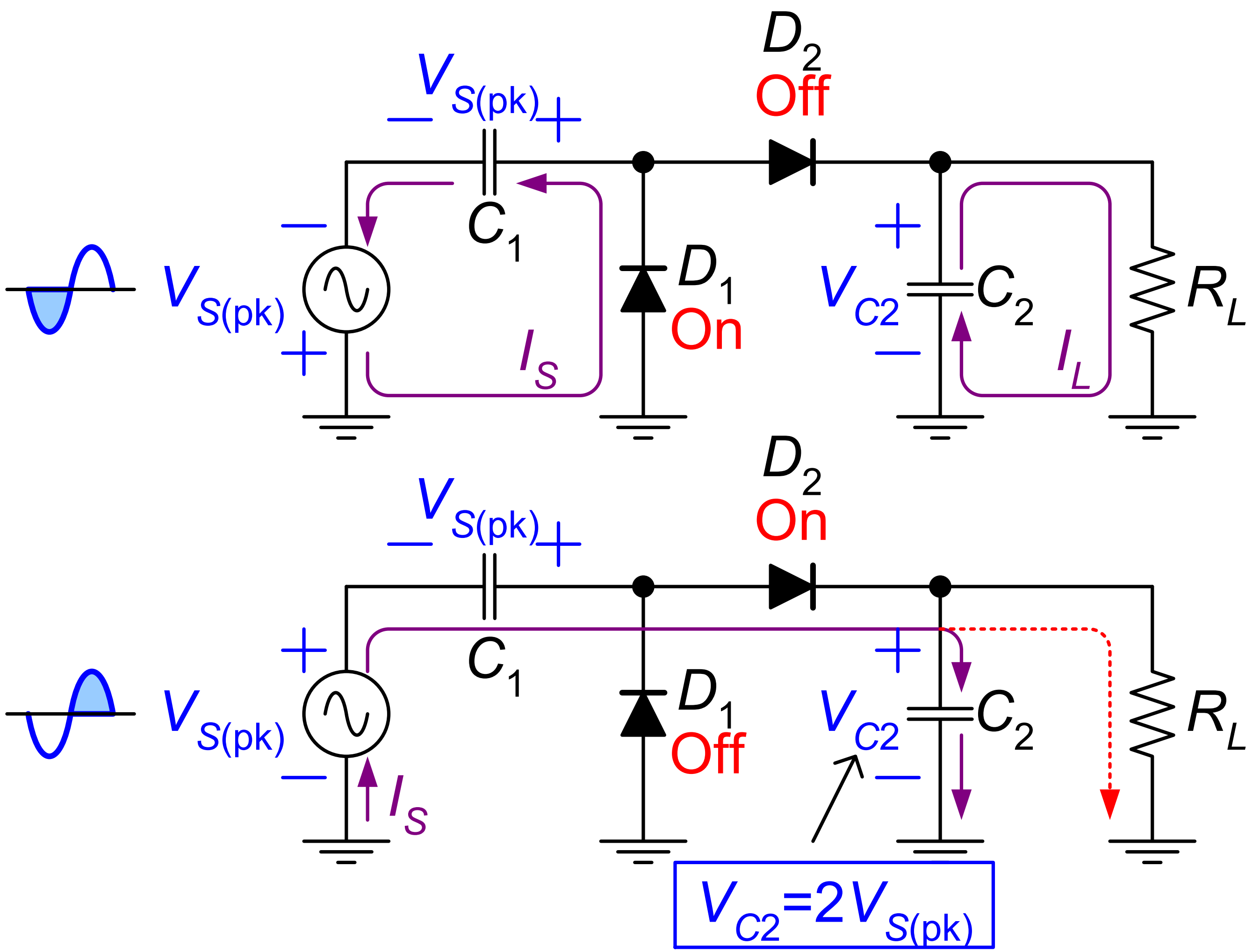
Vout = 2Vm

Voltage multipliers.

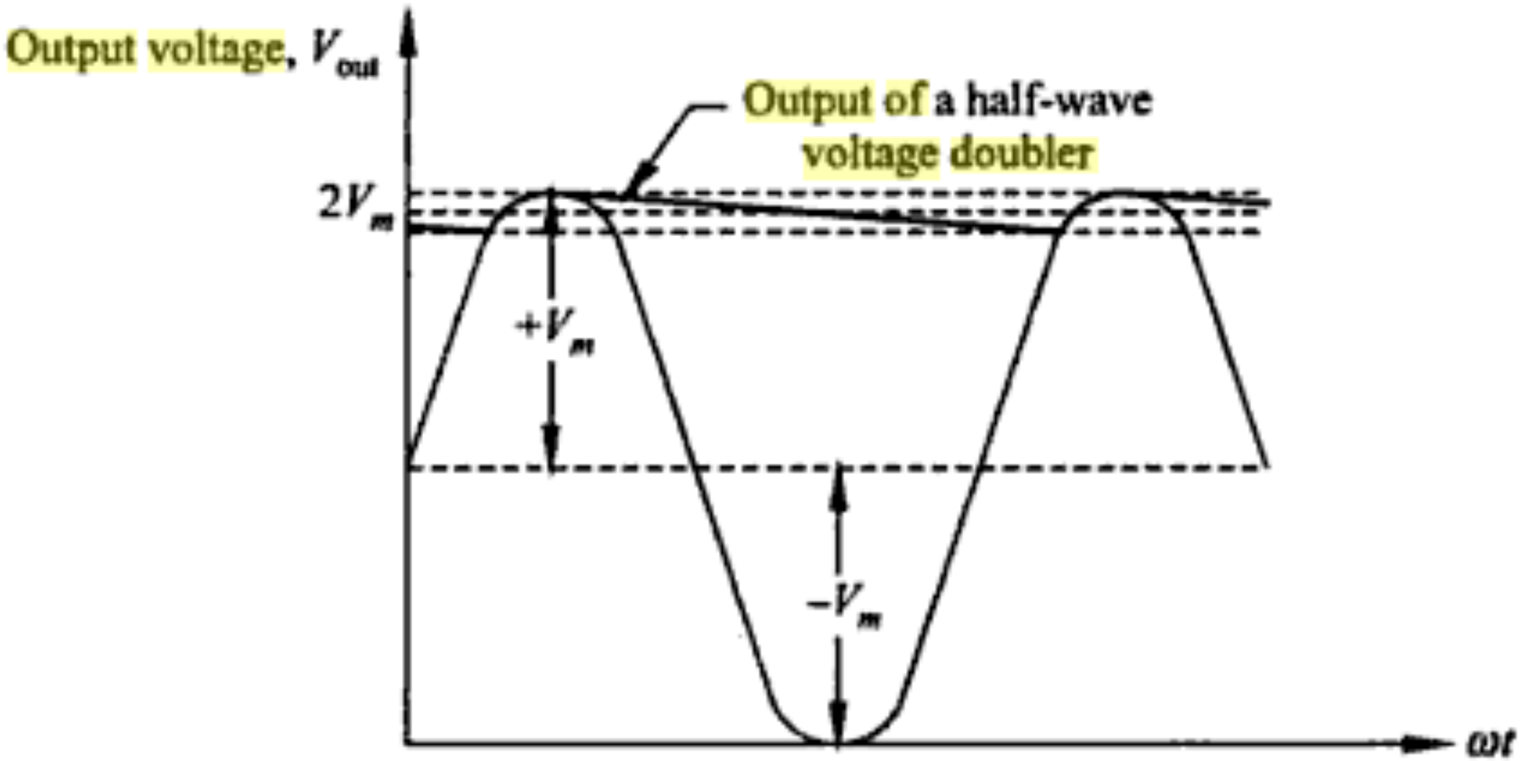


Half-wave voltage doublers to get output of opposite polarity.

Working of Voltage multipliers

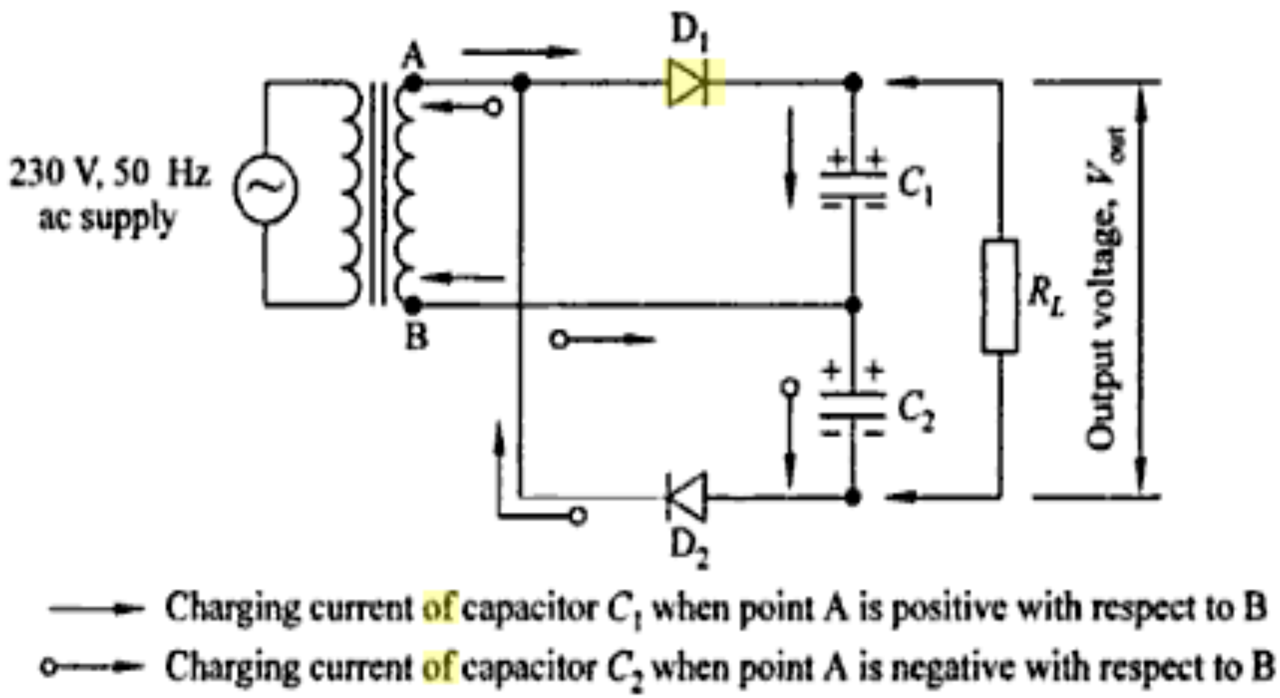


Waveform of voltage doubler



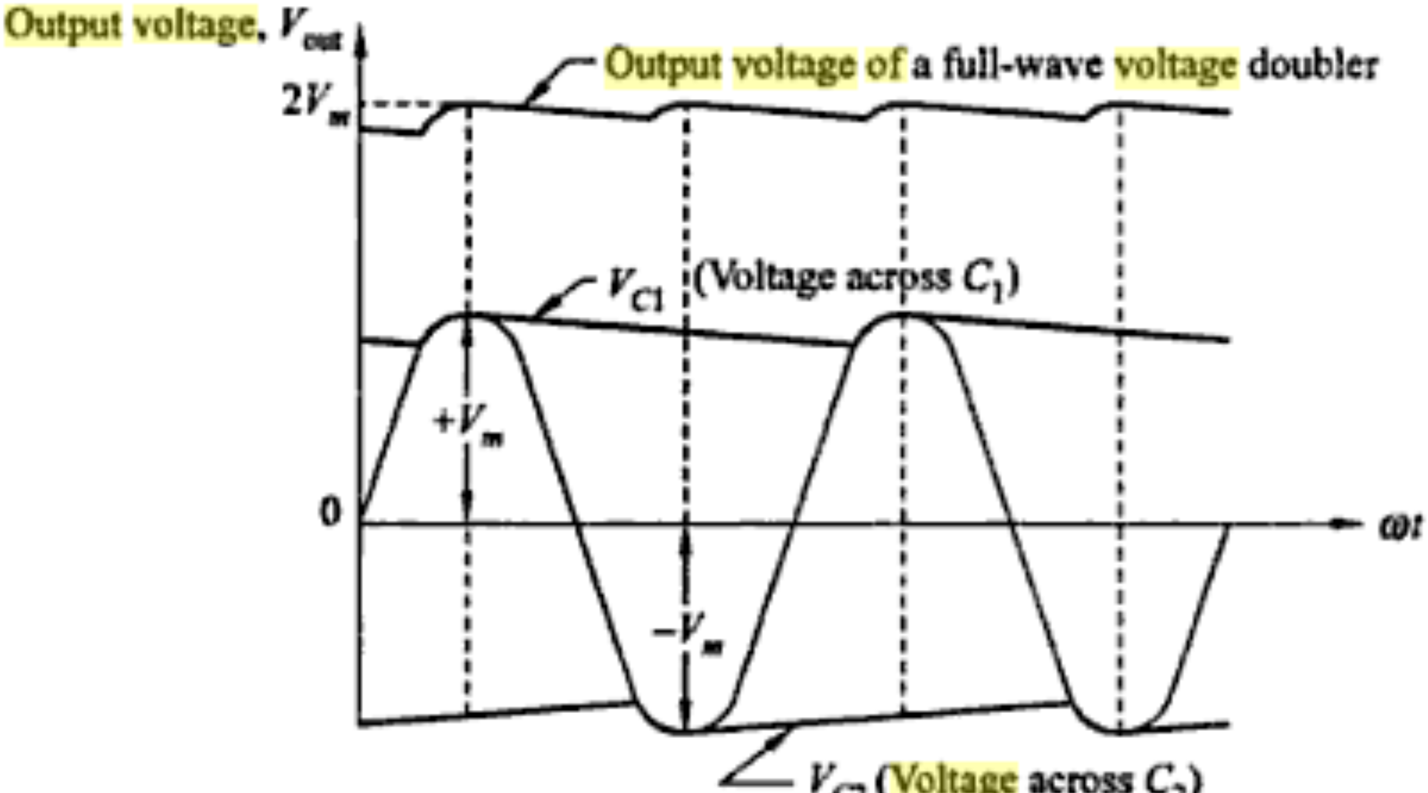
Output voltage waveform of a half-wave voltage doubler.

Full-wave voltage doubler.



Circuit diagram of a full-wave voltage doubler.

Waveform



Output voltage waveforms of a full-wave voltage doubler.