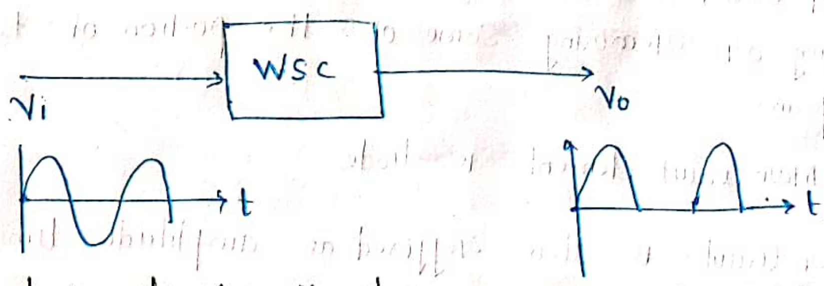
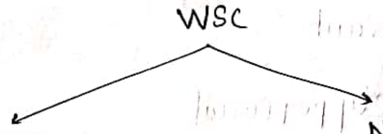
Diode Circuits

* Wave shaping Circuits

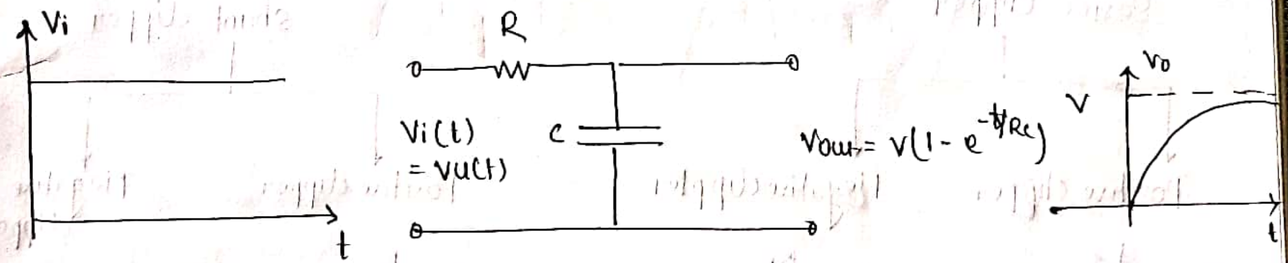


- It is used for changing the shape of waveform.

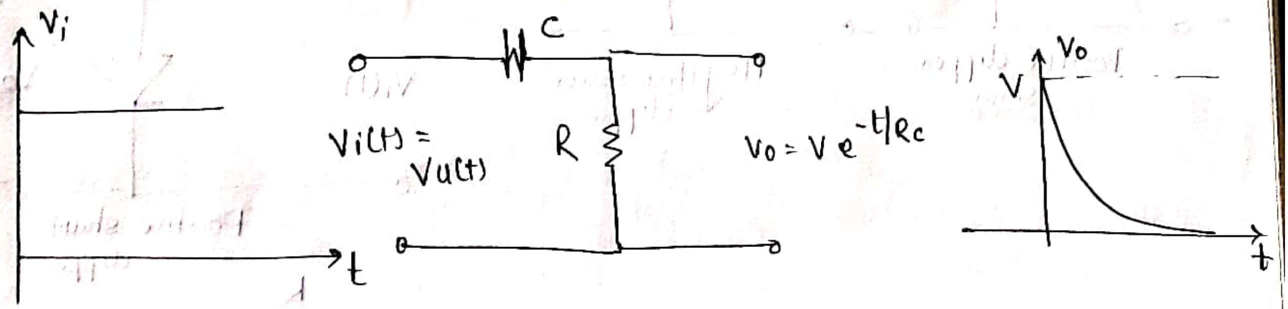


Linear WSC
based on linear element
R, L, C
eg. RC HPF LPF

Non-Linear WSC
Based on Nolinear element like diode
eg Half wave Rectifier



$V_{out} = V(1 - e^{-t/RC})$

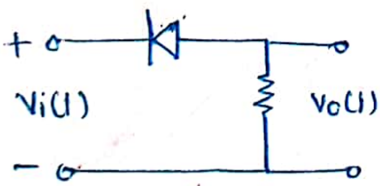


$V_o = V e^{-t/RC}$

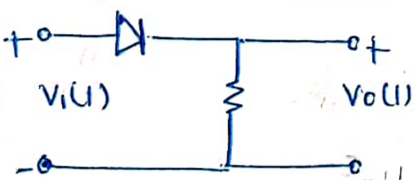
* Clipper Circuits

- Clipper Circuit is a non linear wsc which is used for clipping or removing some of the portion of transmitted waveform.
- The Main Circuit element is diode
- Clipper Circuit is also reffered as amplitude limiter or amplitude Selector Circuit.
- Classification of clipper Circuit

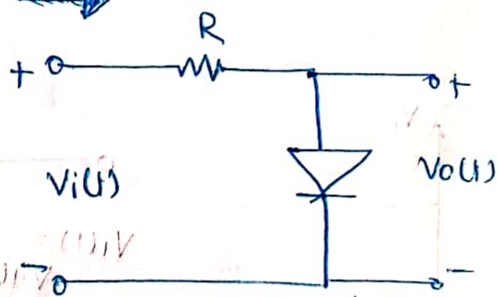
Clipper Circuit
- Series Clipper
  - Positive clipper
  - Negative clippter
- Shunt clipper
  - Positive clipper
  - Negative clipper



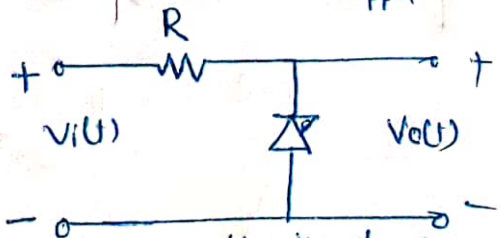
Positive clipper series



Negative series clippa



Positive shunt clippa



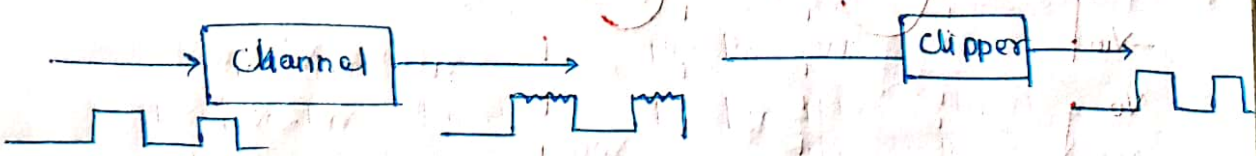
Negative shunt clippa

- In Series clipper circuit diode is Connected in Series and in shunt clipper circuit diode is Connected in parallel (structure wise)

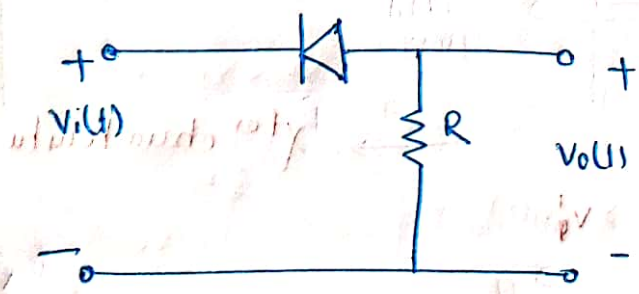
- Positive clipper circuit removes maximum Positive portion of xmitted wave form.

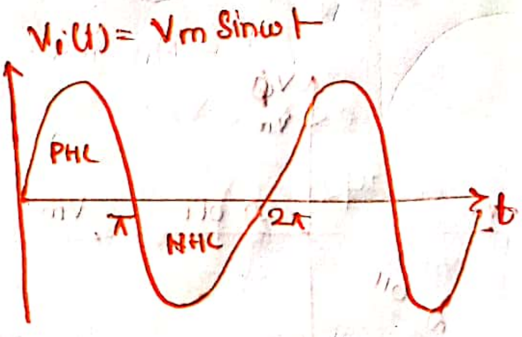
- Negative clipper circuit remove maximum Negative portion of xmitted waveform.

- clipper circuit can be used for eliminating the effect of noise from waveform in digital Communication.



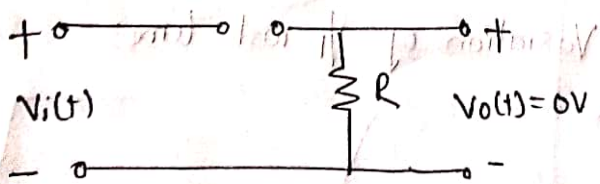
* Positive Series Clipper Circuit





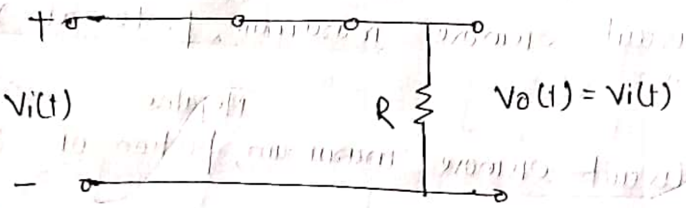
- During positive half cycle (PHC) $(0 < \omega < \pi)$

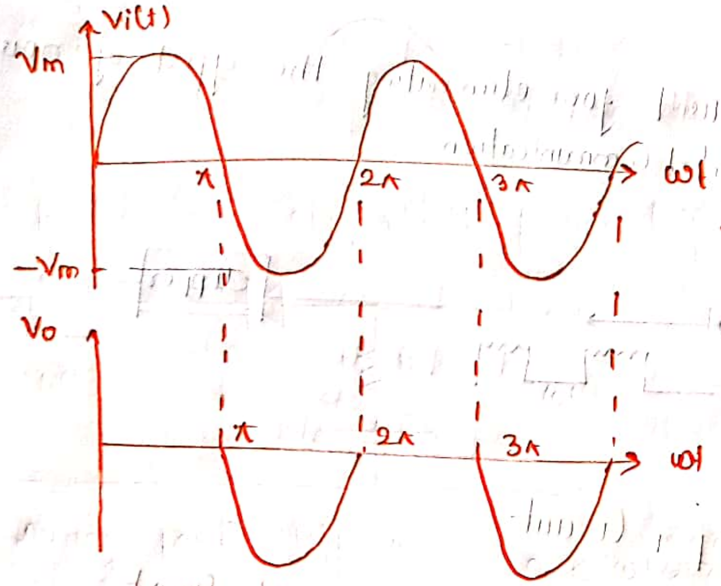
  Diode = Reverse Bias (RB)



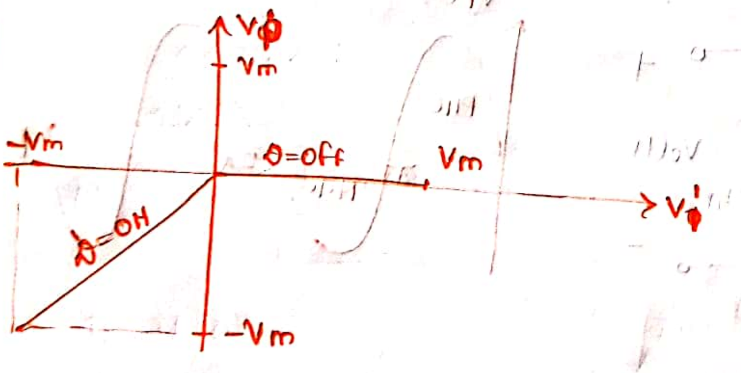
• During Negative Half cycle   Diode = forward Bias (FB)

$\pi < \omega t < 2\pi$





→ output characteristic

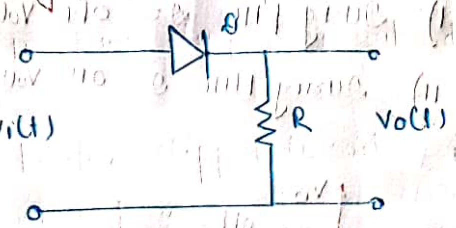


→ Xfer characteristic

• output characteristic describe the Variation of o/p wrt time

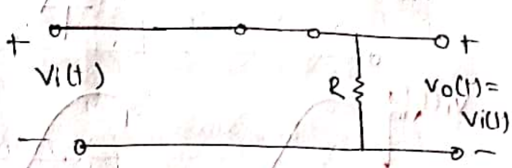
• Xfer characteristic describe Variation of i/p wrt time.

* Negative Series clipper



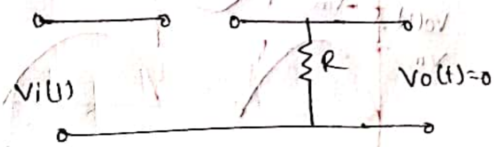
i) During positive half cycle $0 < \omega t < \pi$

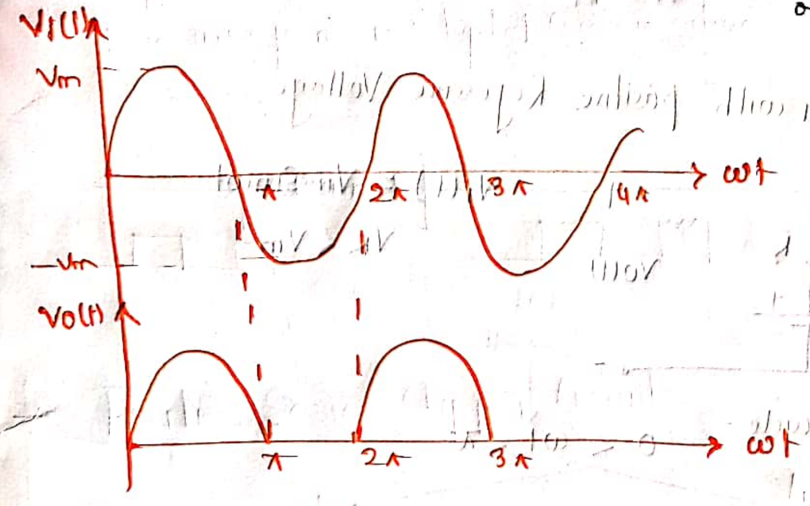
Diode = ON (FB)

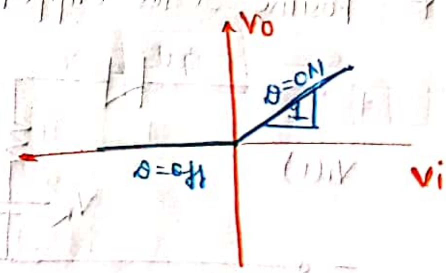


ii) During Negative half cycle $\pi < \omega t < 2\pi$

D = off



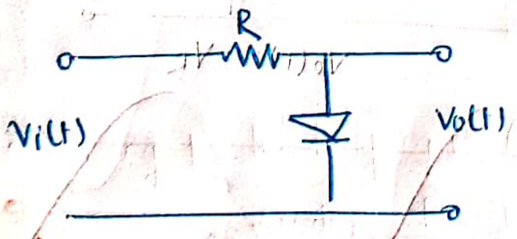




$V_o(avg) = \frac{V_m}{\pi}$

Output charac.

* Positive shunt clipper Circuit



i) PHC

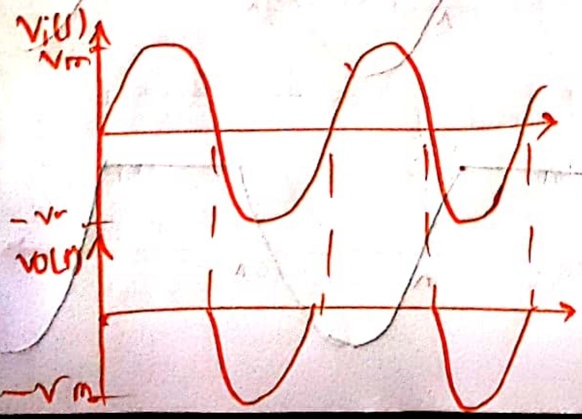
D ⇒ ON

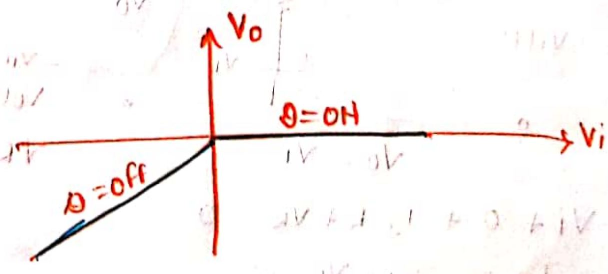
Vo(t) = ~~Vi(t)~~ 0

ii) NHC

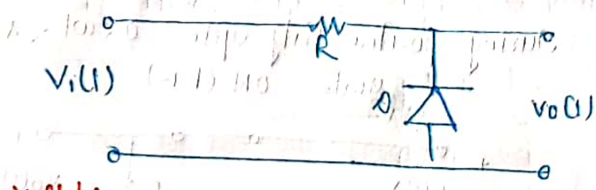
D ⇒ off

Vo(t) = Vi(t)



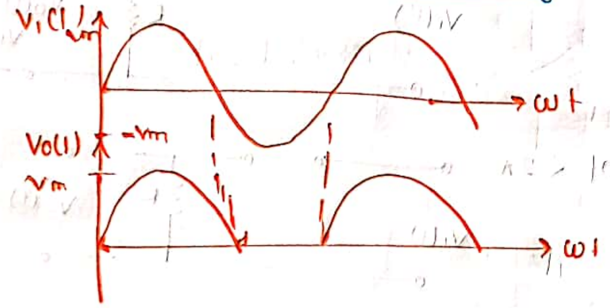


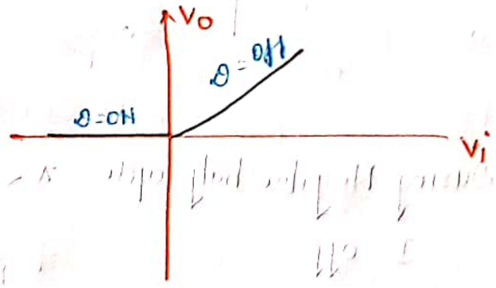
* Negative shunt clipper circuit



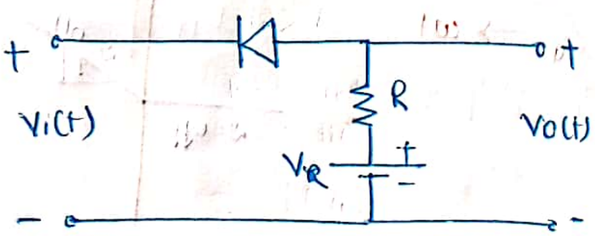
1) During PHC $D =$ OFF $V_o(t) = V_i(t)$

11) During NHC $D =$ ON $V_o(t) = 0$





* Positive Series clipper with positive Reference Voltage

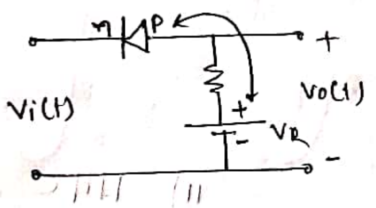


$V_i(t) = V_m \sin\omega t$

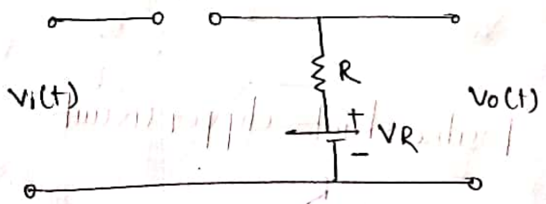
$V_R < V_m$

1) During positive Half cycle :- $0 < \omega t < \pi$

$0 < V_i < V_\gamma$



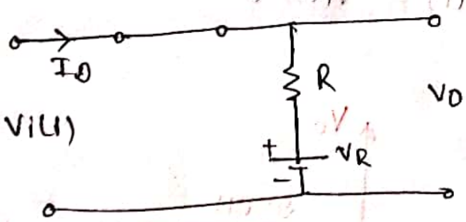
$V_R < V_i < V_m$



$V_o(t) = V_R$

$I_D = f(V_R)$

$D =$ ON

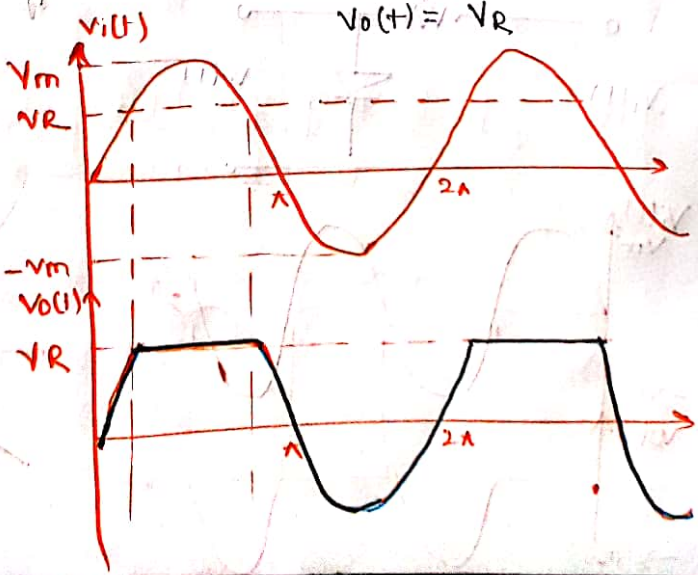


$V_o = V_i$

$-V_i + 0 + I_D R + V_R = 0$

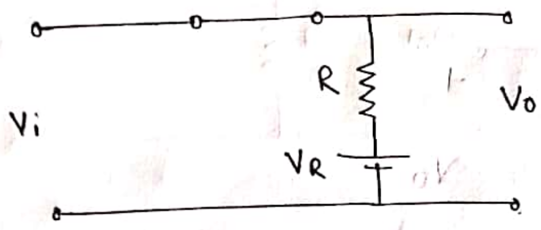
$I_D = \dfrac{V_i - V_R}{R}$

$V_o = I_D R + V_R = V_i$



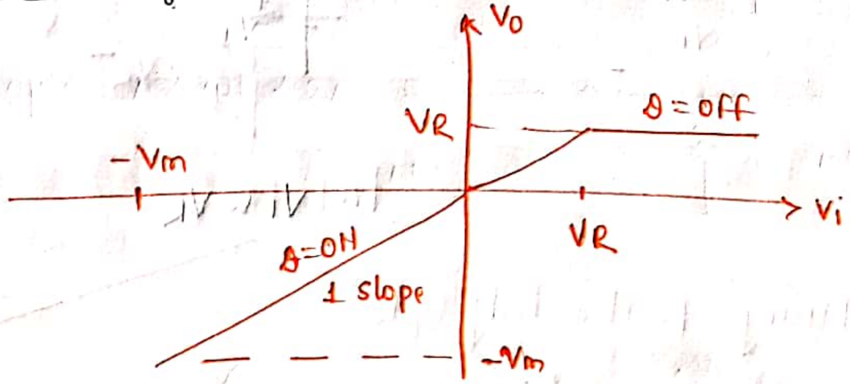
2) During Negative half cycle :-

$\pi < \omega t < 2\pi$



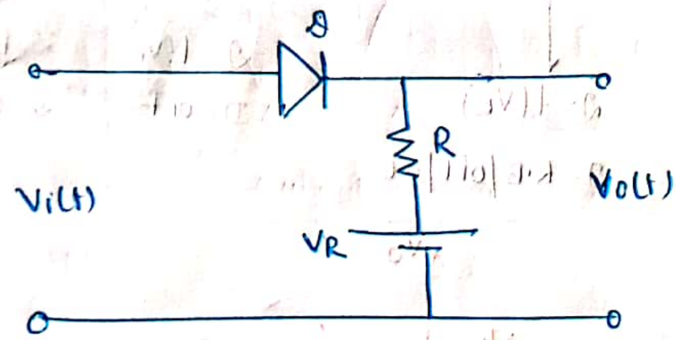
$D = f(V_i)$ or $D = f(V_R)$

$V_o(t) = V_i(t)$



* Negative Series clipper Circuit with Positive reference Voltage

$V_R < V_m$



i) $V_i > V_R$

$D = f(V_i)$ $\quad D \to ON$

$V_o = V_i$

ii) $V_i < V_R$

PMC

$D \to f(V_R)$

$D \to$ off

NMC

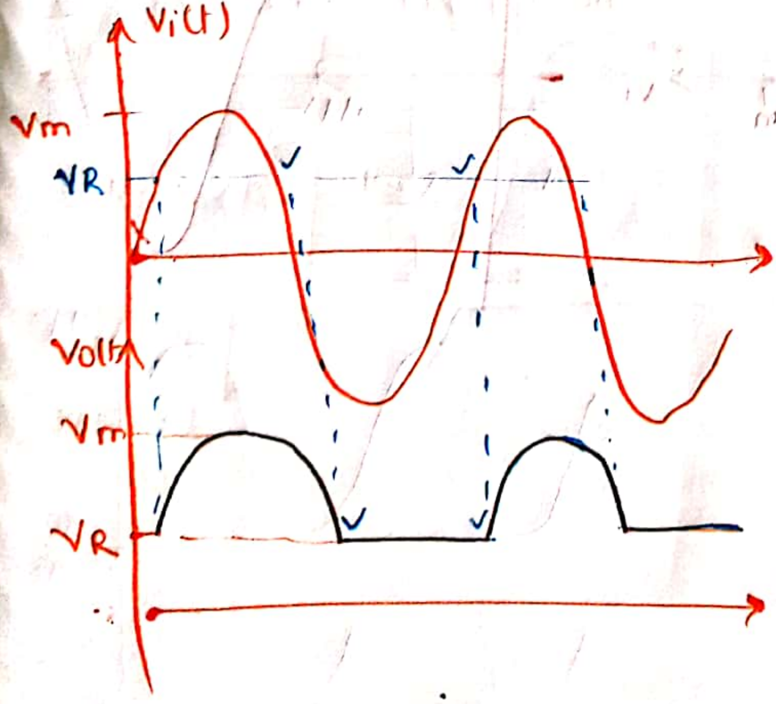
$D \to f(V_i)$

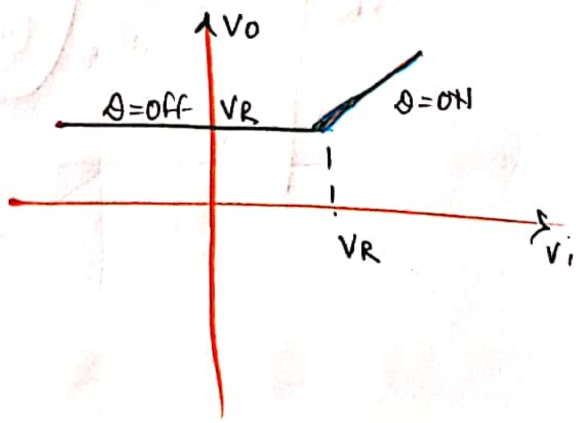
or

$D \to f(V_R)$

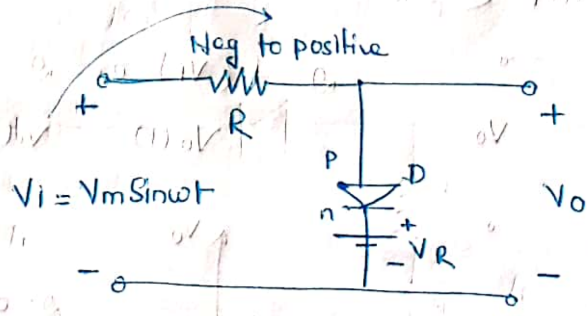
$D \to$ off

$V_o = V_R$



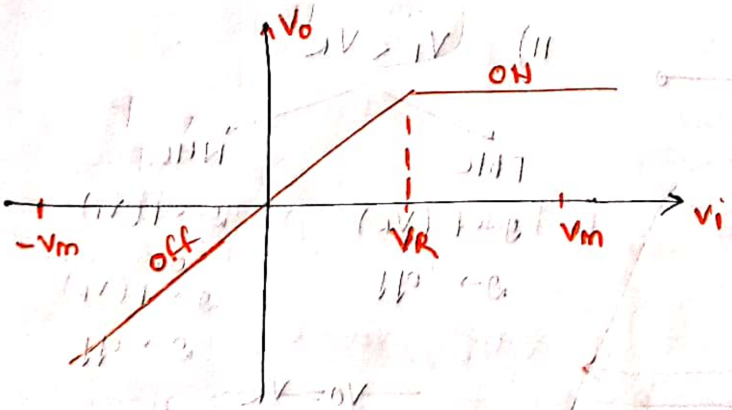


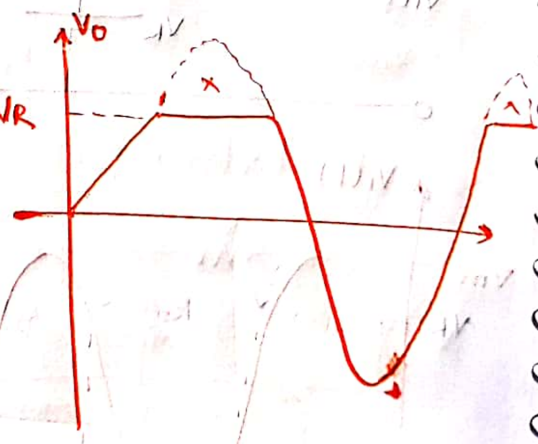
* Positive shunt clipper Circuit with Positive Reference Voltage



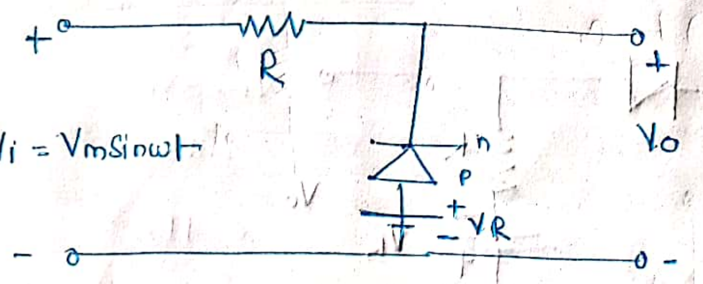
V_i & V_R

- $V_i > V_R$
  - Positive Half Cycle (PHC)
  - $D = f(V_i)$
  - D = ON / F.B / S.C
  - $V_o = V_R$
- $V_i < V_R$
  - PHC
    - Small
    - ↓
    - $D = f(V_R)$
    - D = R.B / off / O.C
  - NHC
    - $D = f(V_i)$, D = off
    - $D = f(V_R)$, D = off





* Negative shunt clipper circuit with positive Ref. Voltage



V_i & V_R

$V_i > V_R$

PHC

$D = f(V_i)$

D = off | RB | OC

$V_o = V_i$

$V_i < V_R$

PHC small

$D = f(V_R)$

D = ON | FB | SC

NHC

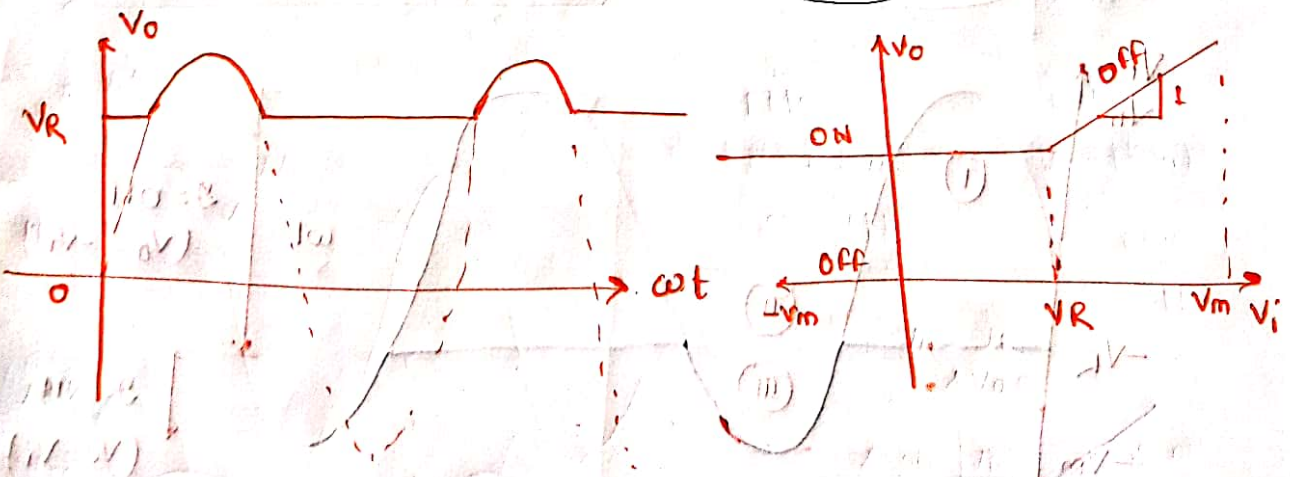
$D = f(V_i)$

D = ON

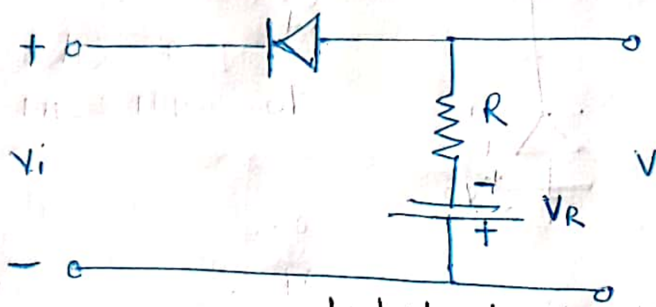
$D = f(V_R)$

D = ON

$V_o = V_R$



* Positive Series Clipper Circuit with negative reference Voltage



$|V_R| < |V_m|$

During positive half Cycle

(I) $0 < \omega t < \pi$

$V_i = +ve$

$V_R = -ve$

$D = f(V_i)$ — $D = OFF$

$D = f(V_R)$ — $D = ON$

$V_o = -V_R$

During Negative Half cycle

(II) $V_i > -V_R$

$D = f(-V_R)$

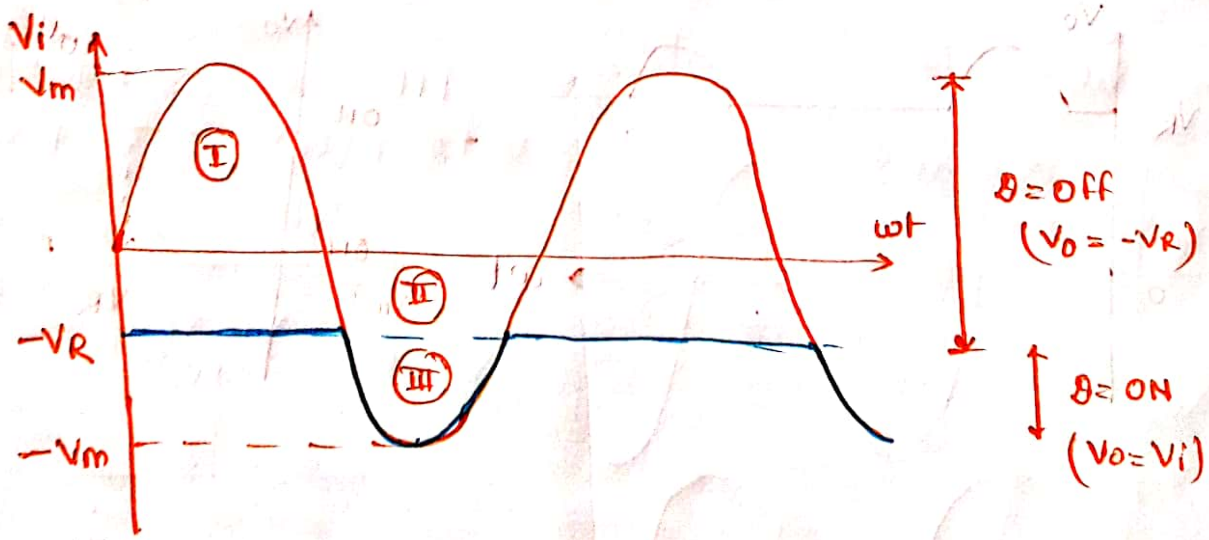
Diode = OFF

(III) $V_i < -V_R$

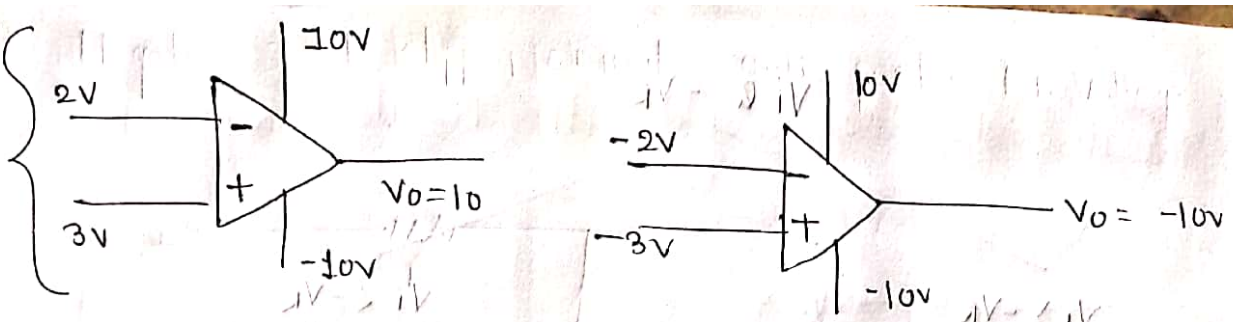
$D = f(V_i)$

Diode = ON

$V_o = V_i$



Scanned by CamScanner

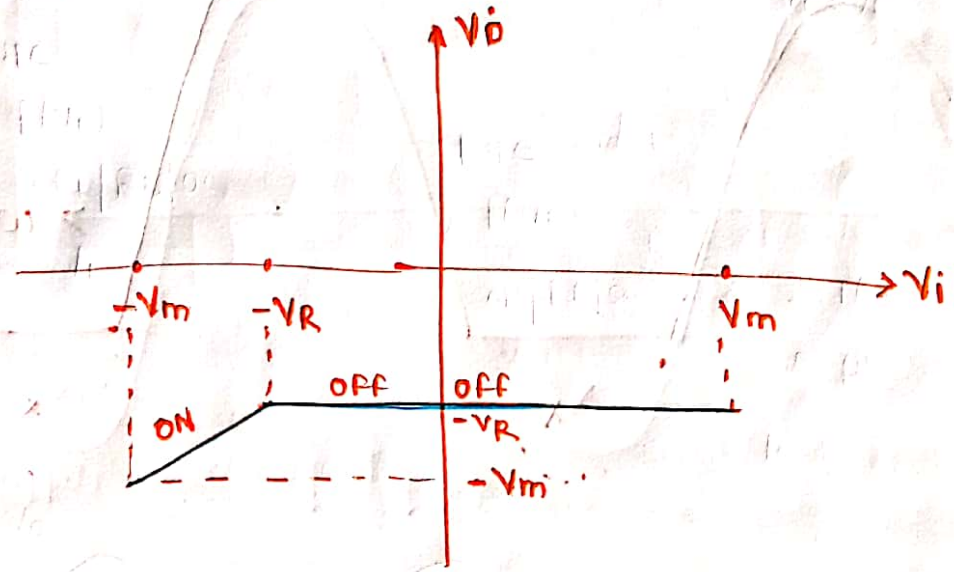


Comparator

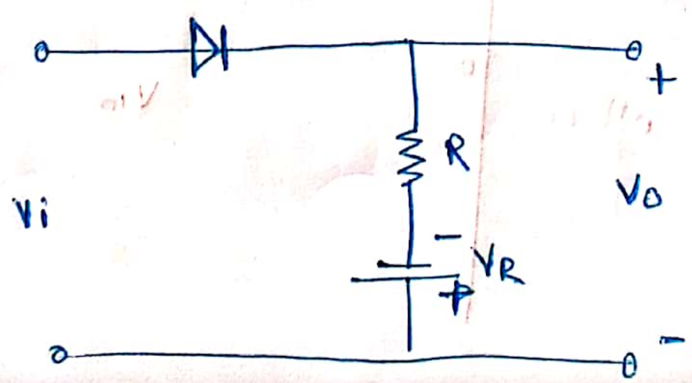
i) non Inverting > Inverting   ii) Non Inverting < Inverting

In Comparator greater numbers decide the output

In Case of diode greater potential decide the output



* Negative Series Clipper Circuit with Negative Reference Voltage



V_i & $-V_R$

$V_i > -V_R$

PHC & NHC

$D = f(V_i)$

or

$D = f(-V_R)$

$D = f(-V_R)$

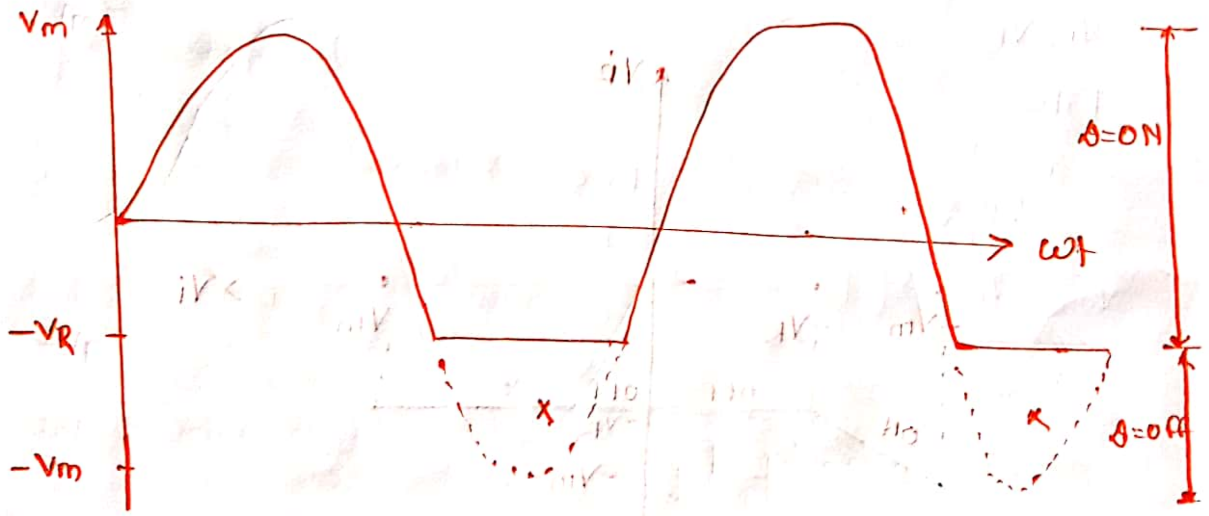
Diode = ON

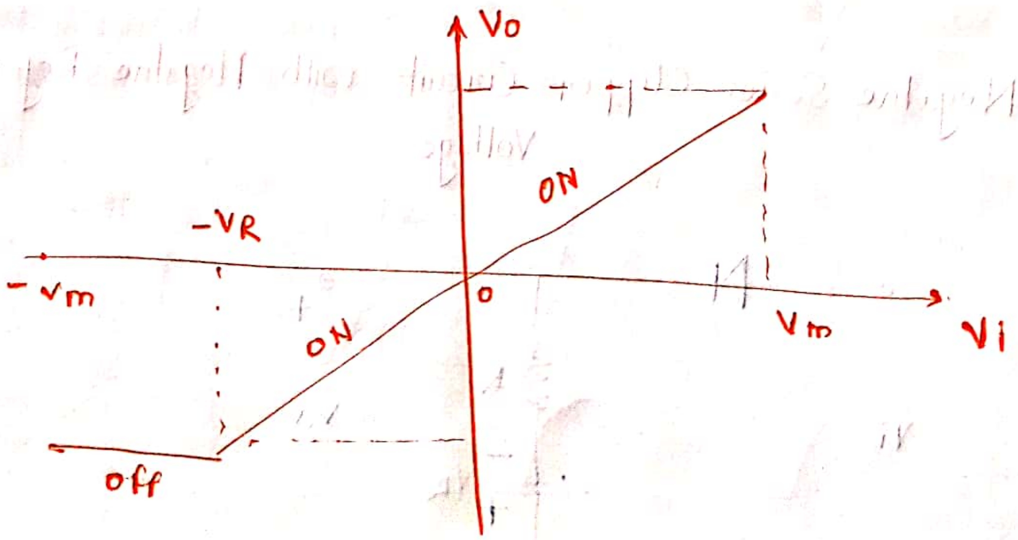
$V_i < -V_R$

NHC

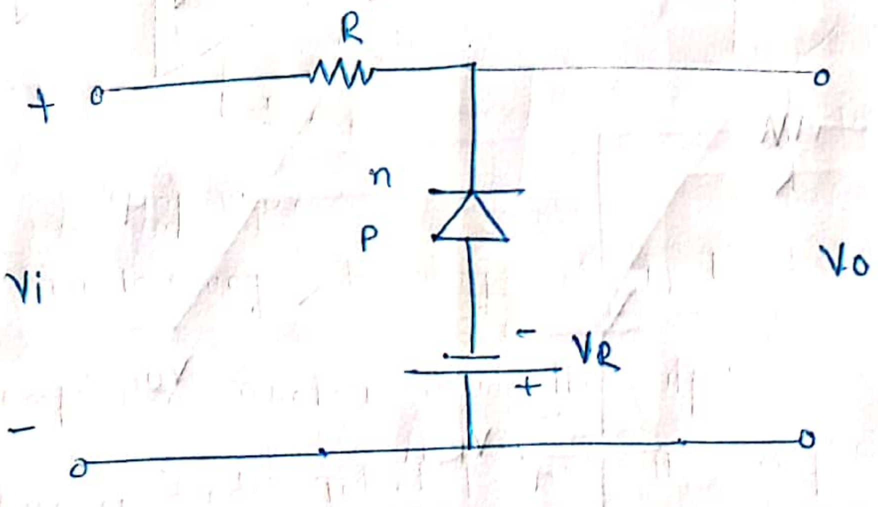
$D = f(V_i)$

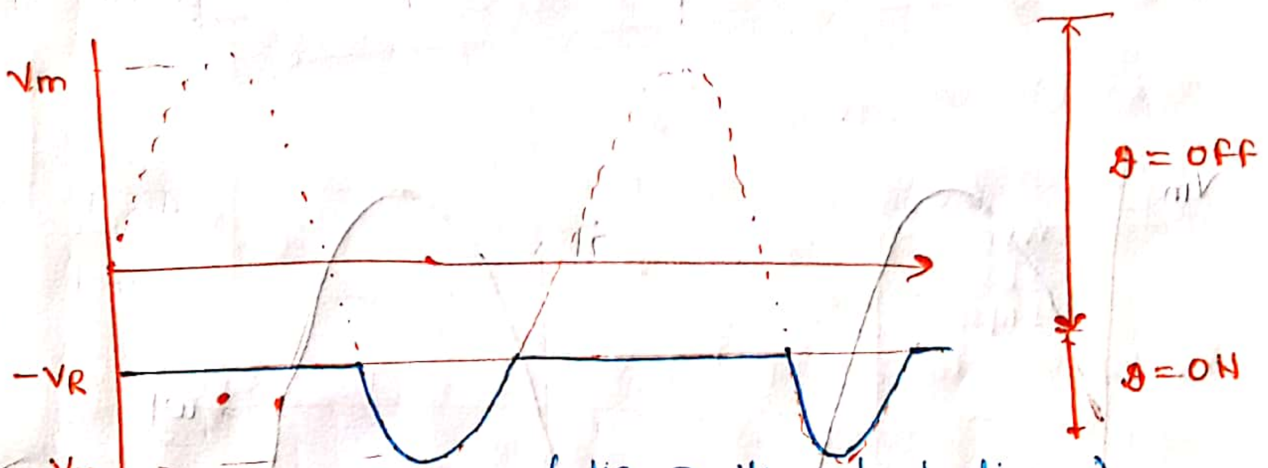
Diode = OFF



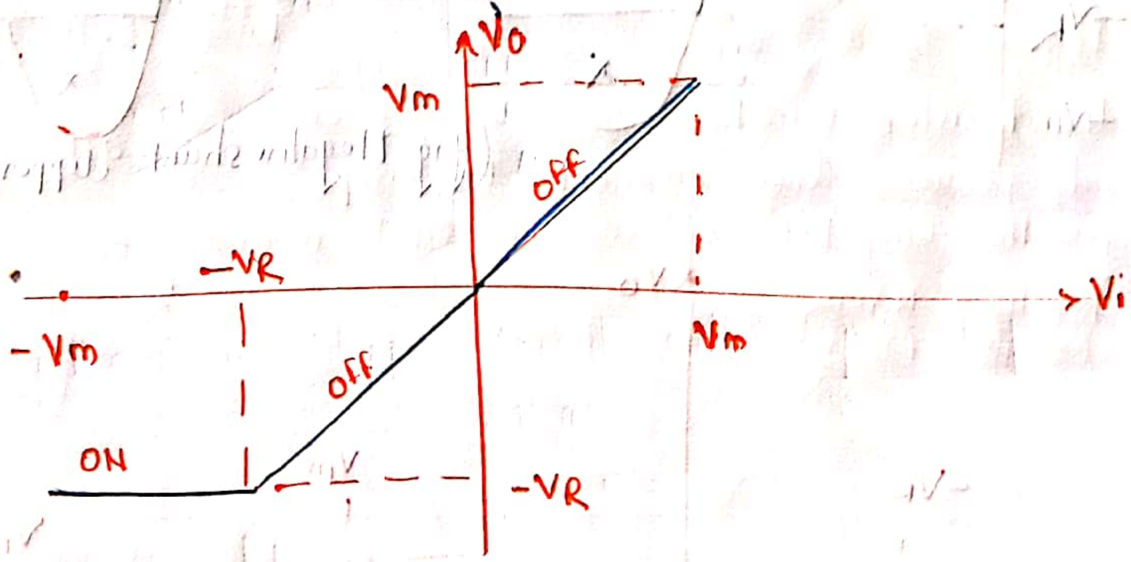


* Negative shunt clipper circuit with Negative Ref. Voltage

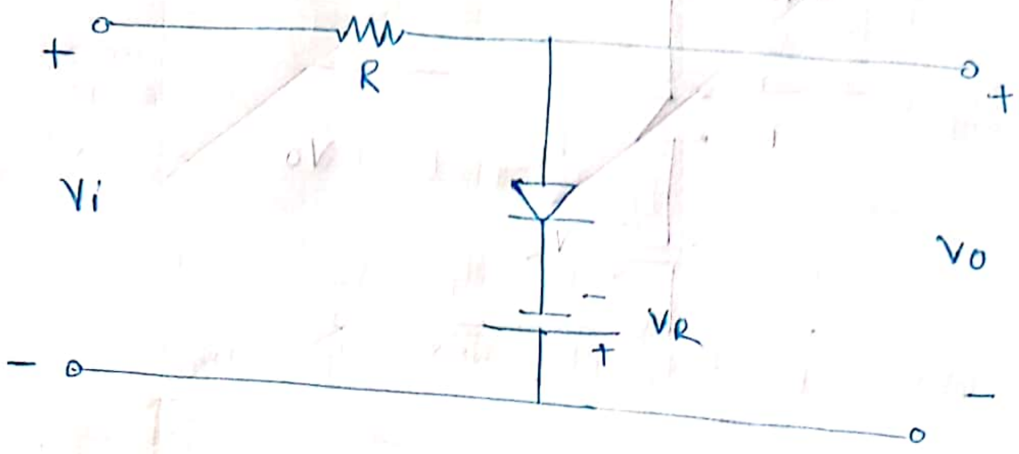


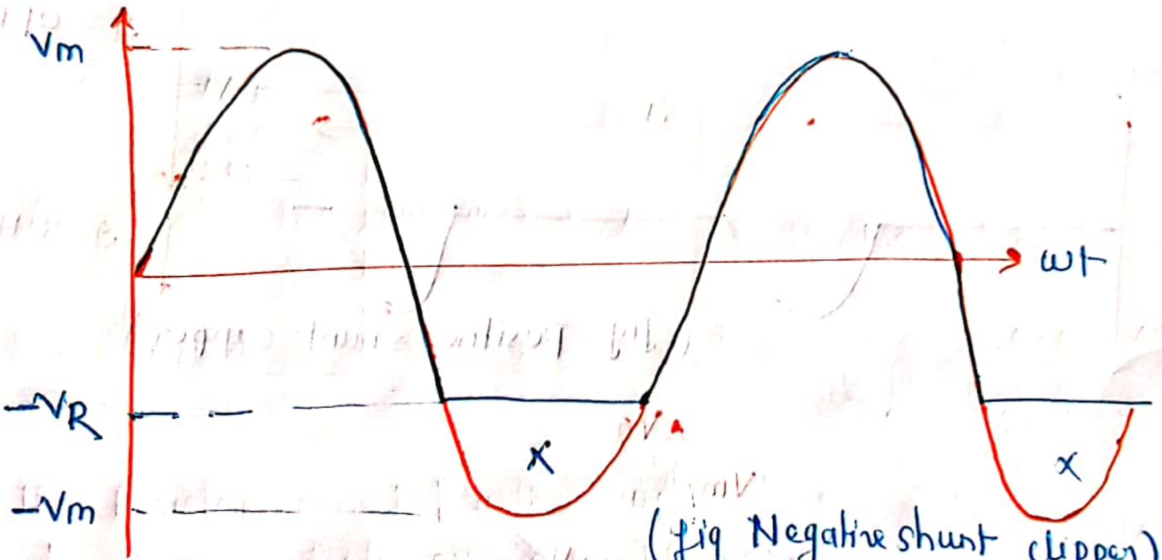


(fig positive shunt clipper)

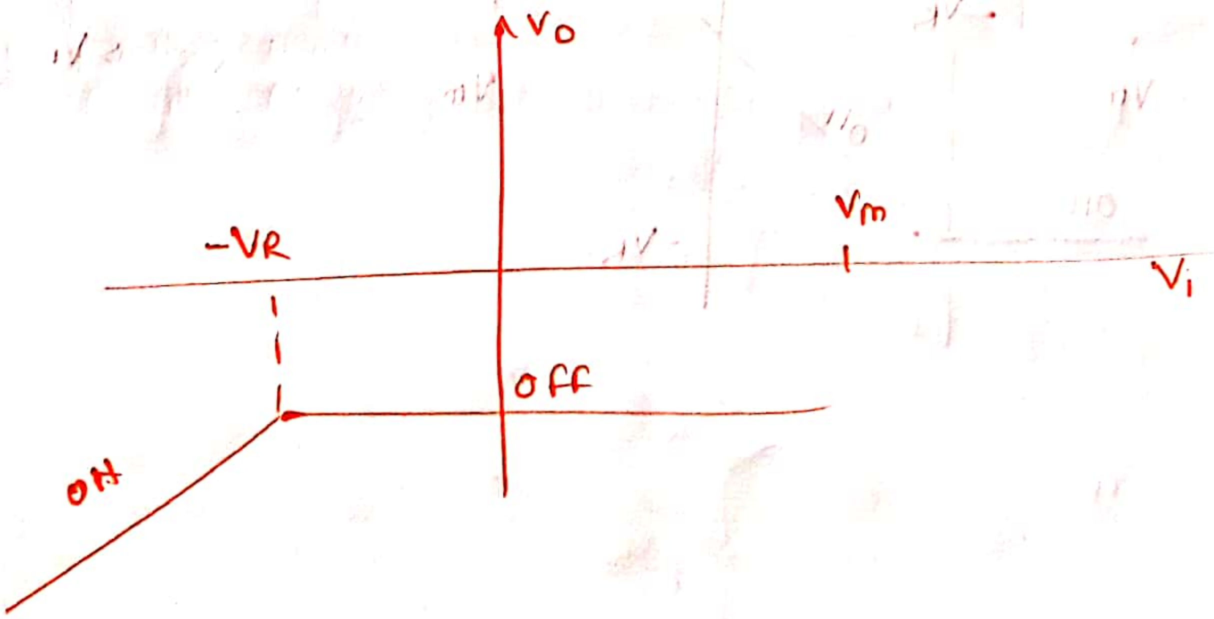


* Positive shunt clipper ckt with Negative Ref. Voltage

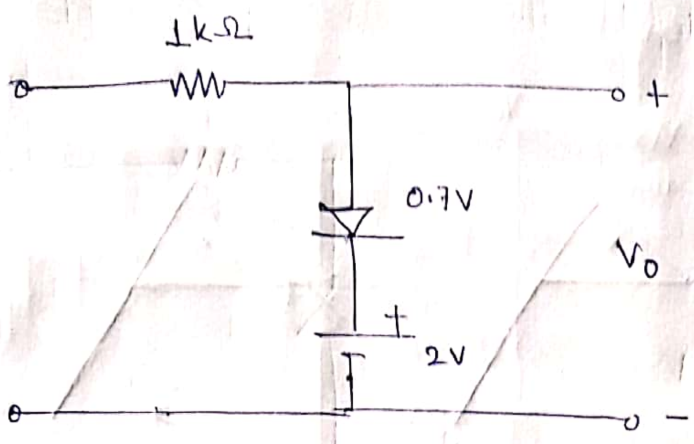


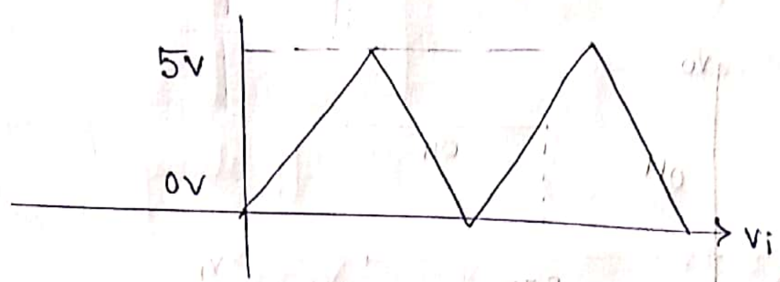


(fig Negative shunt clipper)

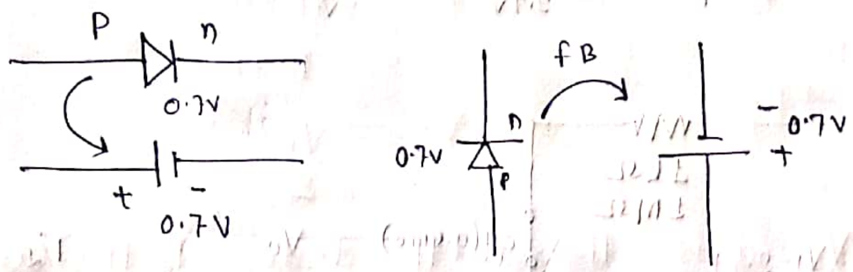


Que1

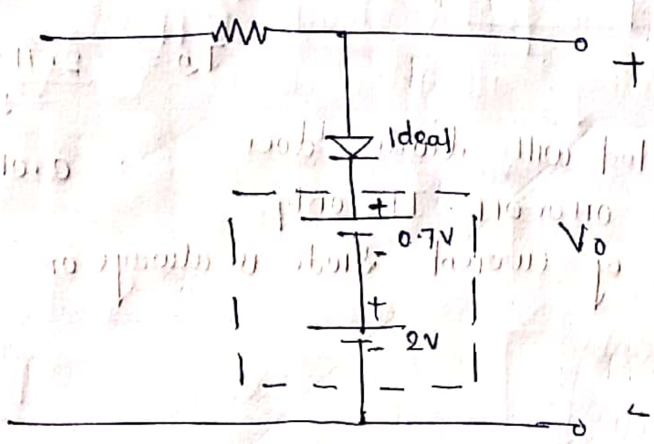




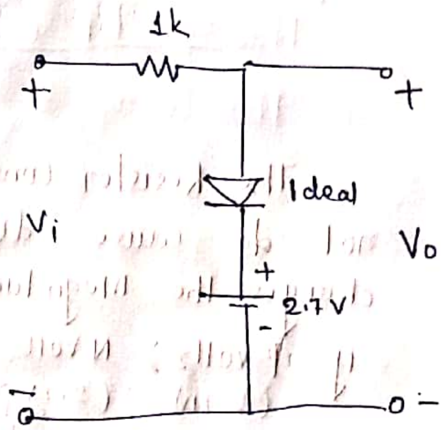
Sol



Assumⁿ diode as Ideal

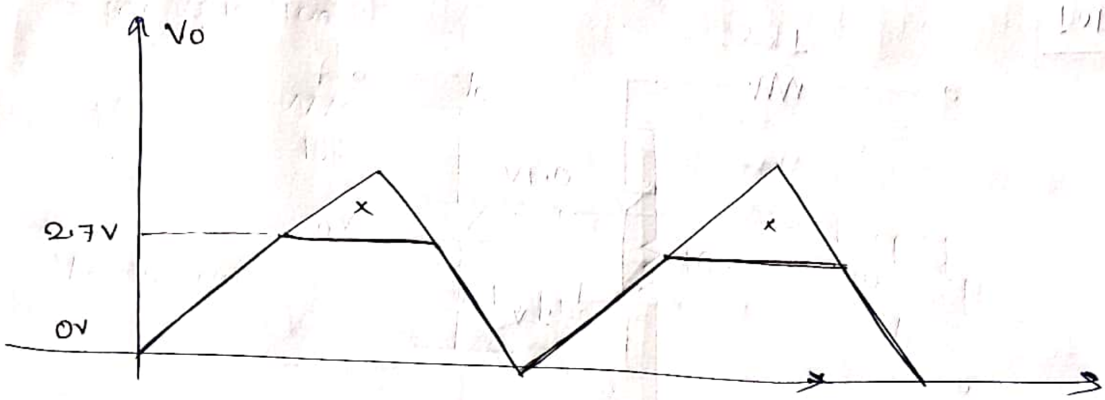


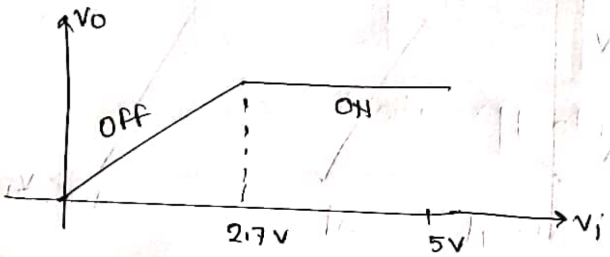
⇒ Vi

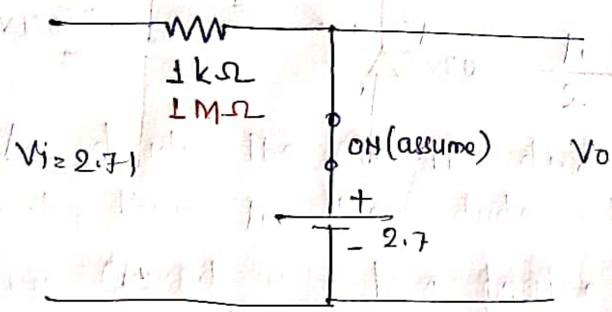


Vi & 2.7V

$V_i > 2.7V$	$V_i < 2.7V$
$D = f(V_i)$	$D = f(2.7V)$
D = ON / S.C	D = OFF
$V_0 = 2.7V$	$V_0 = V_i$







$$I_D = \frac{2.71 - 2.7}{1}$$

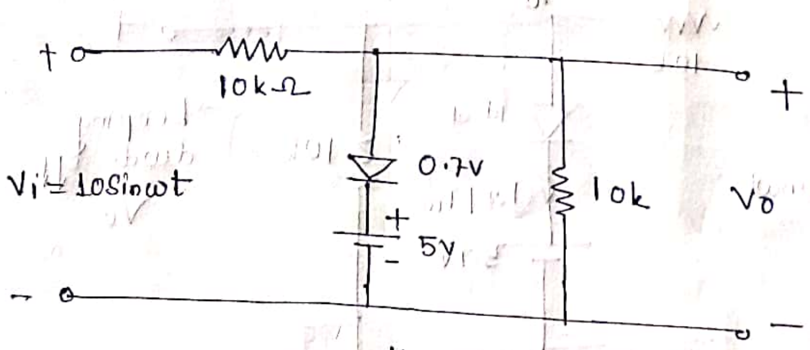
$$= 0.01 mA$$

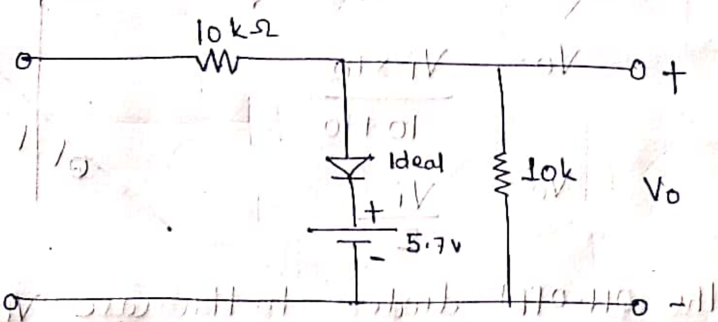
$$I_D = \frac{2.71 - 2.7}{1}$$

$$= 0.01 \mu A$$

The Resistor Connected with diode does not ~~do~~ Cause diode ON or OFF. It only changes the Magnitude of current. Diode is always on if P volt > N volt
(2.71V) (2.7V)

Que 2 Draw xfer and output characteristic for a given below figure.

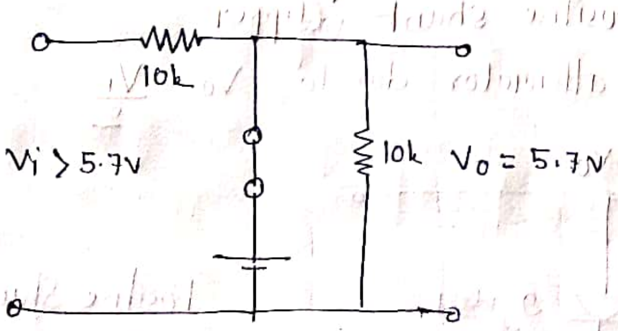




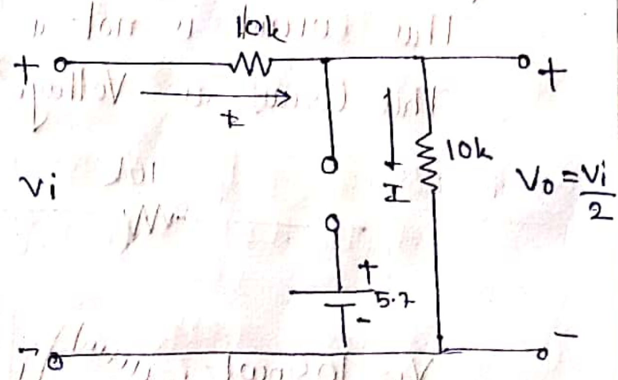
Wrong solution

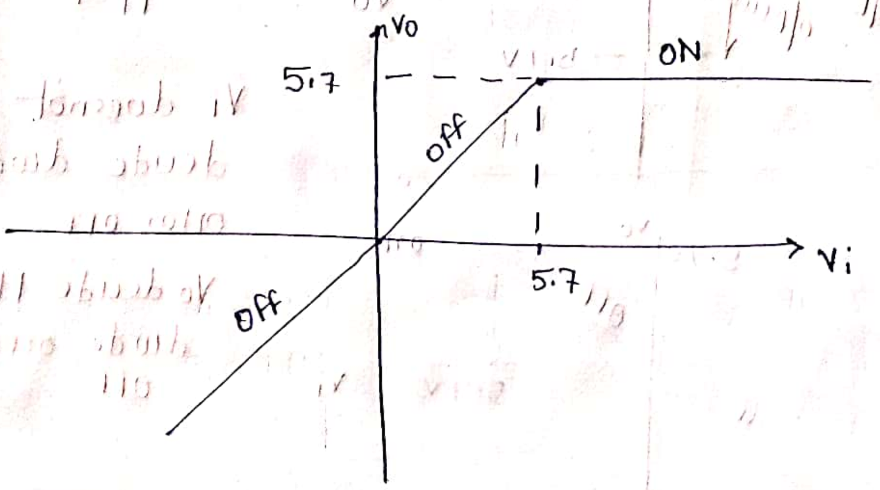
In actual diode is not Comparing with Vi

1) Vi > 5.7V diode ON S.C

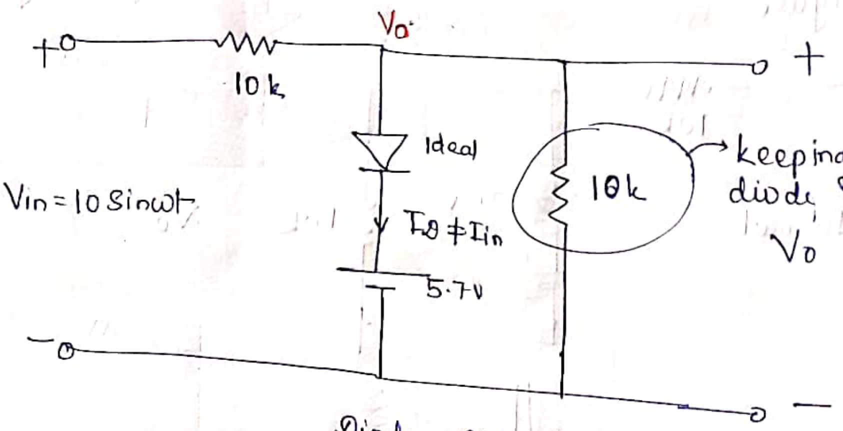


II) Vi < 5.7V diode off





Que 3 Same question :

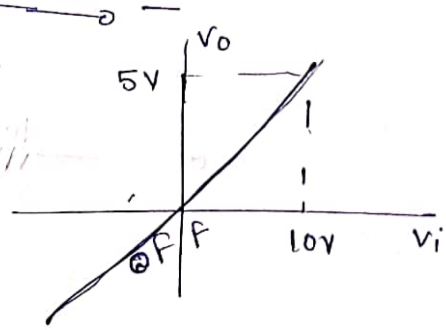


Diode off always

$V_i < 5.7V$

$$V_o = \frac{V_i \times 10}{10 + 10}$$

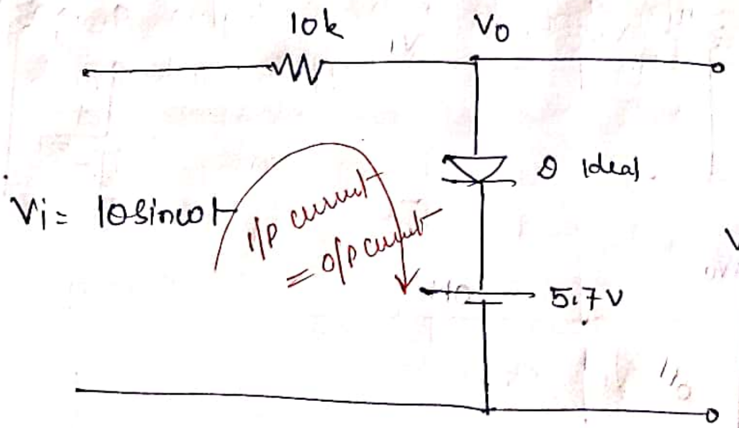
$$V_o = \frac{V_i}{2}$$



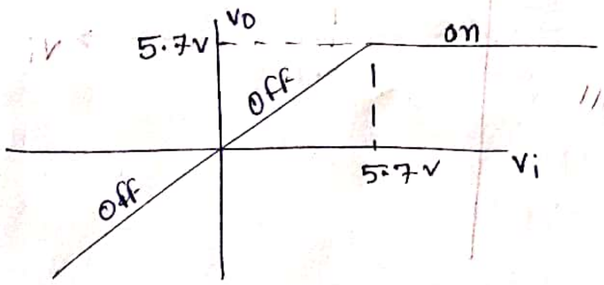
V_o decide the (ON-OFF) diode. In this case V_o never greater than V_i. Hence diode always off.

This circuit is not a positive shunt clipper.

This circuit is voltage attenuator due to $V_o = \frac{V_i}{2}$



Positive Shunt clipper



V_i doesnot decide diode ON or OFF

V_o decide the diode ON or OFF

Que 3 $V_i = 20 \sin \omega t$

$V_i = 11.4$

$V_i > 11.4V$

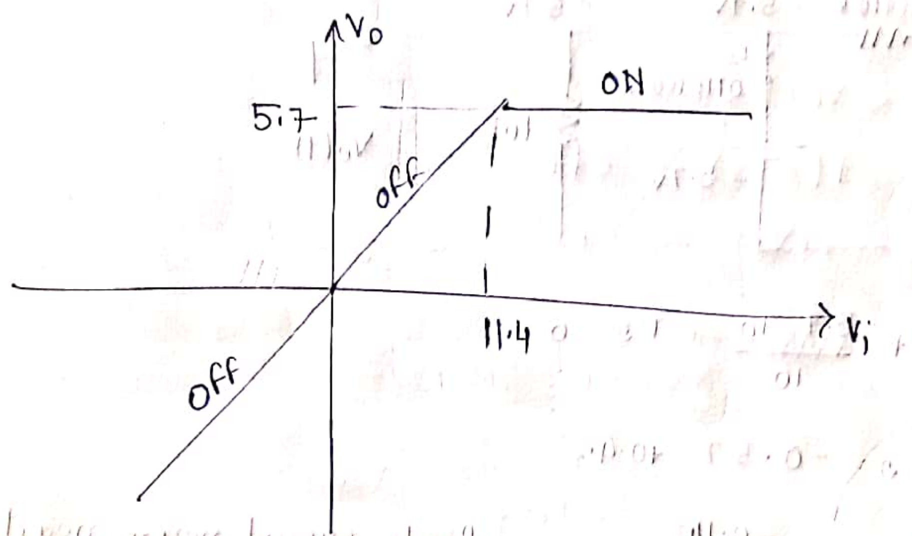
Diode ON

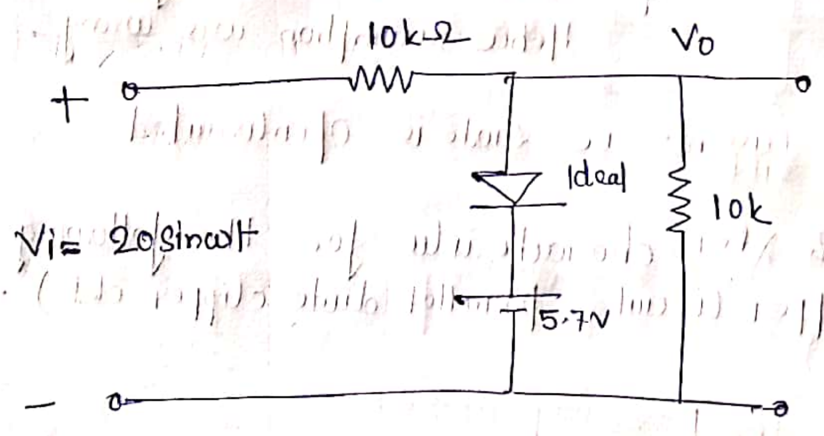
$V_o = 5.7$

$V_i < 11.4V$

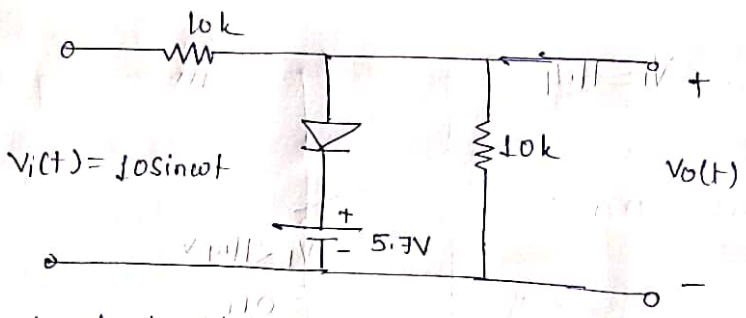
Off

$V_o = \frac{V_i}{2}$

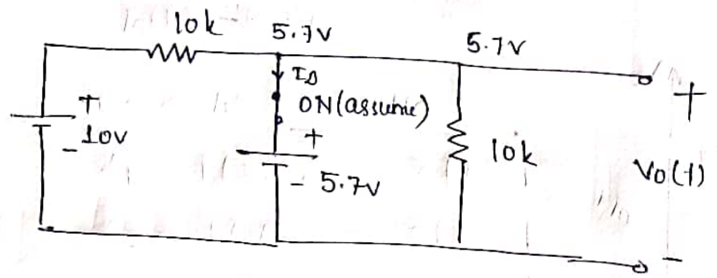




Que.



How to check diode -



$$\frac{5.7}{10} + \frac{5.7-10}{10} + I_D = 0$$

$I_D = -0.57 + 0.43$

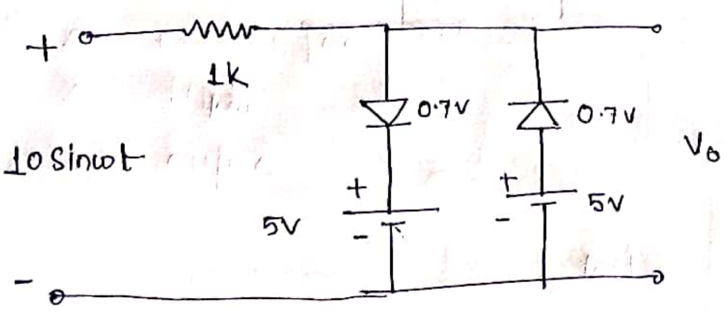
$I_D = -0.14$ { Diode Current never negative Hence assumption was wrong. }

$I_D = 0\,A$

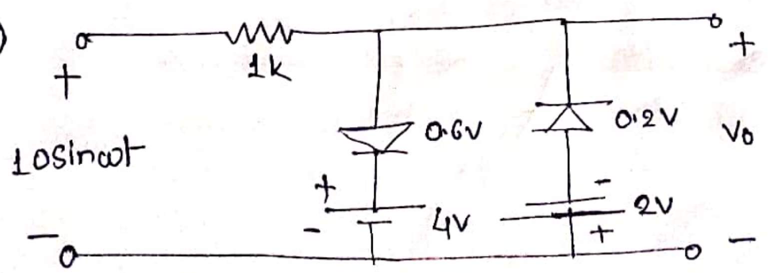
negative value of diode Current i.e Diode is open circuited

Que 4. Draw output & Xfer characteristic for the following double diode clipper Circuit (parallel diode clipper ckt).

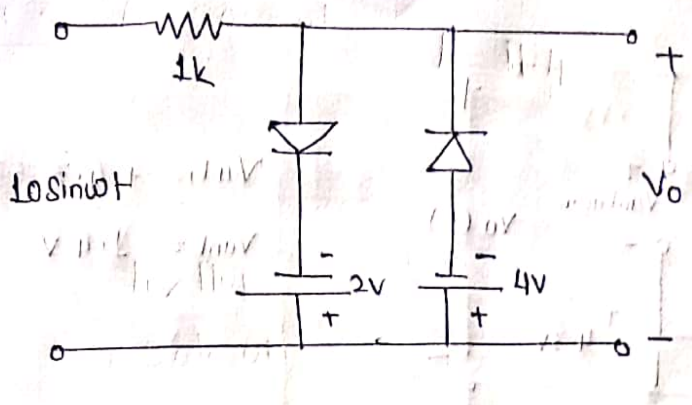
(I)



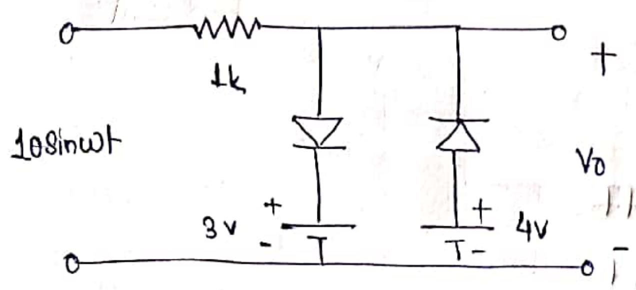
(II)



(3)

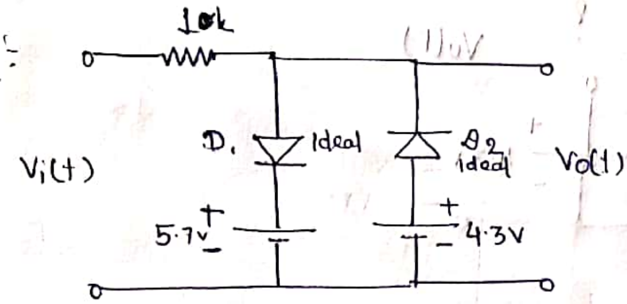


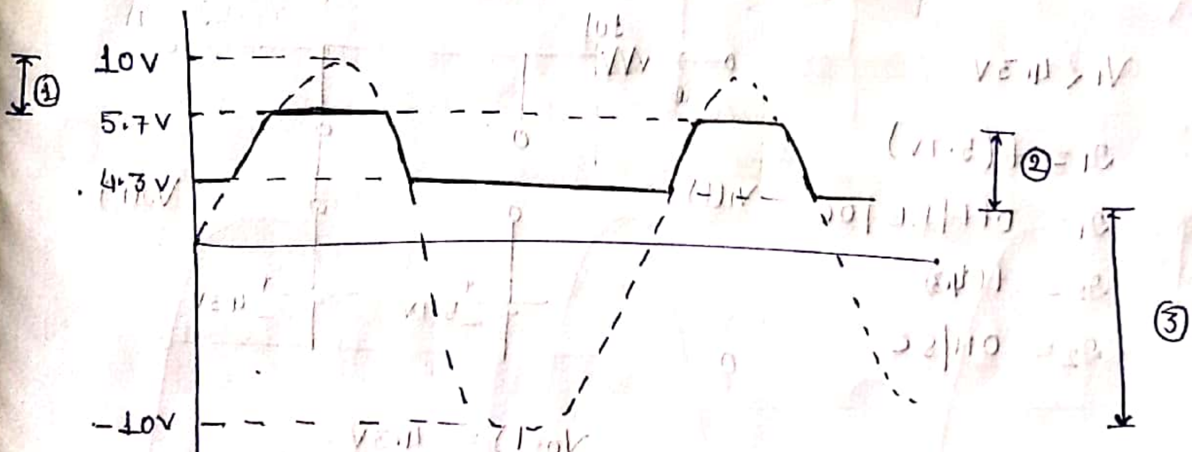
(4)



- If there is no Information of diode that means Ideal or practical then we assume Ideal diode.

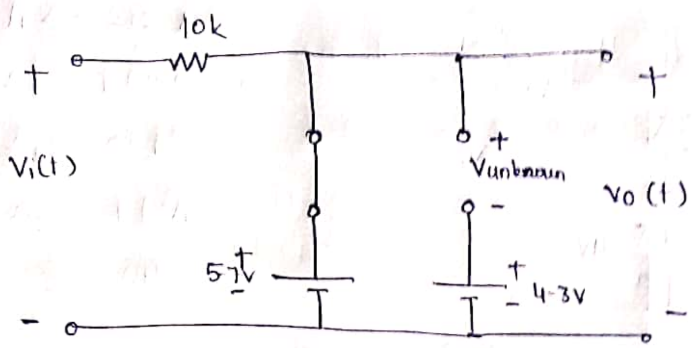
Soln :-





Case I :- $V_i > 5.7$ $D_1 = f(V_1)$ $D_1 =$ ON/SC/FB

$D_2 = f(V_1)$ $D_2 =$ OFF/OC/RB



Vunknown + 4.3 = 5.7.

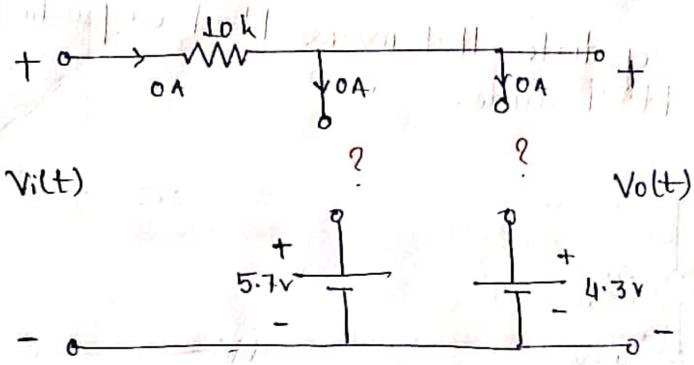
Vunk = 1.4 V

$V_o(t) = 5.7V$

Case II $4.3 < V_i(t) < 5.7$

$D_1 = f(5.7V) = \text{off}$

$D_2 = f(V_i) = \text{off}$



$V_o(t) = V_i(t)$

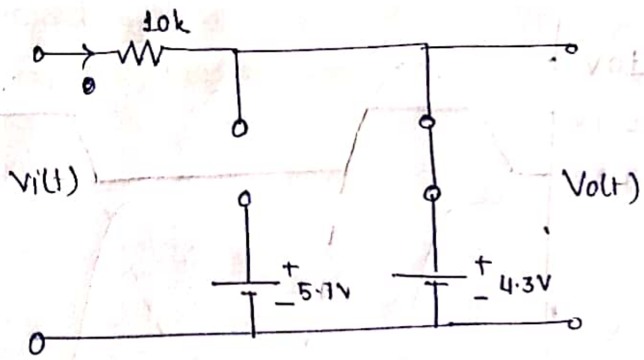
Case III $V_i < 4.3V$

$D_1 = f(5.7V)$

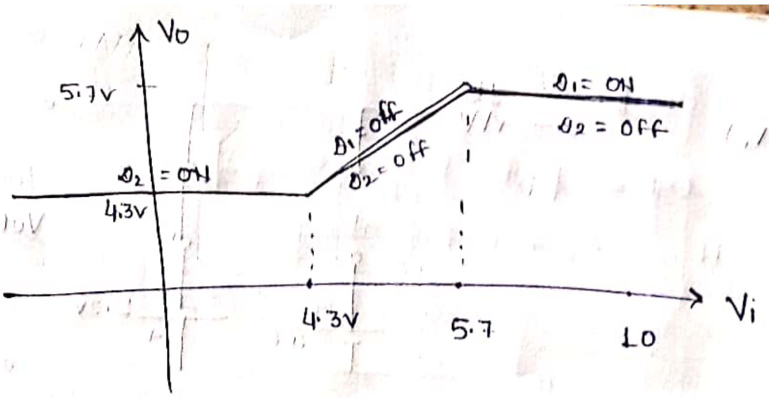
$D_1 = \text{off} | \text{RB} | \text{OC}$

$D_2 = f(V_i)$

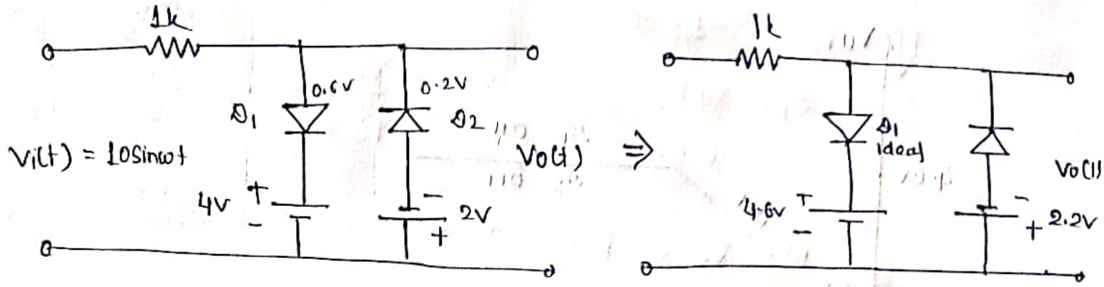
$D_2 = \text{ON} | \text{S.C}$

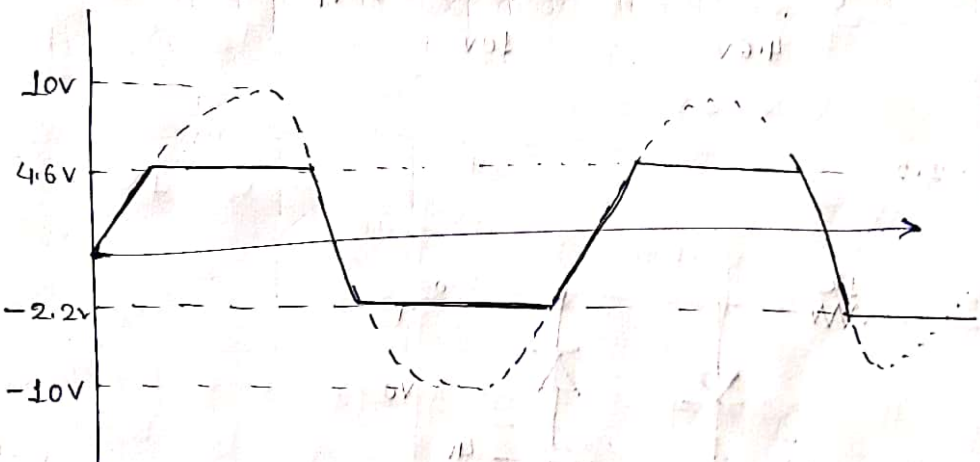


$V_o(t) = 4.3V$



Sol 2 :





(i) $V_i > 4.6V$

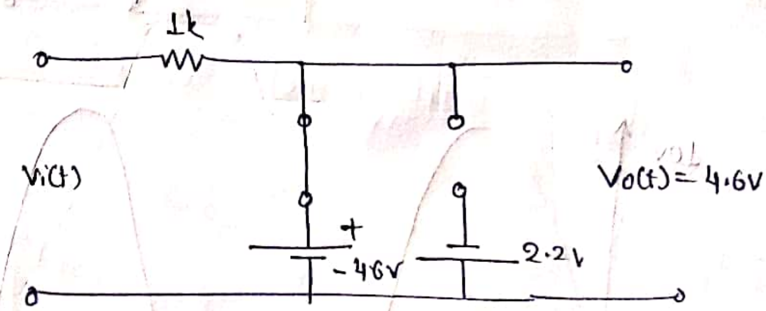
$D_1 = f(V_i)$

D_1 = ON | FB | SC

D_2 = Off | RB | OC

$D_2 = f(V_i \text{ or } -2.2V)$

$V_o = 4.6V$



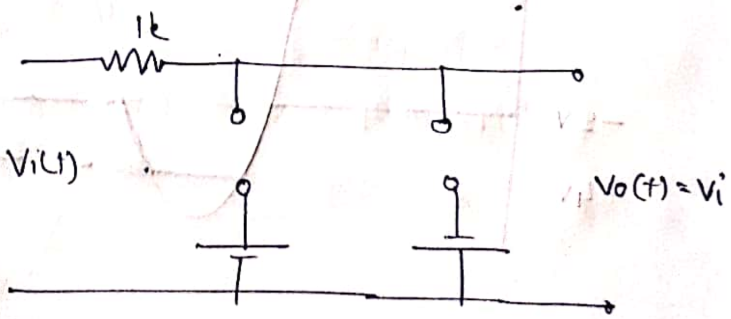
(ii) $-2.2 < V_i < 4.6$

D_1 = off $= f(4.6V)$

$D_2 = f(V_i \text{ or } -2.2V)$

D_2 = off

$V_o(t) = V_i$



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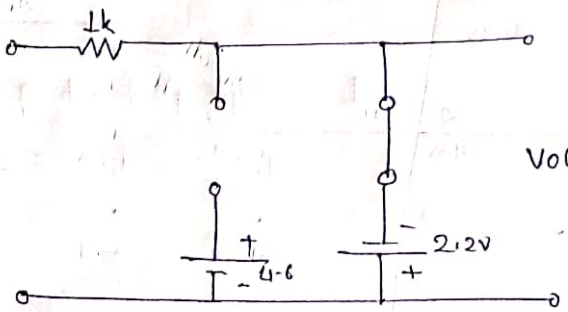
(3) $V_i < -2.2V$

$D_1 = f(4.6 \text{ or } V_i)$

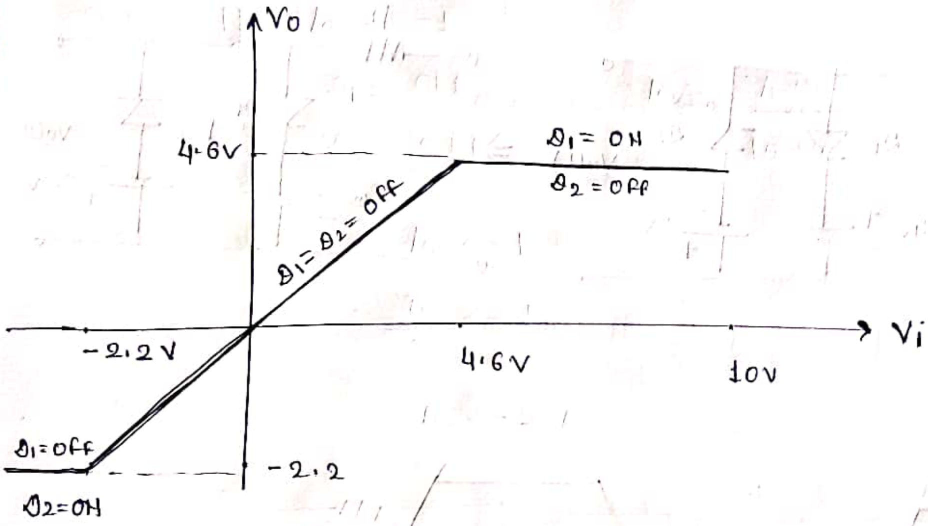
$D_1 = \text{off}$

$D_2 = f(V_i)$

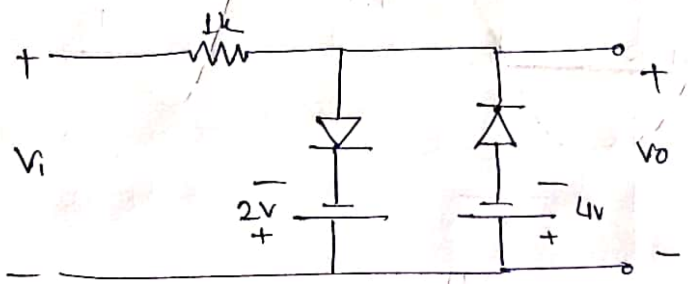
$D_2 = \text{ON}$

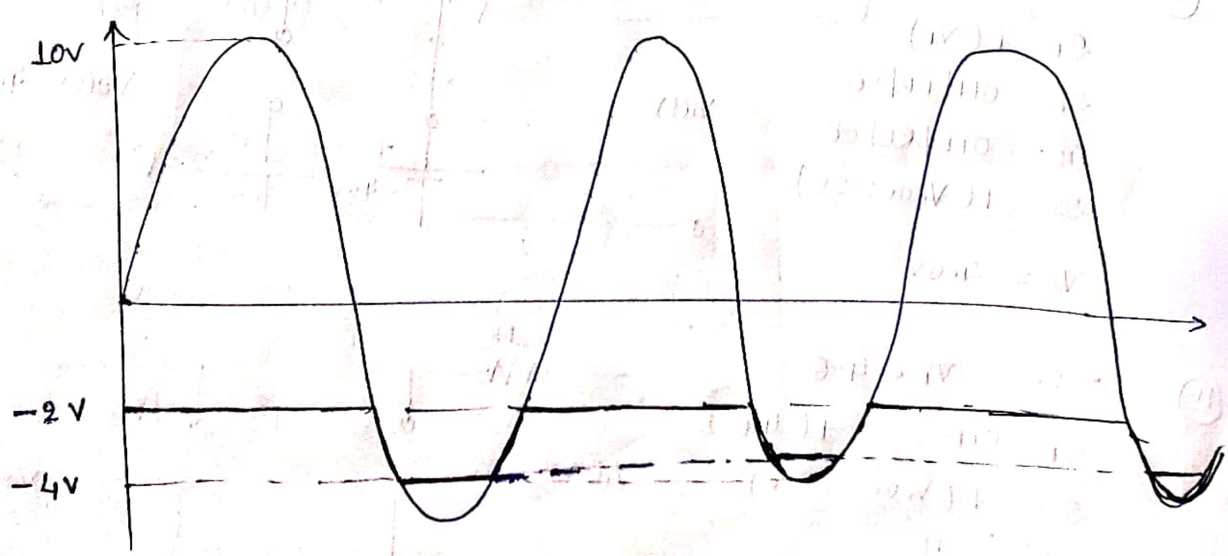


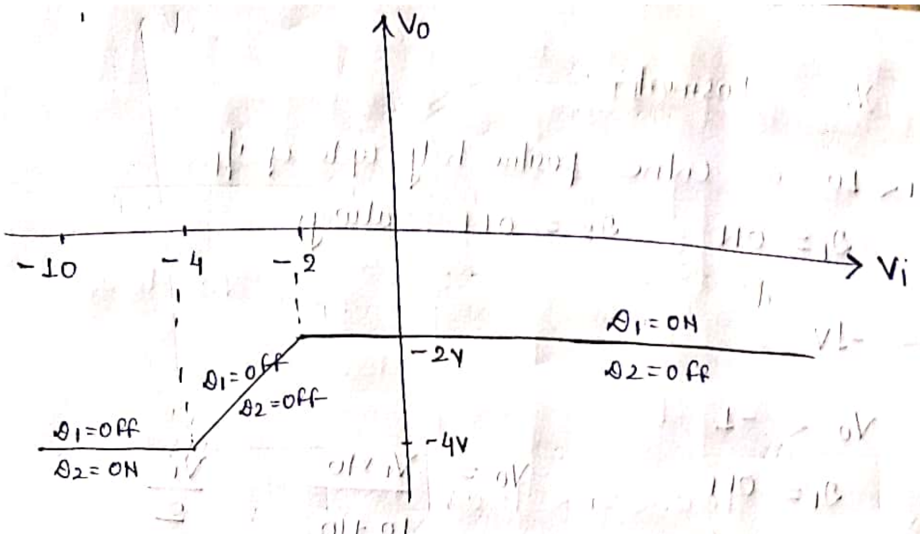
$V_o(t) = -2.2V$



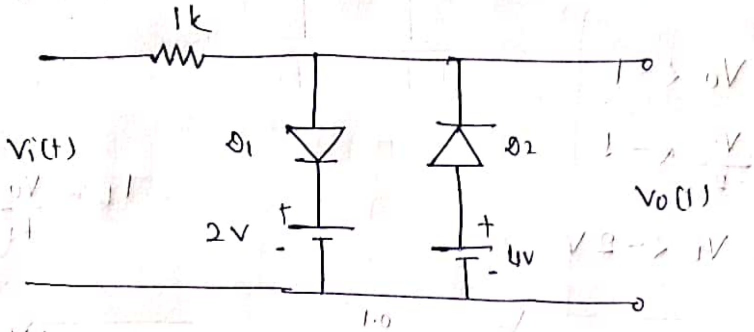
Sol3



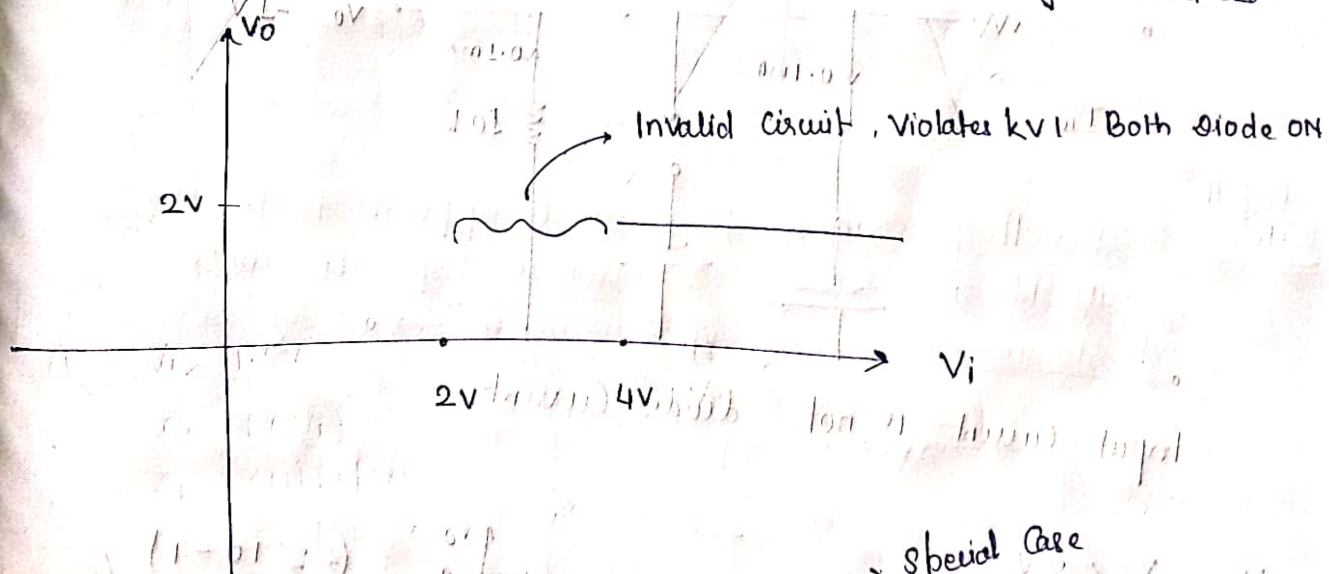




Sol14:

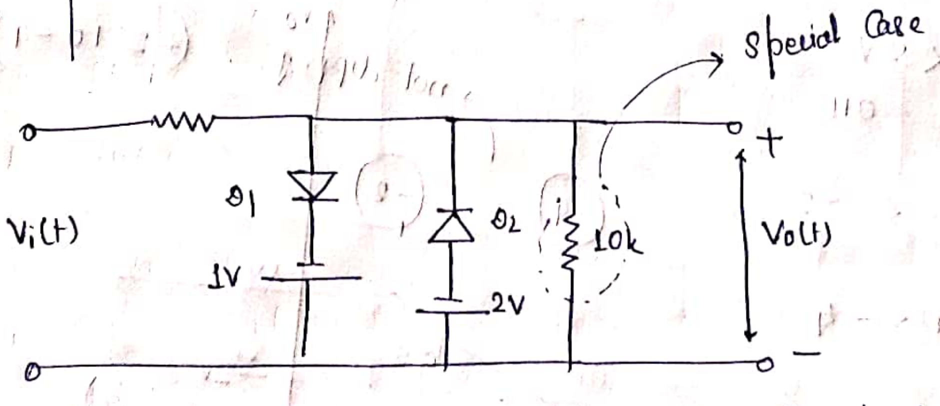


Reference Volt of P→N diode should always be at higher potential for a valid ckt.



1-14

Q16.



Assuming diode to be Ideal, for o/p to be clipped the i/p volt V_i must be outside range.

Sol let $V_i = 10\sin\omega t$

$0 < V_i < 10$ or Entire positive half cycle of i/p

$D_1 = ON \quad D_2 = OFF$ always

$V_o = -1V$

now, If $V_o < -1$

$D_1 = Off$ $\quad V_o = \frac{V_i \times 10}{10+10} = \frac{V_i}{2}$

$D_2 = off$

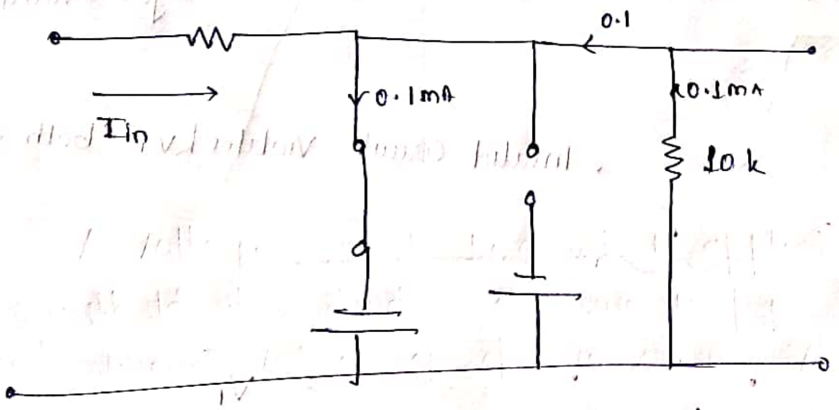
$V_o < -1$

$\frac{V_i}{2} < -1$

$V_i < -2V$

$I_L = \frac{V_o}{R_L} = \frac{-1}{10}$

$= -0.1mA$



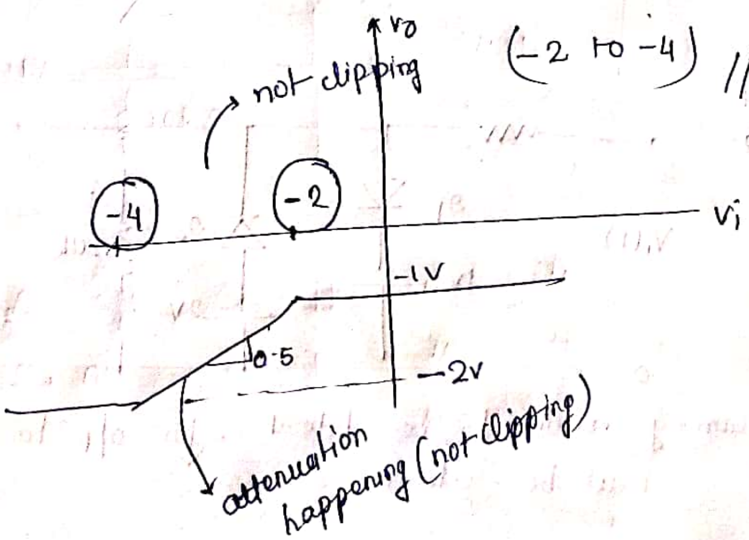
Input current is not diode current.

If $V_o < -2V$

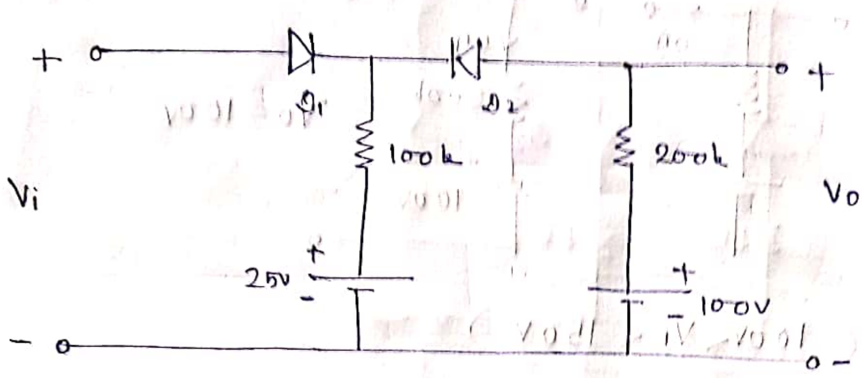
$D_2 = ON$

$\frac{V_i}{2} < -2$

$V_i < -4$



Que. Draw the Xfer characteristic of clipper circuit where input Voltage vary linearly from (0 to 150V)



Sol:-

$V_i > 100V$ ✗

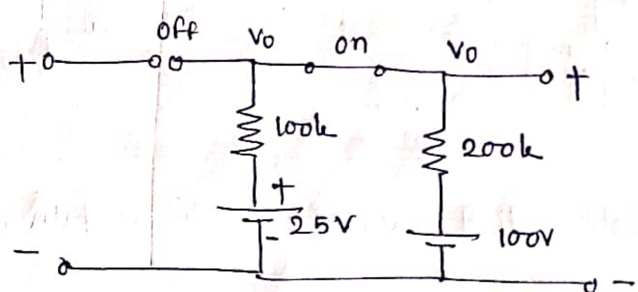
$V_i < 25V$ ✗

$25V < V_i < 100V$ ✗

$V_i = 0.1V$ [Initially]

D_2 = ON [due to 100V]

D_1 = off [due to 25/100V]



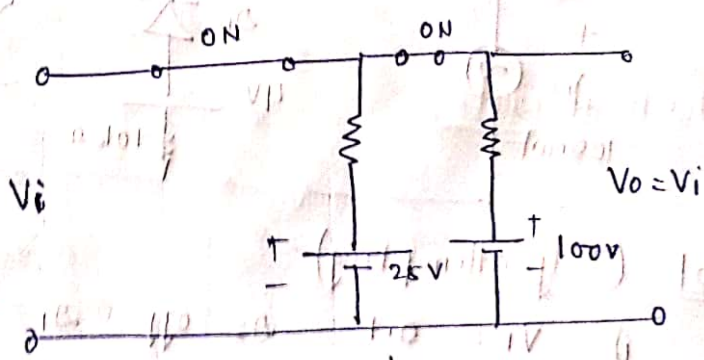
$$\frac{V_o - 100}{200} + \frac{V_o - 25}{100} + 0 = 0$$

$V_o = 50V$

$0 < V_i < 50$

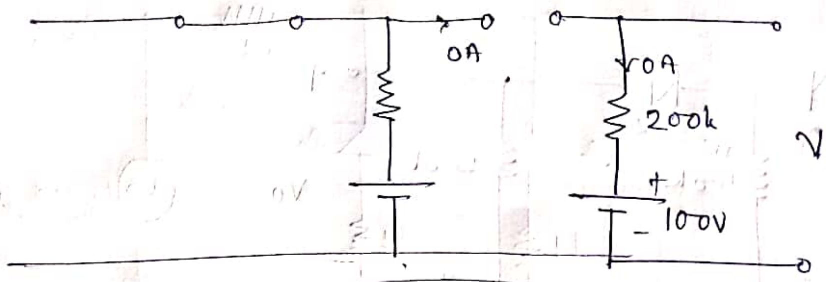
If $V_i > 50V$

D_1 = ON D_2 = ON



$50 < V_i$ 100

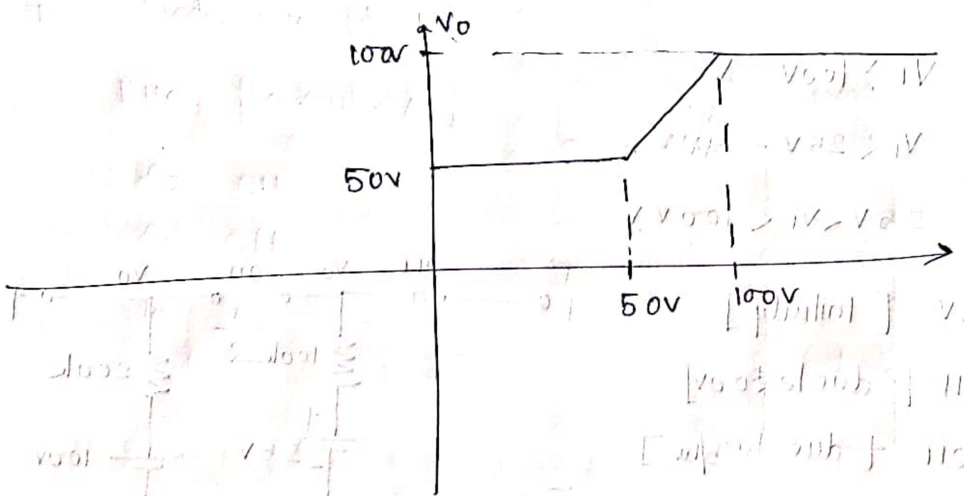
If $V_i > 100V$ $D_2 = \text{off}$



$V_o = 100V$

fig.

$100V < V_i < 150V$



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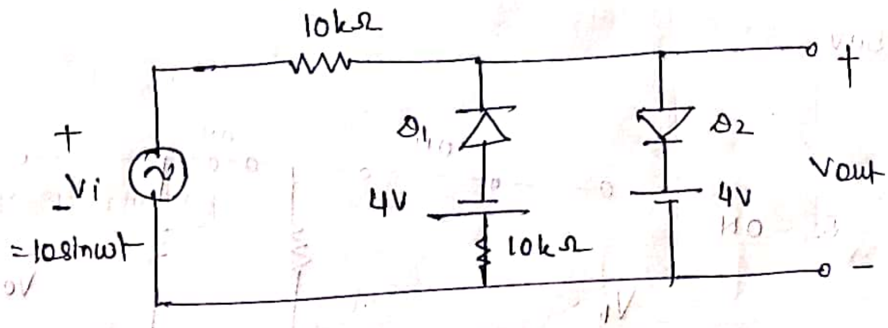
Que 7. A voltage signal $10\sin\omega t$ is applied to the ckt with Ideal diode as shown in fig. The Max^m and $Minim^n$ value of o/p waveform Vout of ckt are



Sol (Self attempting) :-

1) $V_i = 0.1$ D_2 off $D_1 =$ off $V_o = V_i$

ii) $V_i < -4$ D_1 ON D_2 off $V_o = \cancel{4}$

$$\frac{V_o + 4}{10} + \frac{V_o - V_i}{10} = 0$$

$$2V_o = V_i - 4$$

$V_o = \frac{V_{in}+4}{2}$

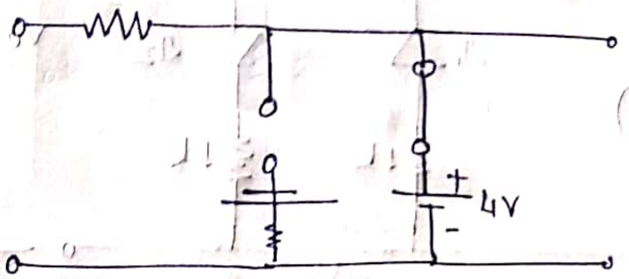
~~$V_{o\,min} =$~~

actual Solution

$V_i = 10V\ (\text{max})$

$D_2 = ON$

$D_1 = off$



$V_{o\,max} = 4V$

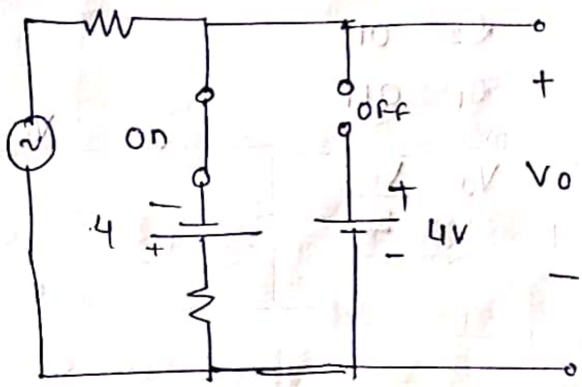
If $V_i = -10V\ (\text{min})$

$D_1 = ON$

$D_2 = OFF$

$$\frac{V_o+4}{10} + \frac{V_o - V_{in}}{10} = 0$$

$$V_o = \frac{V_{in}}{2} - 2$$

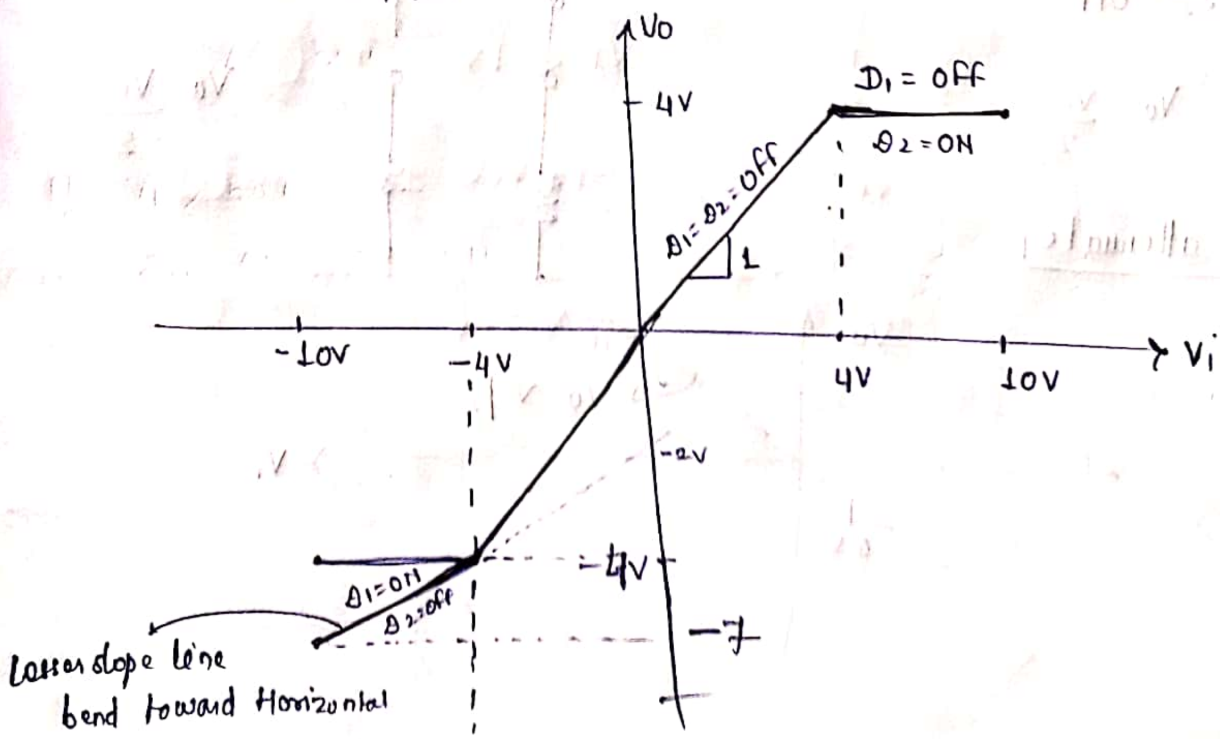


$$V_{o\,min} = \frac{-10}{2} - 2$$

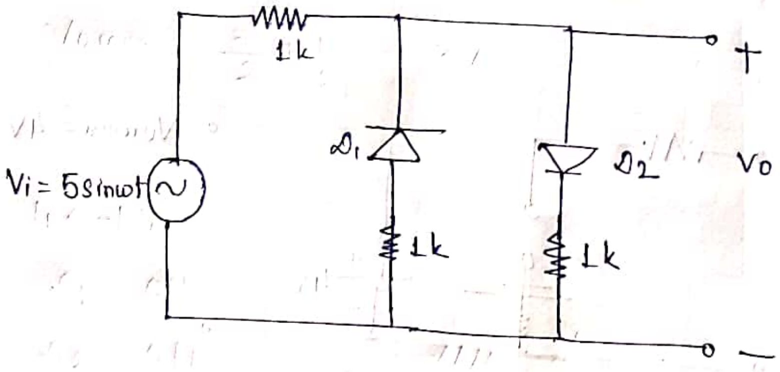
$$= -7\ \text{Volt}$$

$v_o + \cancel{0} = \frac{-7-4}{-10+4}$

$v_o = -7 \cdot v_o$



Que. Draw the Xfer characteristic for a given below figure
i) Diode are Ideal ii) If offset voltage of diode is 1V.



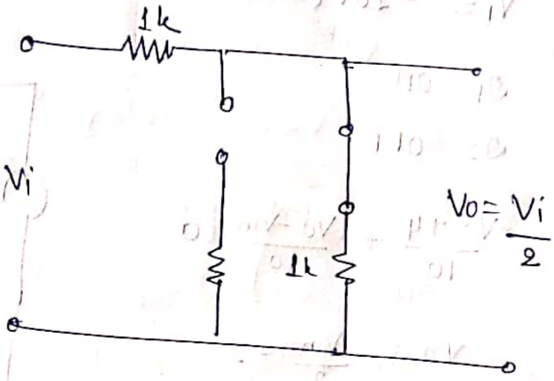
Sol I. Diode are Ideal

PHC $[0 < \omega t < \pi]$

$D_2 = ON$

$D_1 = Off$

$V_o = \frac{V_i}{2}$

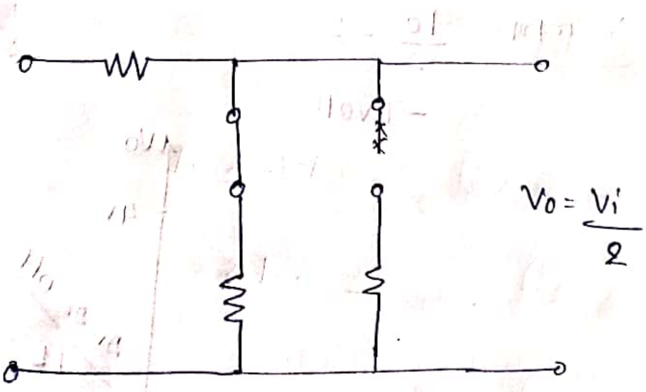


NHC $[\pi < \omega t < 2\pi]$

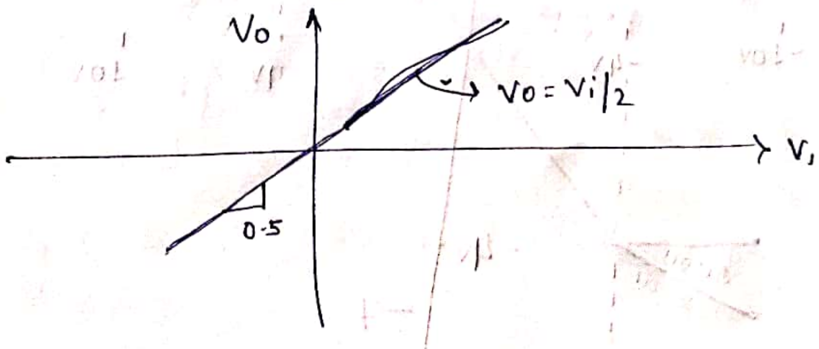
$D_1 = ON$

$D_2 = Off$

$V_o = \frac{V_i}{2}$



This is attenuator



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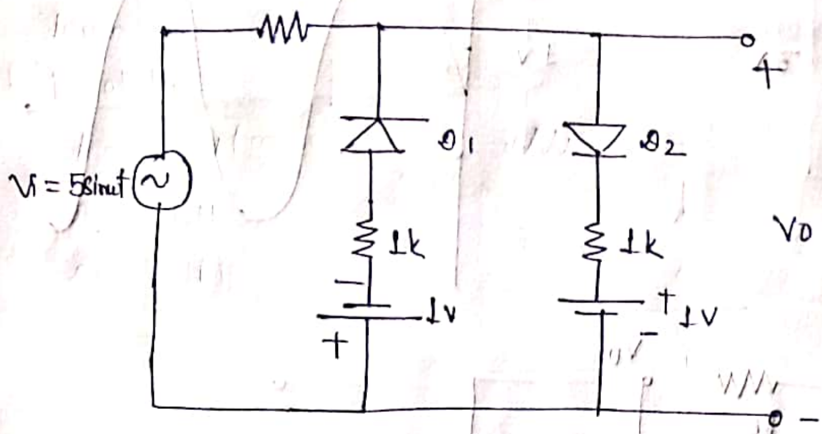
11) Offset Voltage 1V



Initially $V_s = 0.1V$

$D_2 = f(1V)$

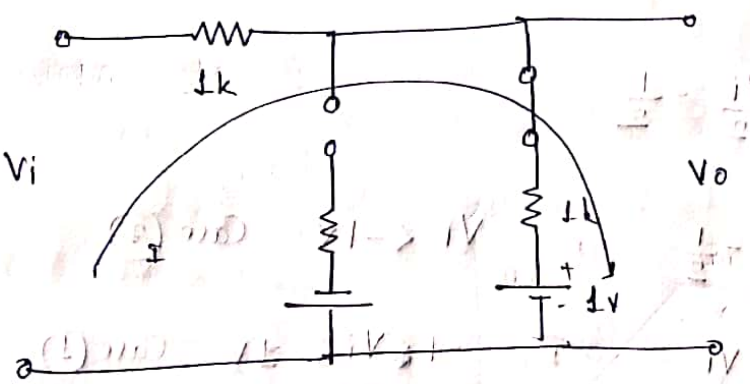
$D_2 = off$

$D_1 = f(-1V)$ $\quad V_0 = V_i$

$D_1 = off$

V_0 always V_i when reference Voltage is equal & opposite

$V_i > 1V$ $\quad D_2 = ON$ $\quad D_1 = OFF$



$$V_1 - I - I - 1 = 0$$

$$V_1 - 2I = 1$$

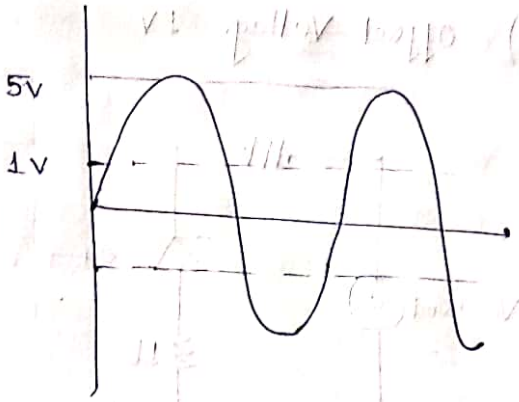
$$I = \frac{V_1 - 1}{2}$$

$$V_0 = I \times 1 + 1$$

$$= \frac{V_1 - 1}{2} + 1$$

$$V_o = \frac{V_i}{2} + \frac{1}{2}$$

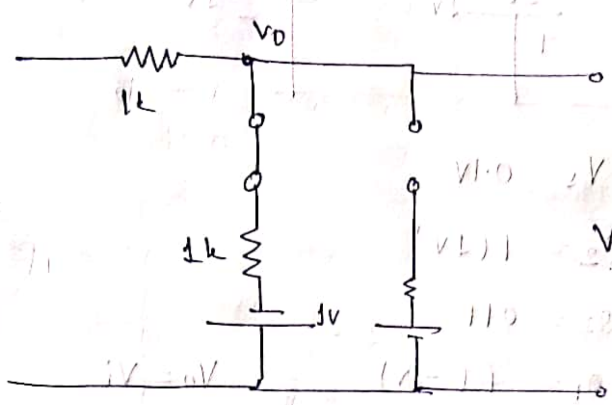
$$V_{o\,max} = \frac{5}{2} + \frac{1}{2} = 3V$$



$V_i < -1V$

$D_1 = ON$

$D_2 = OFF$

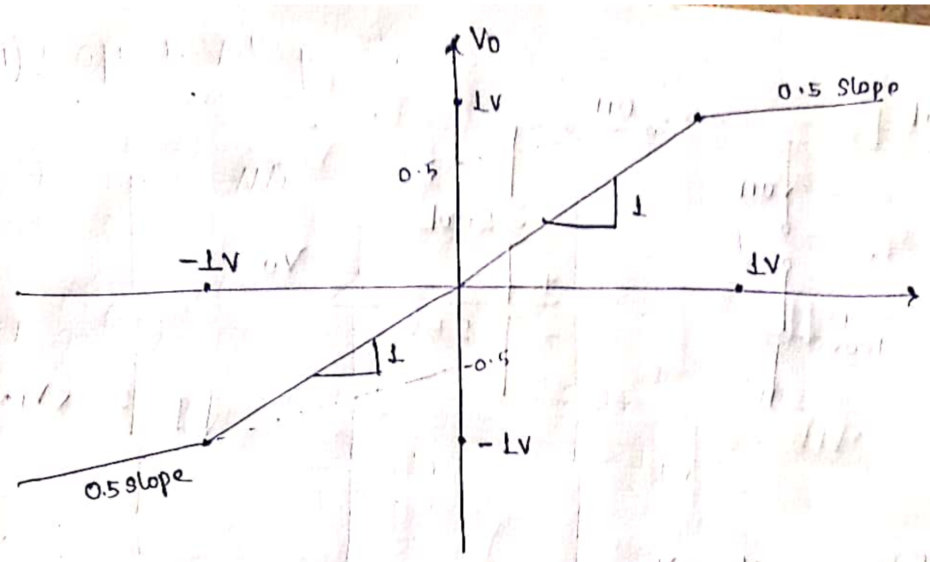


$$\frac{V_o - V_i}{1} + \frac{V_o + 1}{1} = 0$$

$$\Rightarrow 2V_o - V_i + 1 = 0$$

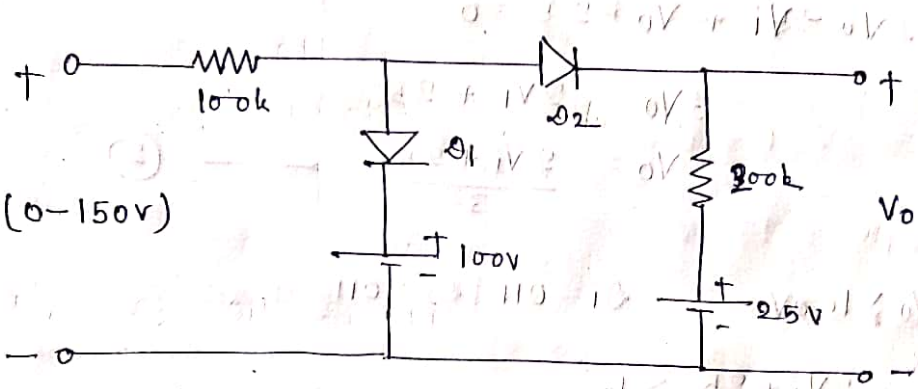
$$V_o = \frac{V_i}{2} - \frac{1}{2}$$

$$V_o = \begin{cases} \frac{V_i}{2} - \frac{1}{2} ; & V_i < -1V \quad \text{Case (3)} \\ V_i ; & -1 \leq V_i < 1V \quad \text{Case (1)} \\ \frac{V_i}{2} + \frac{1}{2} ; & V_i > 1V \quad \text{Case (2)} \end{cases}$$



H.W

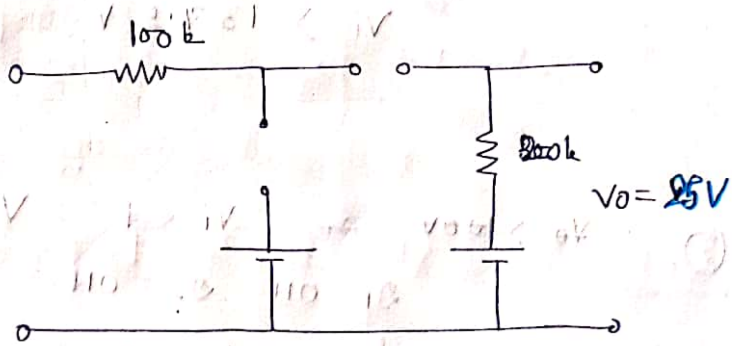
Que. Draw Xfer characteristic for a given below figure



Sol: When $V_i = 0.1$

D_1 = off D_2 = off $V_o = 25V$ { Series Resistance doesnot effect Diode ON off }

that is when $0 < V_i < 25$



When $V_i > 25V$ D_2 ON D_1 = off

Scanned by CamScanner

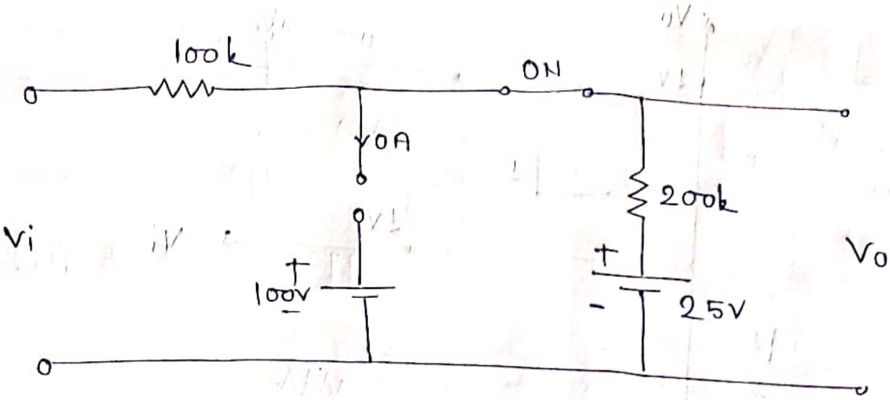


fig. $25 < V_i < 137.5$

$$\frac{V_o - 25}{200} + \frac{V_o - V_i}{100} + 0 = 0$$

$$2V_o - 2V_i + V_o - 25 = 0$$

$$3V_o = 2V_i + 25$$

$$V_o = \frac{2V_i + 25}{3} \quad \text{———} \quad (2)$$

(2) When $V_o > 100V$ $\quad D_1 = ON \quad D_2 = ON$

$$\frac{2V_i + 25}{3} > 100$$

$$V_i > \frac{275}{2}$$

$$V_i > 137.5\ V$$

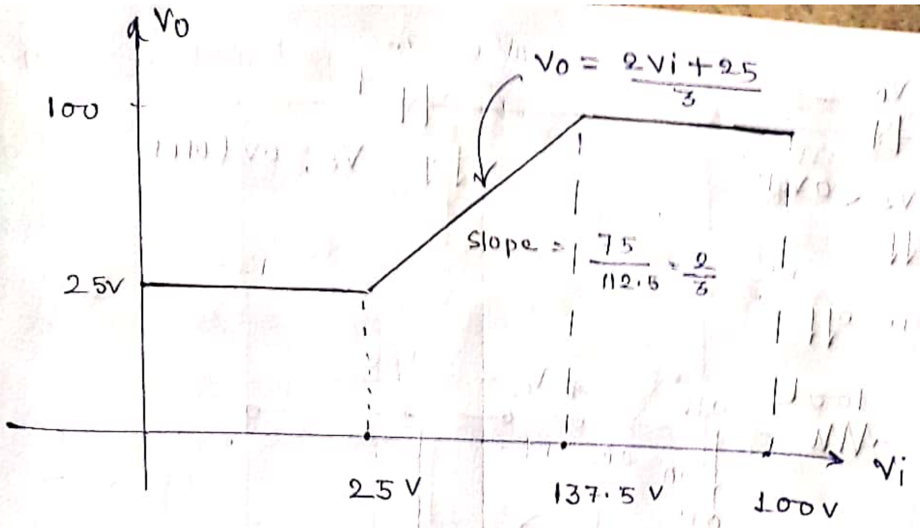
Hence fig (2)

$25 < V_i < 137.5V$

(3) ~~$V_o > 100V$~~ ~~or~~ ~~$V_i <$~~ $V_i > 137.5$

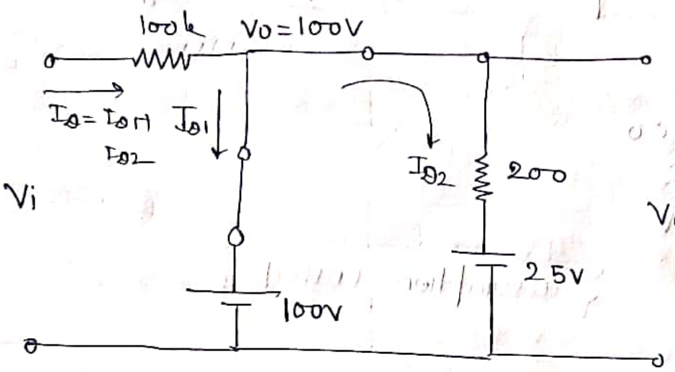
$D_1 = ON \quad D_2 = ON$

$$V_o = 100V$$



Concept of Diode

Initially both diode are ON { Diode current greater than 0A from plot? }



$$200\, I_{D2} = 75$$

$$I_{D2} = \frac{75}{200} = 0.375$$

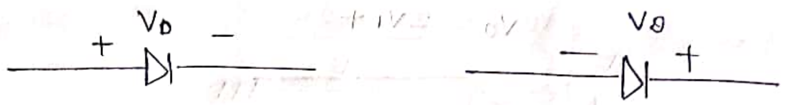
$$I_{D1} + I_{D2} = \frac{V_0 - V_i}{100} + \frac{V_0 - 25}{200} = 0$$

If $V_i = 0.1$

$$I_{D1} + I_{D2} = \frac{-100 + 0.1}{100} + \frac{100 - 25}{200}$$

$$= -0.99 \text{ mA}$$

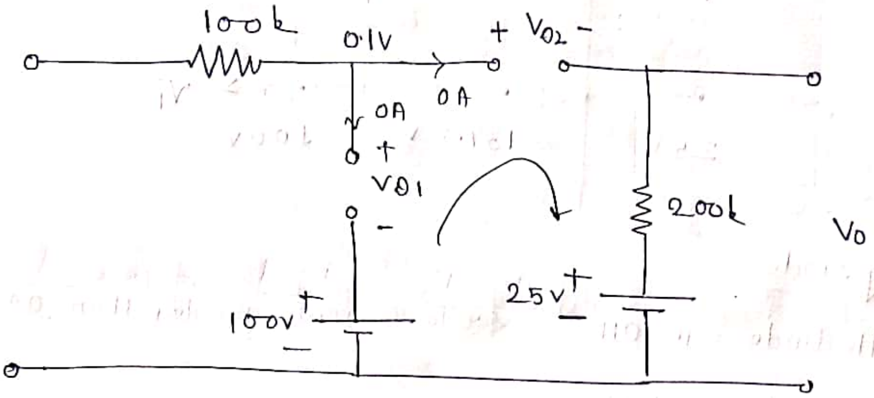
$I_{D1} = -1.374$ mA { Invalidate assumption }



$V_D < 0$ Volt
off

fig. $V_D > 0V$ (off)

Let both diode are off



$0.1 = V_{D1} + 100$

$V_{D1} = -99.9V$

$V_{D1} < 0V$ { assumption Correct }

also,

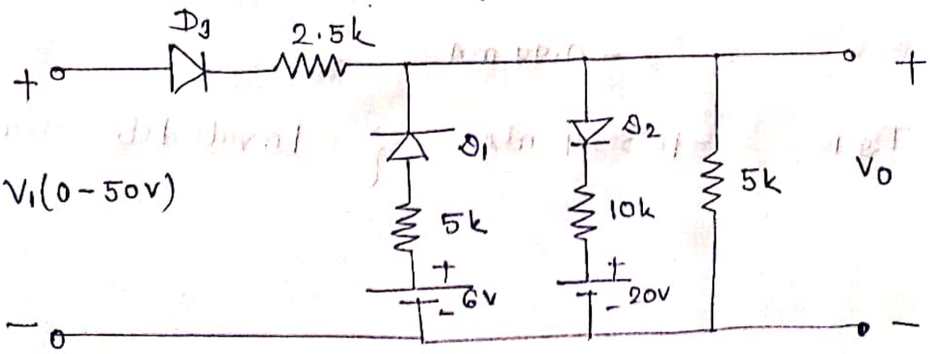
$0.1 = V_{D2} + 25V$

$V_{D2} = -24.9V$

$V_{D2} < 0$ { assumption is Correct }

Both diode are off for $V_i = 0.1V$

Que2. Draw xfer characteristic for a given below figure.



{ HW D2 off assume

D_1 on, D_3 off] $V_i (0-50V)$

$I_{D1} > 0$ $V_{D3} < 0V$ }

Sol :

D_2 off due to 20V

D_1 ON due to 6V

D_3 off due to 6 V & Small Value of v_i

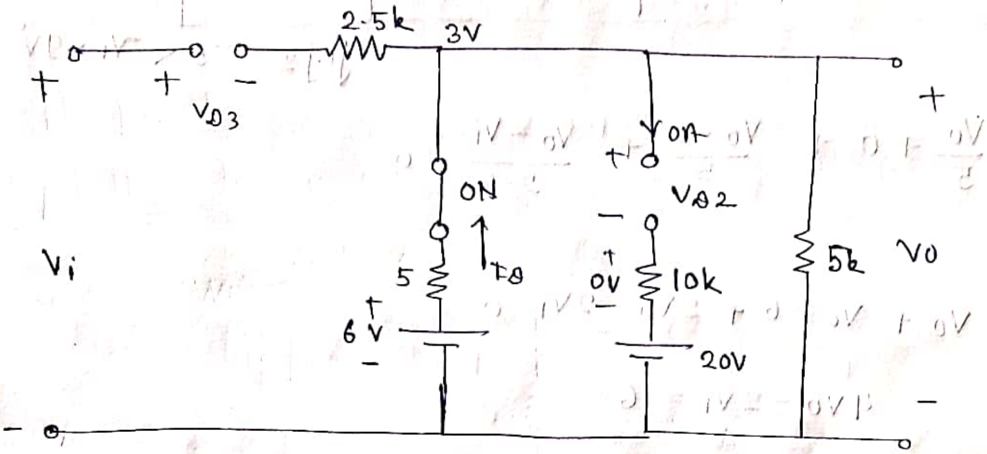


fig 1 $0 < V_i < 3V$

By Voltage division

$$V_o = \frac{6 \times 5}{5+5} = 3V$$

Hence $3 + V_{D2} + 20 = 0$

$V_{D2} = -17V$

$D_2 =$ off

$V_i = V_{D3} + 3V$

$V_{D3} = V_i - 3$

$= 0.1 - 3$

$V_{D3} = -2.9V$ { D_3 = off }

D_3 will change (ON) first due to 3V in right of D_3

Case : $V_i > 3V$ $D_3 = ON$ Hence fig 1 $0 < V_i < 3V$

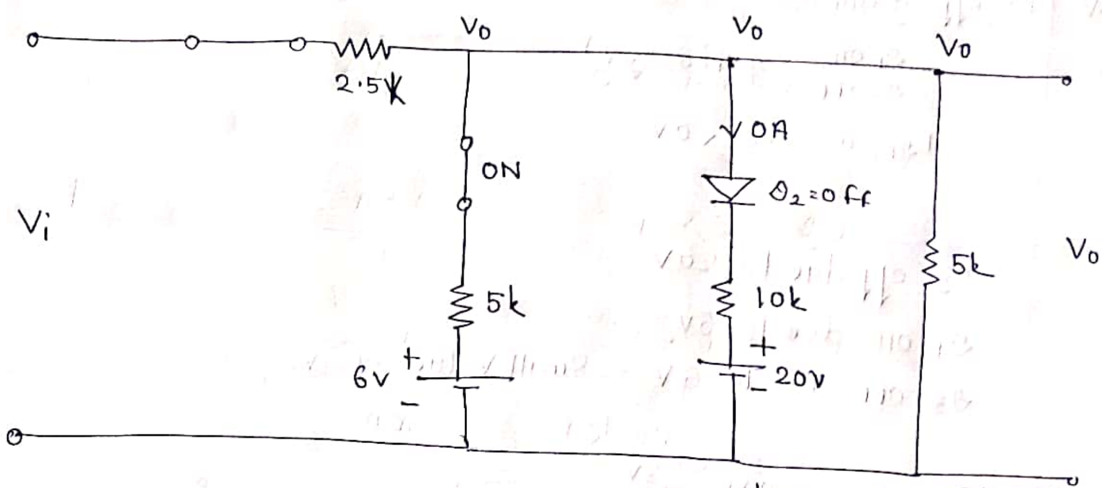


fig 2 $3 < V_i < 9V$

$$\frac{V_o}{5} + 0 + \frac{V_o - 6}{5} + \frac{V_o - V_i}{2.5} = 0$$

$$\Rightarrow \quad V_o + V_o - 6 + 2V_o - 2V_i = 0$$

$$\Rightarrow \quad 4V_o - 2V_i = 6$$

$$2V_i = 4V_o - 6$$

$$V_o = \frac{2V_i + 6}{4}$$

Now D_1 to be off

$V_o > 6V$

$D_2 = $ off

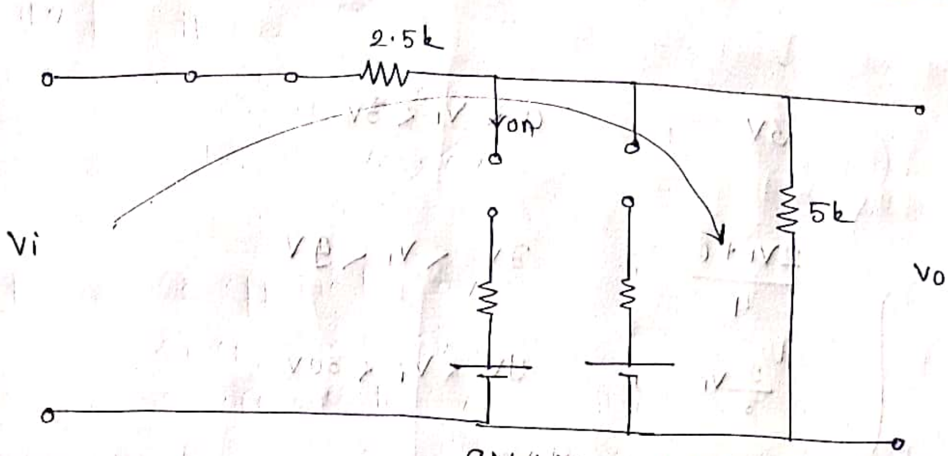
D_3 ON

D_1 off

$$\frac{2V_i + 6}{4} > 6$$

$$2V_i > 24 - 6$$

$V_i > 9V$ Hence fig 2 is $3 < V_i < 9V$



$9V < V_i < 30V$

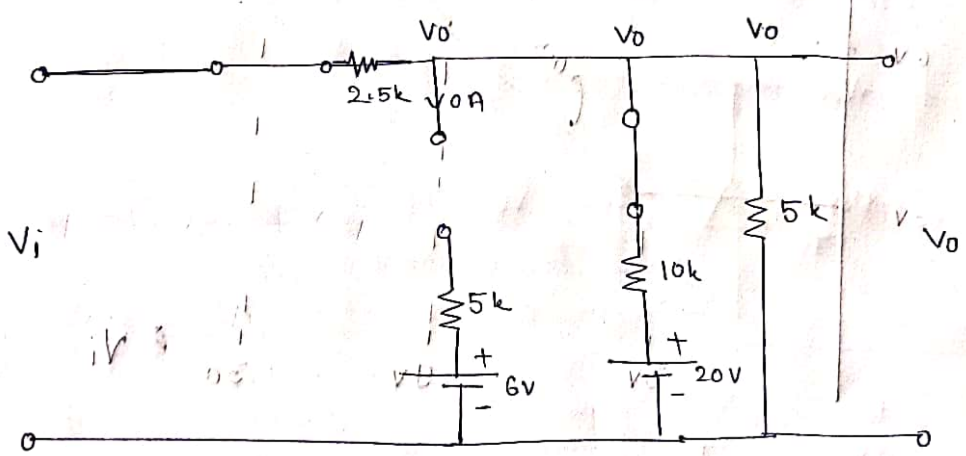
$$V_o = \frac{V_i \times 5}{7.5}$$

$$V_o = \frac{2}{3} V_i$$

Case $V_o > 20$ volt to ON D_2

$$\frac{2}{3} V_i > 20$$

$V_i > 30V$ Hence fig 3 $9V < V_i < 30V$



$$\frac{V_o}{5} + \frac{V_o - 20}{10} + \frac{V_o - V_i}{2.5} = 0$$

$\Rightarrow$ $2V_o + V_o - 20 + 4V_o - 4V_i = 0$

$$7V_o = 4V_i + 20$$

$$V_o = (4V_i + 20)/7$$

$$V_o = \begin{cases} 3V & ; \quad 0 < V_i < 3V \\ \dfrac{2V_i + 6}{4} & ; \quad 3V < V_i < 9V \\ \dfrac{2}{3}V_i & ; \quad 9V < V_i < 30V \\ \dfrac{4V_i + 20}{7} & ; \quad V_i > 30V \end{cases}$$

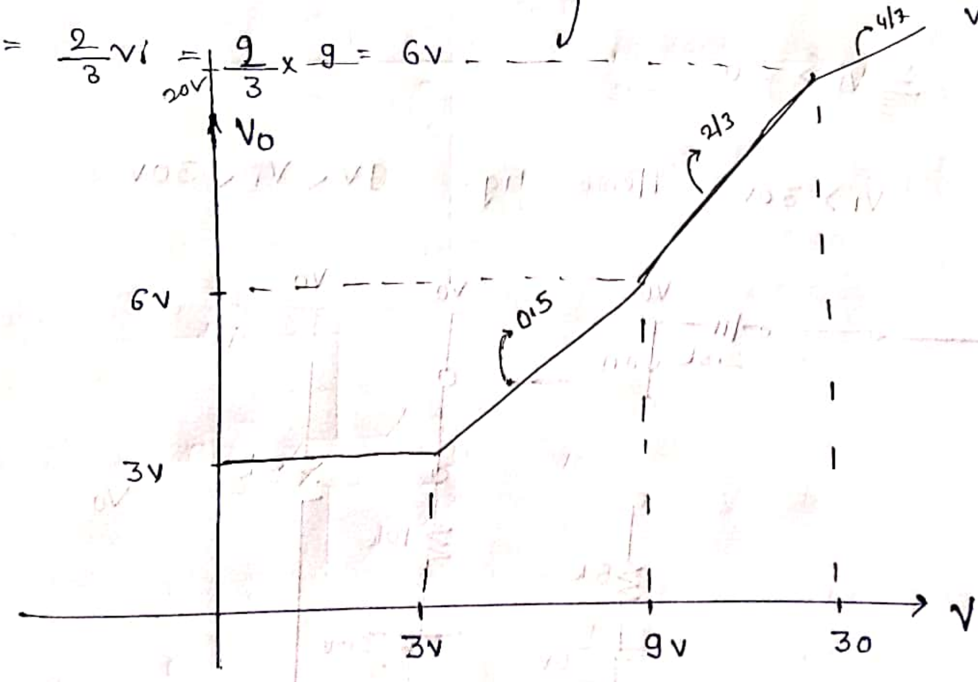
$$V_{o(max)} = \frac{4 \times 50 + 20}{7} = 31.42\,V$$

$V_i = 9V$

$$V_o = \frac{2 \times 9 + 6}{4} = 6V$$

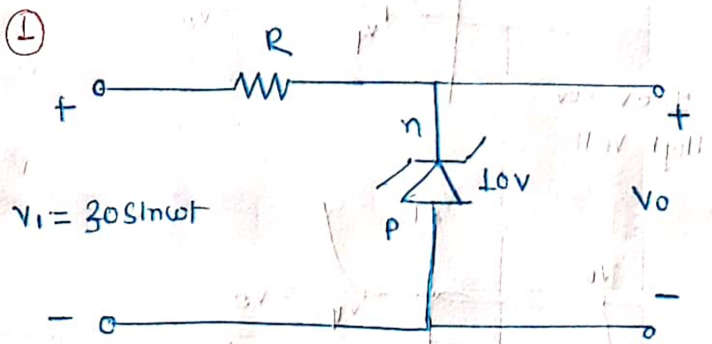
also $v_o = \frac{2}{3}v_i = \frac{9}{3} \times 9 = 6V$

Same Value i.e Continuous wave form



* Clipper Circuit Using Zener diode

①



Reverse Bias Breakdown Voltage = 10V

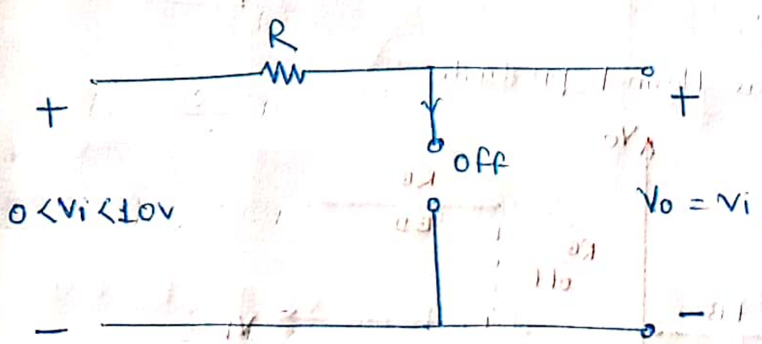


fig. RB/oc/off

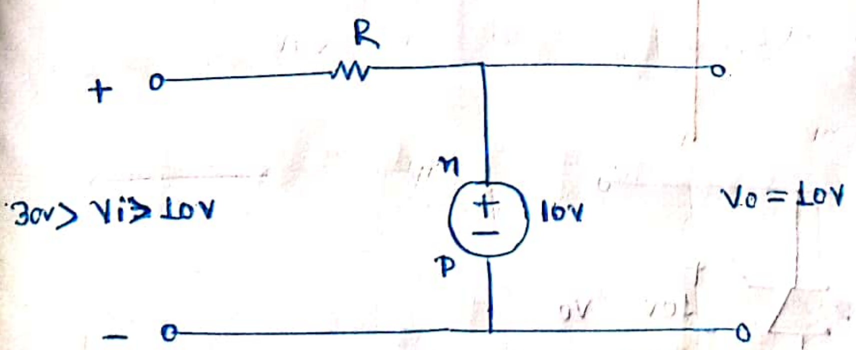


fig. R.B with Breakdown

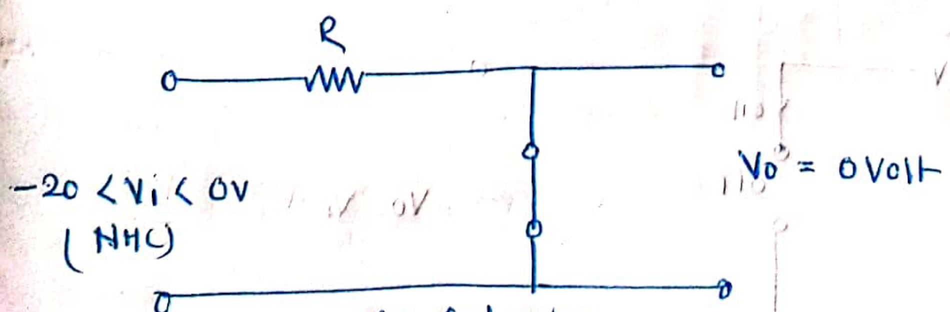
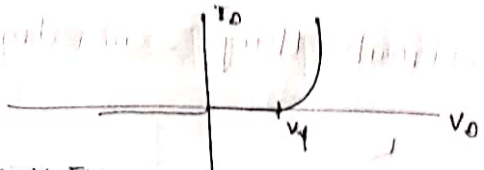


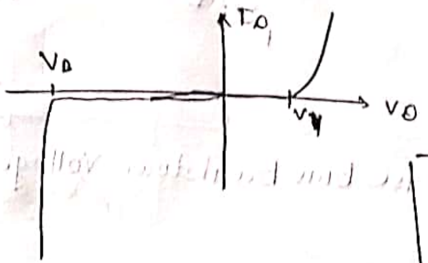
fig. FB/ON/s.c

Normal PN diode characteristic



Low level doping
Breakdown Voltage 100V, 50V
Very High Volt

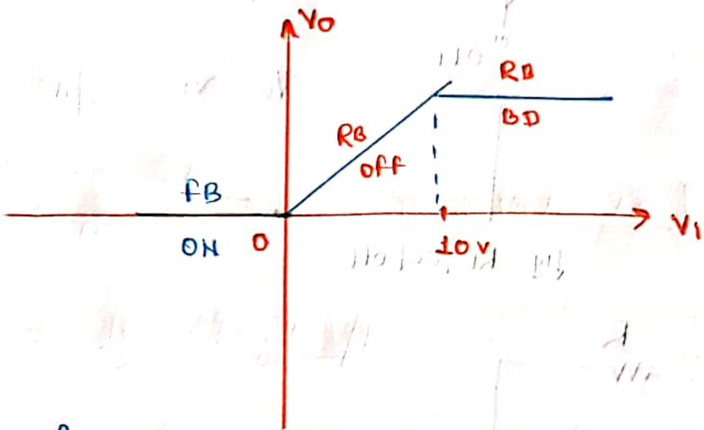
Zener diode characteristic



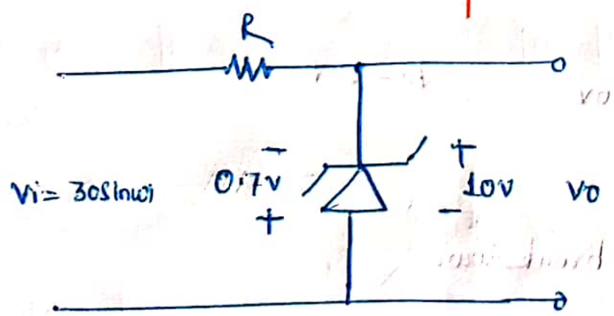
High level doping
Breakdown Voltage
5V, 6V 10V
Low voltage

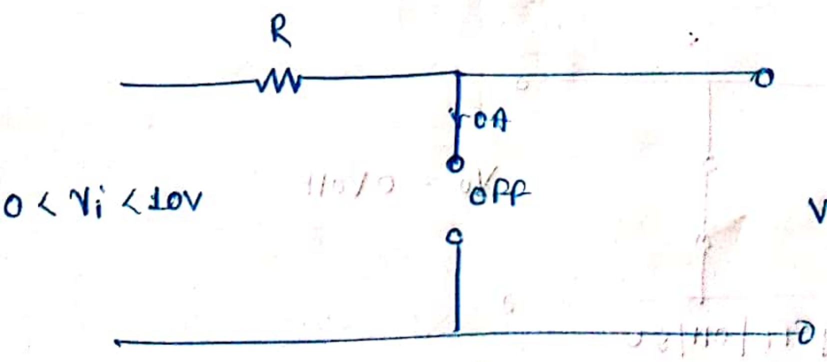
Breakdown volt $\propto \frac{1}{\text{doping}}$

· Zener diode can work as Normal PN diode



(2)





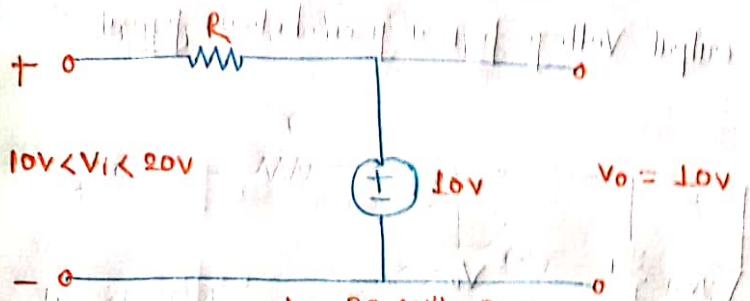


fig. RB with B0

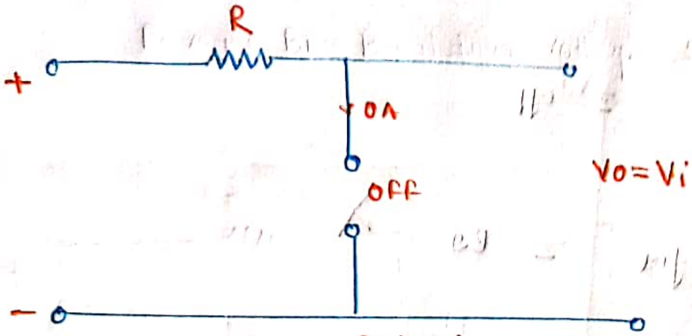
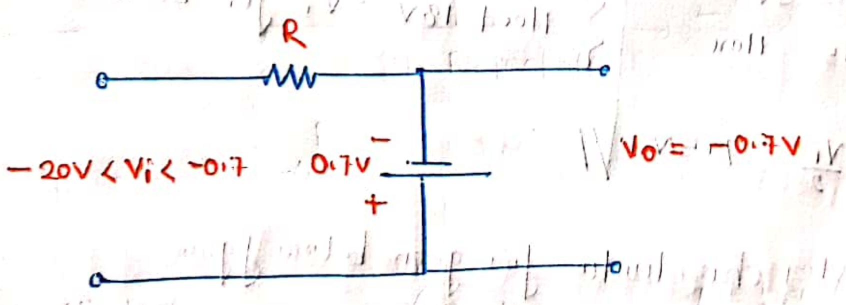
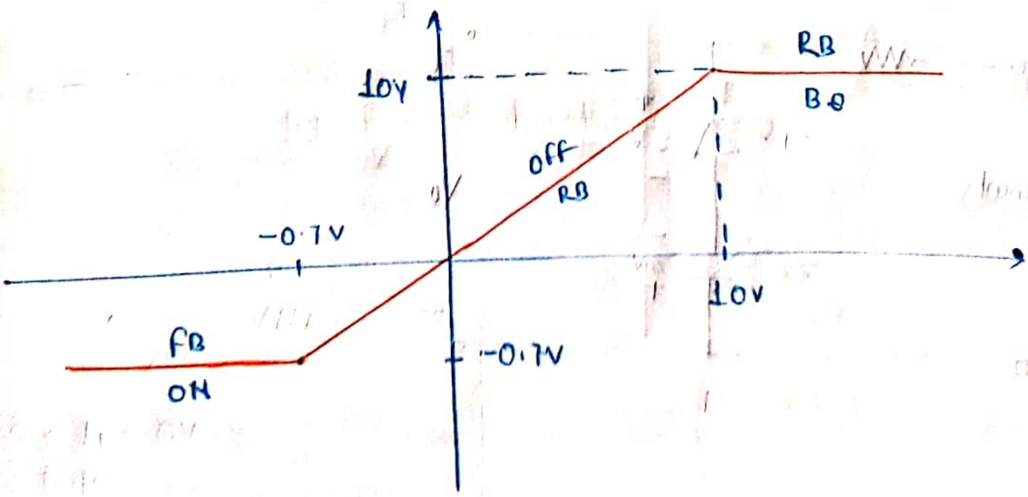
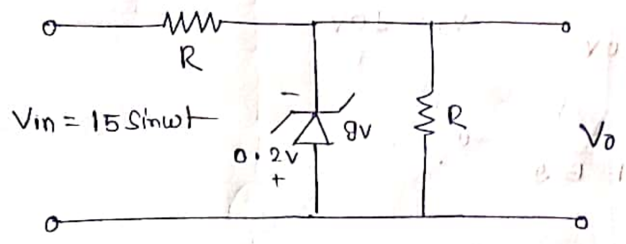


fig. FB|OFF|OC





Que1 find the Maximum Output Voltage for a given below figure.



Sol 1) $0 < V_i < 9V$

$V_0 = \frac{V_i}{2}$ Z = off

11) $9V < V_i < 15V$

$V_0 = 9\ V$ fix. Z = BD

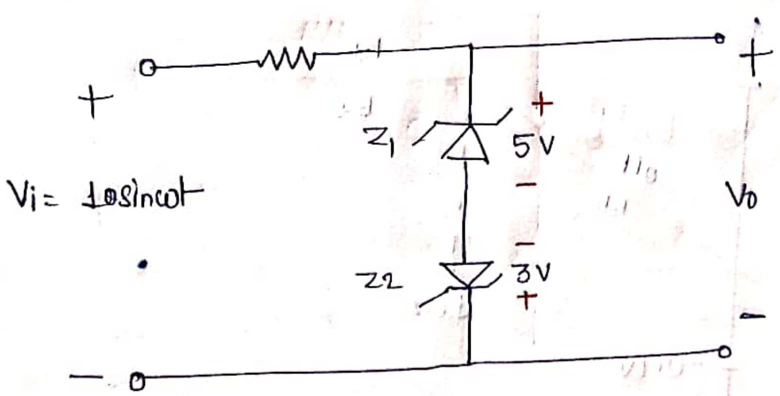
11) $V_0 = V_i/2$

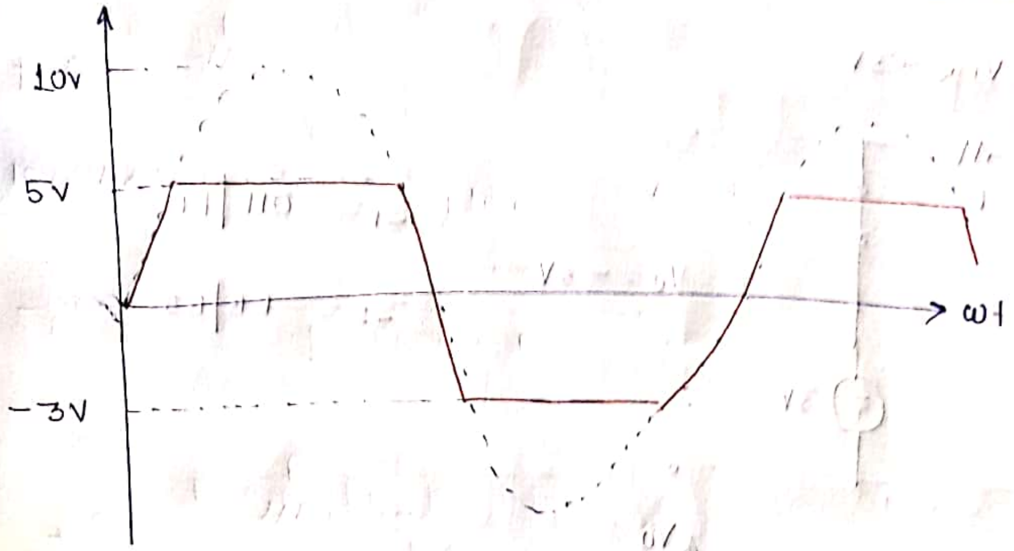
Breakdown = 9V

$V_0 = 7.5$ Max { Need 18V = Vi for breakdown

$V_{max} = \frac{V_i}{2} = 7.5V$ //

Que2 Draw o/p & Xfer characteristic for given below figure.





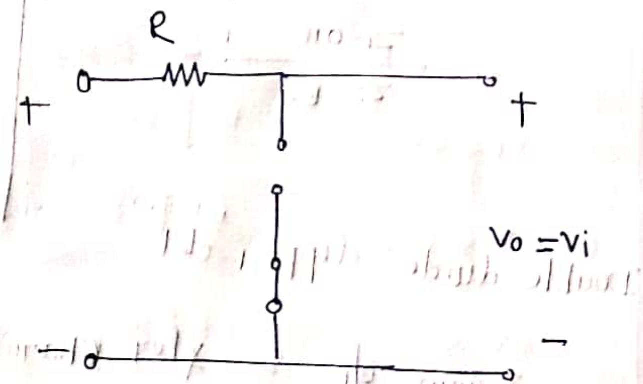
Ideal Zener diode (No cut-in Voltage given)

i) FB | ON | S.C
ii) RB | OFF | S.C
iii) RB | BD

Case I $0 < V_i < 5V$ (PHC)

$Z_1 =$ Off RB | Off

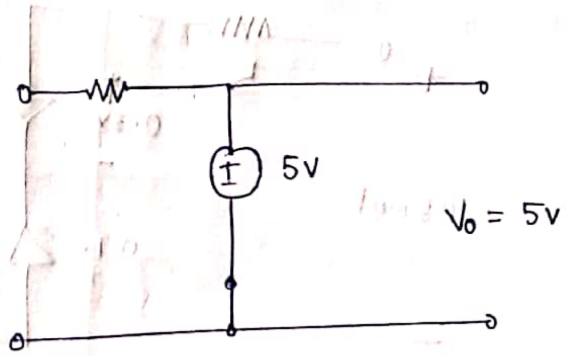
$Z_2 =$ ON FB | ON



Case II $5 < V_i < 10V$ (PHC)

$Z_1 =$ RB (BD)

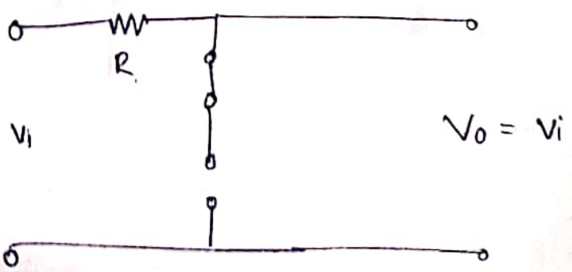
$Z_2 =$ ON (FB)



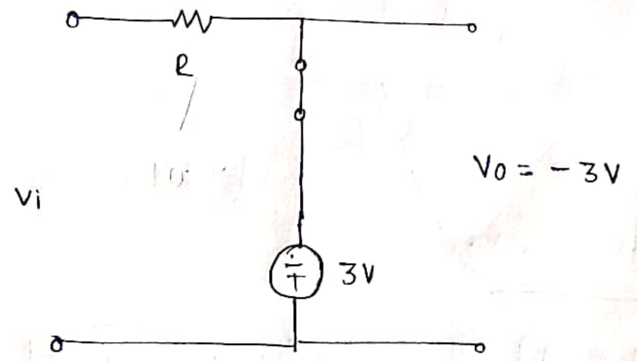
Case III $-3V < V_i < 0V$ (NHC)

$Z_1 =$ FB | ON

$Z_2 =$ RB | Off

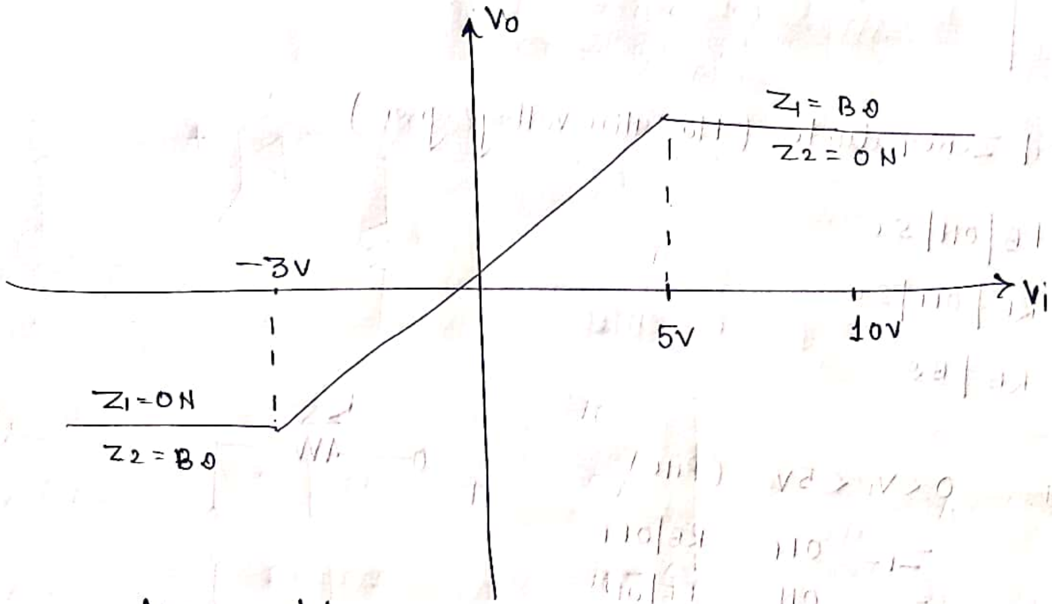


Case 4 $-10 < V_i < -3V$



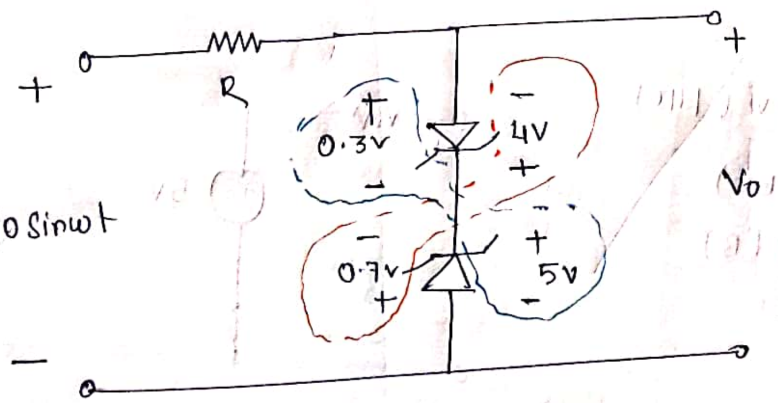
$Z_1 =$ ON | FB

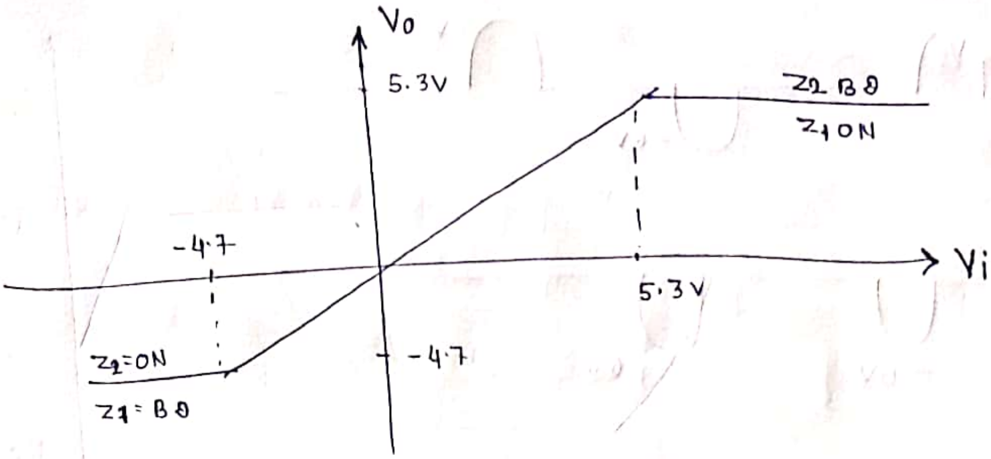
$Z_2 =$ RB | BD



Double diode clipper ckt

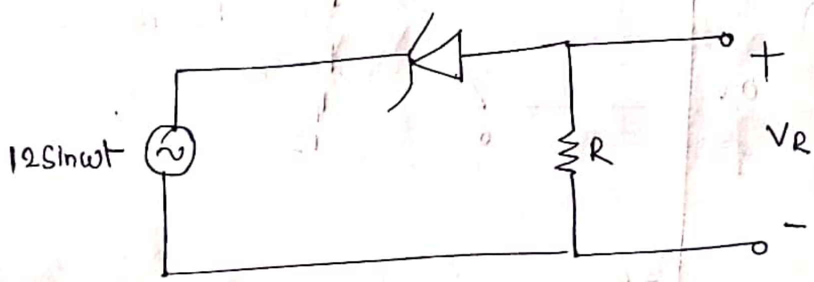
Que 3 Draw o/p & xfer characteristic for a given below figure.



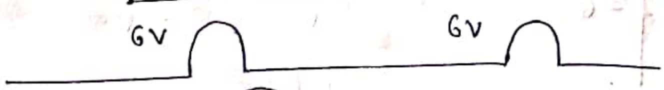


Vi	Z_1	Z_2	Vo
0 < Vi < 0.3V	RB/OFF	RB/OFF	Vi
0.3V < Vi < 5.3	FB/ON	RB/OFF	Vi
5.3V < Vi < 10V	FB/ON	RB/BD	5.3V
-0.7V < Vi < 0V	FB/OFF	RB/OFF	Vi
-4.7V < Vi < -0.7V	RB/OFF	FB/ON	Vi
-10V < Vi < -4.7V	RB/BD	FB/ON	-4.7V

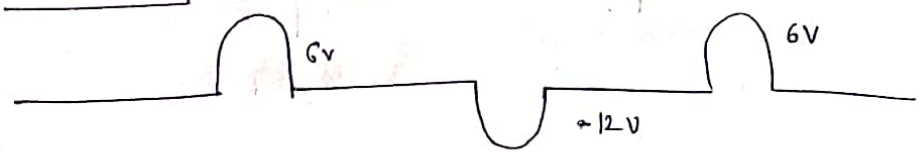
Que. for the circuit shown in below fig, assume Zener diode is Ideal with BD volt 6V. The waveform across R is



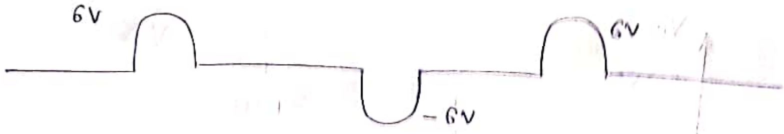
A.



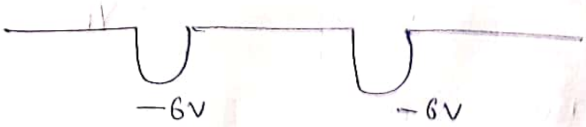
B.



c.



d.

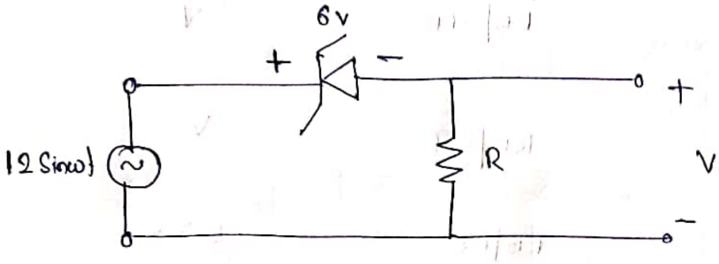


<u>Sol</u> :- Ideal Zenerdiode

i) FB → S.C ON

ii) RB → O.C OFF

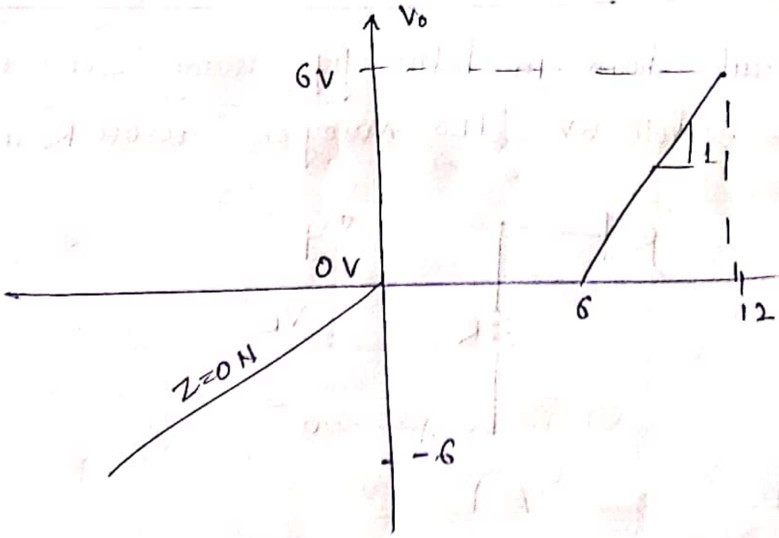
iii) RB = BD Volt. Source

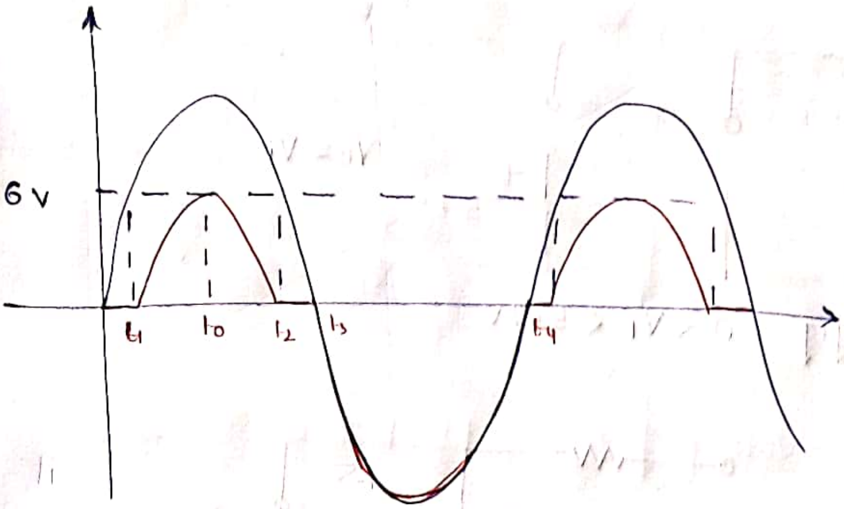


V_i	Z	V_R
$0 < V_i < 6V$	RB | OFF	0V
$6V < V_i < 12V$	RB | BD	$V_R - 6V$
$-12 < V_i < 0V$	FB | ON	V_i

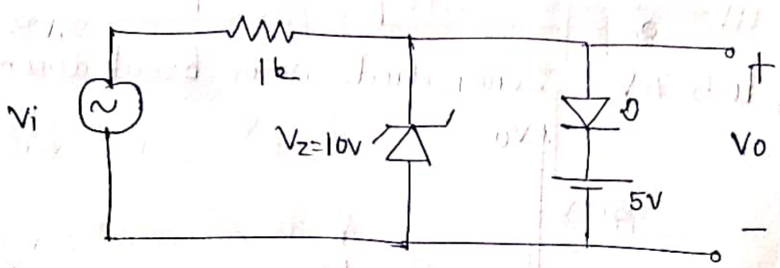
$-V_i + 6 + V_R = 0$

$V_R = V_i - 6$





Q14. A clipper Ckt shown below

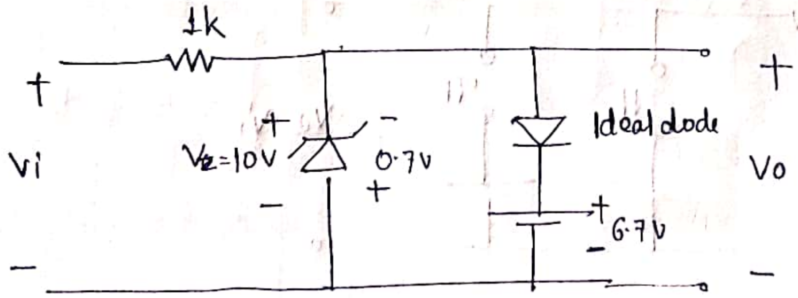


Assuming forward Voltage drop of diode to be 0.7V.
Input o/p characteristic of ckt is

Sol $V_\gamma(D) = 0.7V$

$V_\gamma(Z) = 0.7V$

$V_Z(Z) = 10V$



Initially. $V_i = 0.1V$

D = openckt / off due to 6.7V

Z = off / o.c due to small Vi

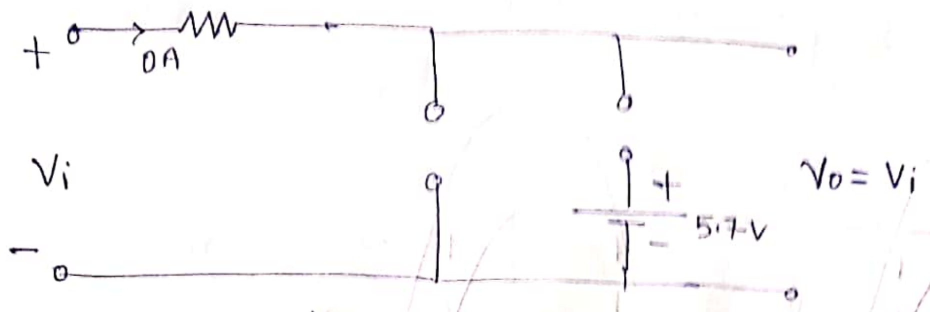
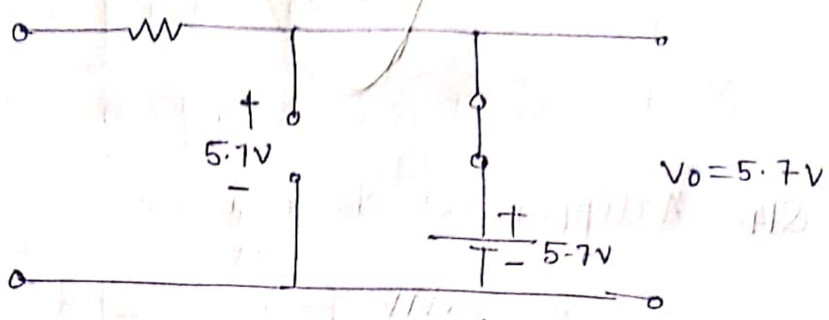


fig. $0 < V_i < 5.7V$

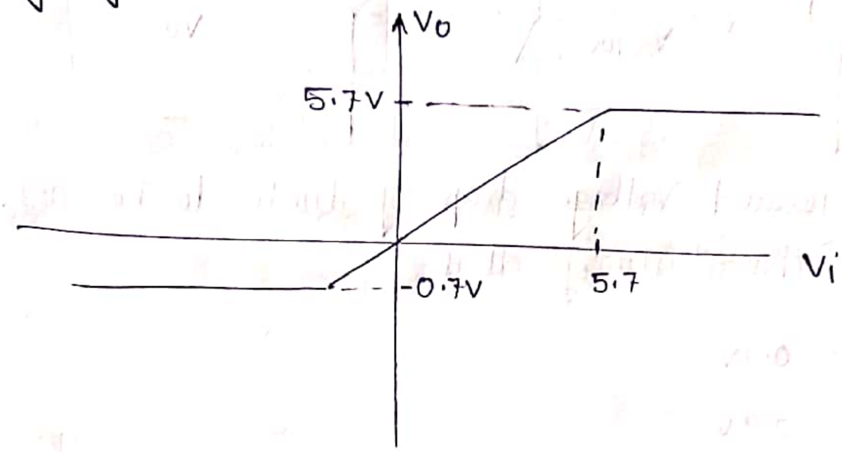
when $V_i > 5.7V$

D = ON

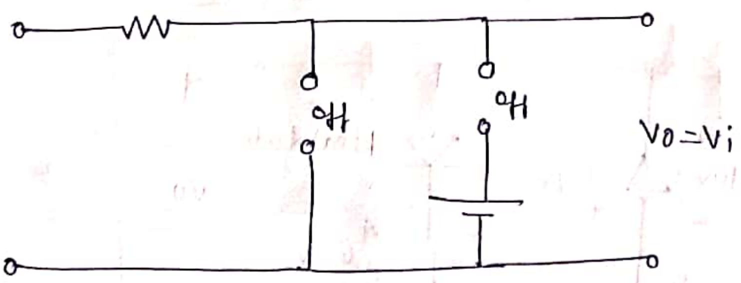
Z = off



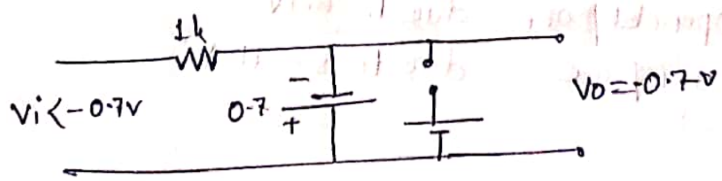
Voltage fixe to 5.7 V   Zener diode never breakdown



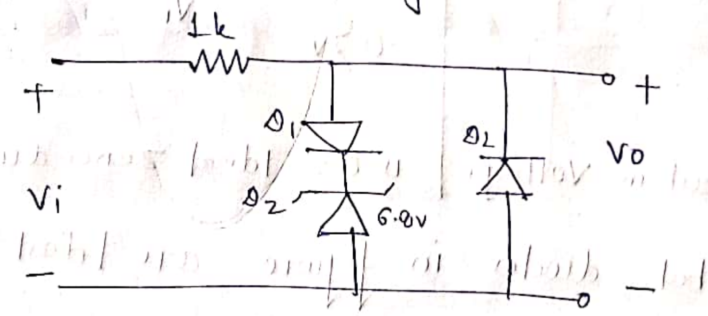
when $-0.7V < V_i < 0V$



when V_i < −0.7V $V_i < -0.7V$



Q12. In the following <u>Limiter Circuit</u> (Clipper ckt) an Input Voltage $V_i = 10 \sin 100\pi t$ is applied. Assume that diode drop is 0.7V when it is forward biased. The Zener breakdown Voltage is 6.8v.

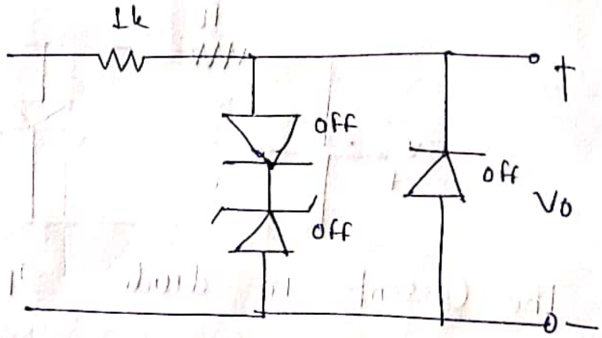


Sol when $V_i = 0.1\,V$

$V_o = V_i$

when $V_i > 0.7$

$V_o = V_i$



$0 < V_i < 0.7$

when $0.7 < V_i < 7.5$

$V_i = V_o$

when $V_i > 7.5$ ($V_{imax} = 10V$)

Z = breakdown

$V_o = 7.5\,V$

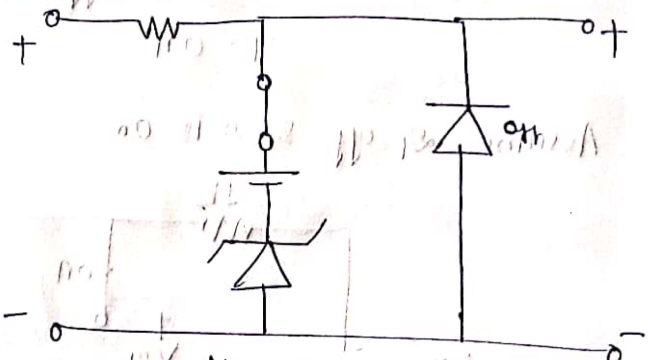


fig. $V_i > 7.5$

$-0.7 < V_i < 0V$

$V_o = V_i$

$V_i > -0.7\,V$ ($V_{min} = -10V$)

D_2 = ON

$V_o = -0.7V$

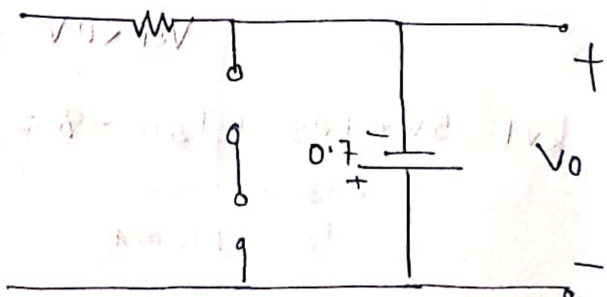
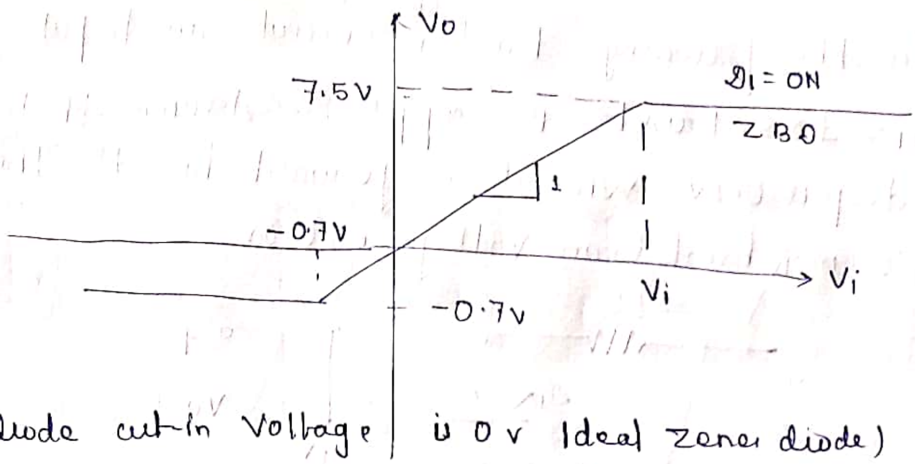


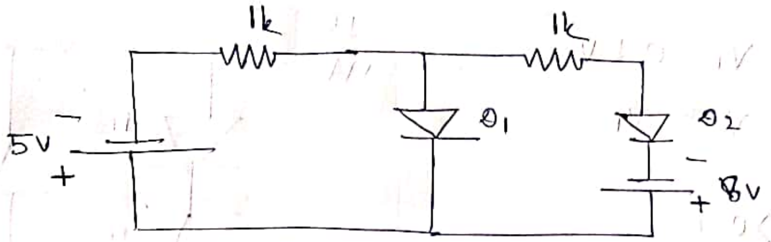
fig. $V_i < -0.7V$

Scanned by CamScanner



(Zener diode cut-in Voltage is 0 v Ideal zener diode)

<u>Que</u>. Assuming that diodes in figure are Ideal



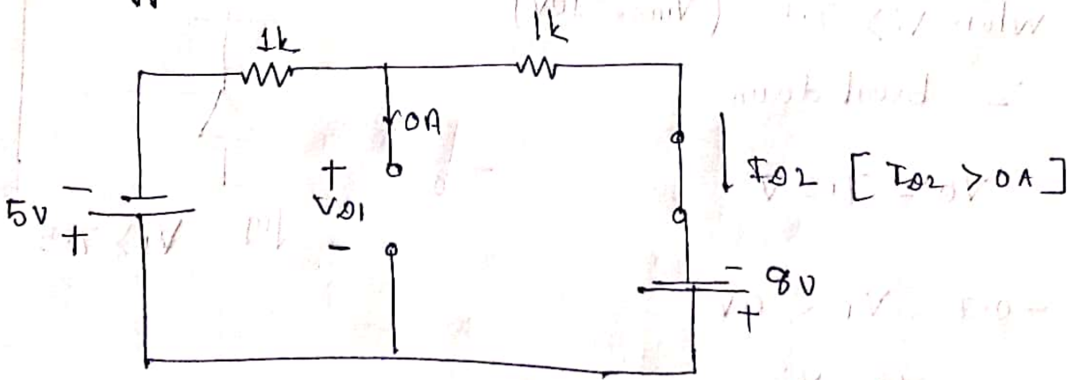
The Current in diode D_1 in (mA) is ______

<u>Sol</u> Prediction: D_2 on due to $-8V$

D_1 off due to $-8V$ & $-5V$

$I = 0A$

Assume D_1 off & D_2 is on



$V_{D1} < 0V$

kvl:- $5V + I_{D2} + I_{D2} - 8 = 0$

$2I_D = 3$

$I_{D2} = 1.5\ mA$

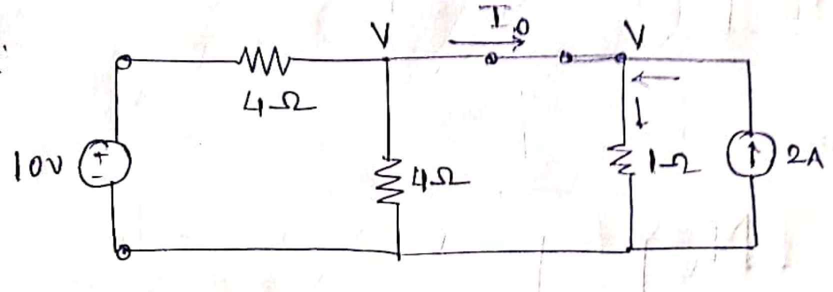
$V_{o1} + 5 + 1 \times I_{o2} = 0$

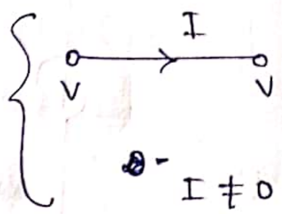
$V_{o1} = -6.5 \text{ V}$

$V_{o1} < 0$ Hence prediction true

<u>note</u> :- 1 prediction correct & another is wrong then whole prediction false.

<u>Que.</u>





$I \neq 0$

I = unknown between short terminal

nodal

$$\frac{V-10}{4} + \frac{V}{4} + \frac{V}{1} - 2 = 0 \quad \text{—(1)}$$

$$\Rightarrow \frac{V}{2} + V = 2 + \frac{10}{4}$$

$$\Rightarrow 3V = 18/2$$

$$V = 3 \text{ Volt}$$

OR

$$\frac{V-10}{4} + \frac{V}{4} + I_o = 0 \quad \text{—(2)}$$

$$\frac{V}{1} - 2 - I_o = 0 \quad \text{—(3)}$$

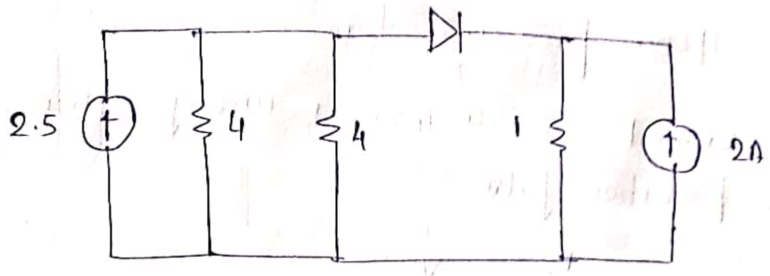
All three eqn are correct

$$I_o = \frac{V}{1\,\Omega} - 2 = 3A - 2A$$

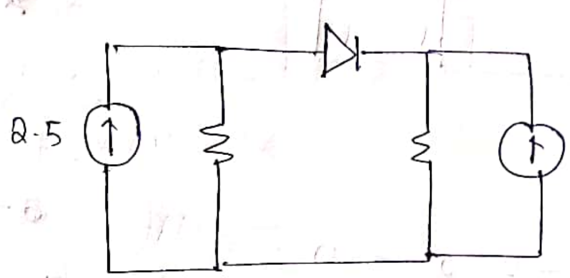
$$= 1A$$

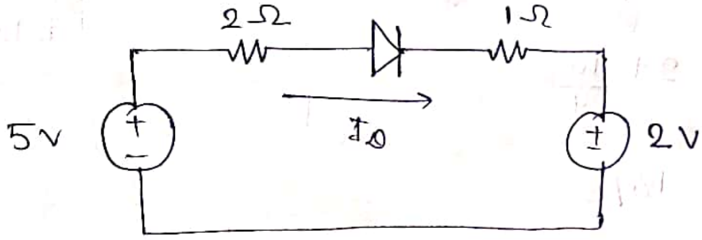
OR

By using Source Xformation in left & Right side



Again Source Xformation





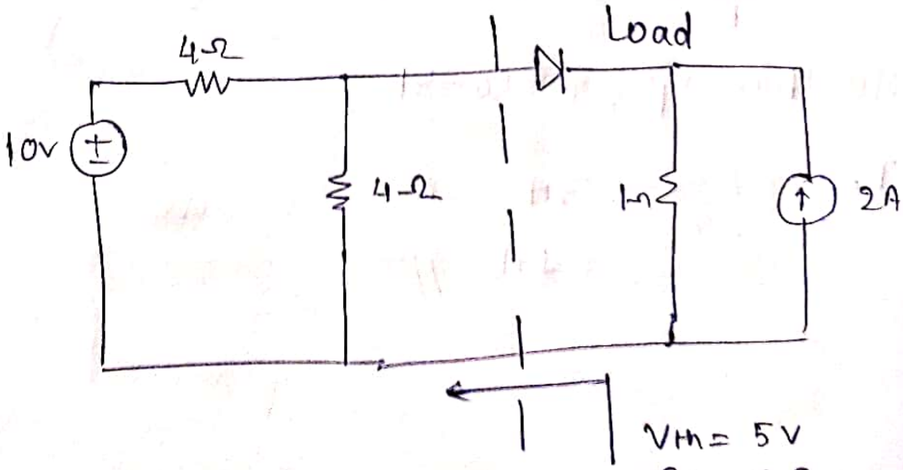
$$-5 + 3I_D + 2 = 0$$

$$3I_D = 3$$

$$I_D = 1\,A \;//$$

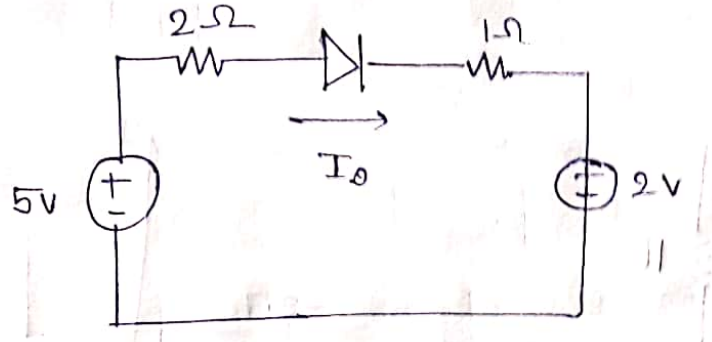
OR

By Thevenin



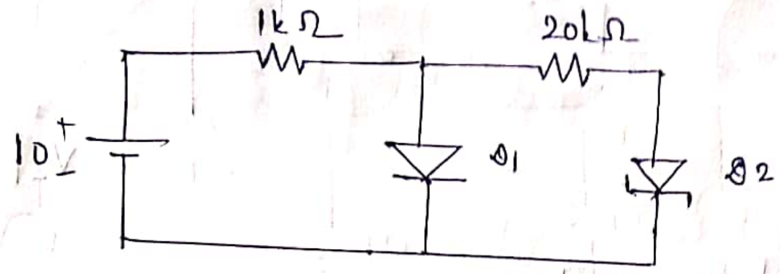
$V_{th} = 5\,V$

$R_{th} = 2\,\Omega$



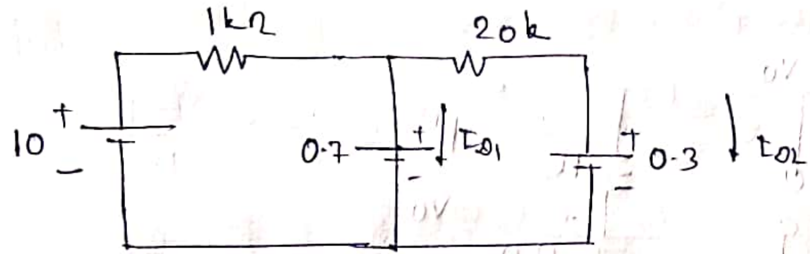
$I_D = 1A$

2.13
Que20



Prediction.

If both D1 and D2



$$I_{D1} + \frac{0.7-10}{1} + \frac{0.7-0.3}{20} = 0$$

$$I_{D2} = \frac{0.7-0.3}{20} = +ve$$ Hence D_2 on

$$I_{D1} = +9.3 - \frac{0.4}{20}$$

$= +ve$ (D1 ~~off~~ ON)   Prediction Correct opt A

If D_2 on D_1 off

I_{D2} :-

$-10 + 21 I_{D2} + 0.3 = 0$

$21 I_{D2} = 10 - 0.3$

$I_{D2} = +ve$ $D_2 = ON$

V_{D1} :-

$-10 + I_{D2} + V_{D1} = 0$

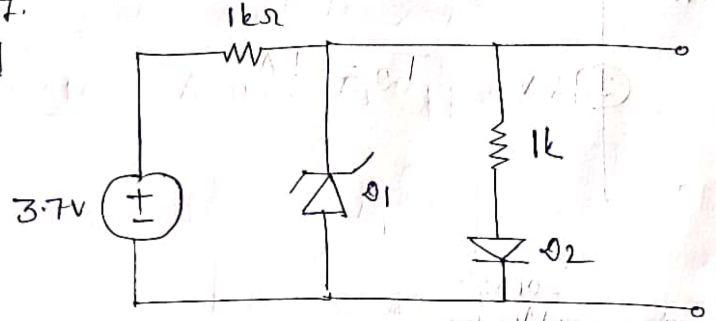
$V_{D1} = 10 - I_{D2}$

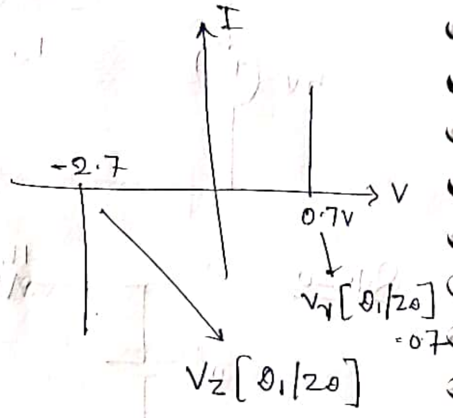
$= +ve$

Wrong predn.

H.W
Q21, 24, 25, 23

Q17.
Sol



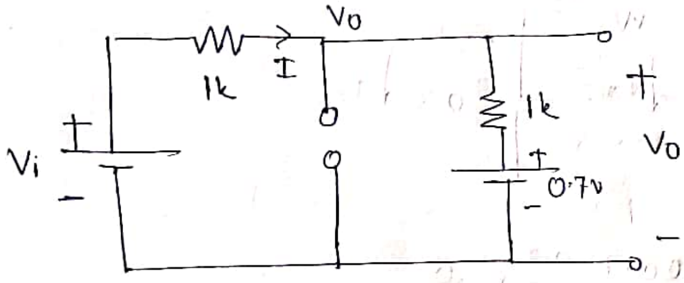


$V_o > 0.7V$

OR

$V_i > 0.7V$ $\quad$ $\left[V_o = V_i\right]$

$D_2 = ON$



$$I = \frac{V_i - 0.7}{2}$$

$$V_o = I \times 1 + 0.7$$

$$V_o = \frac{V_i - 0.7}{2} + 0.7$$

$$V_o = \frac{V_i + 0.7}{2}$$

for $0.7 < V_i < 4.7V$

$V_o > 2.7V$

$D_1 = BD$

$\frac{V_i + 0.7}{2} > 2.7$

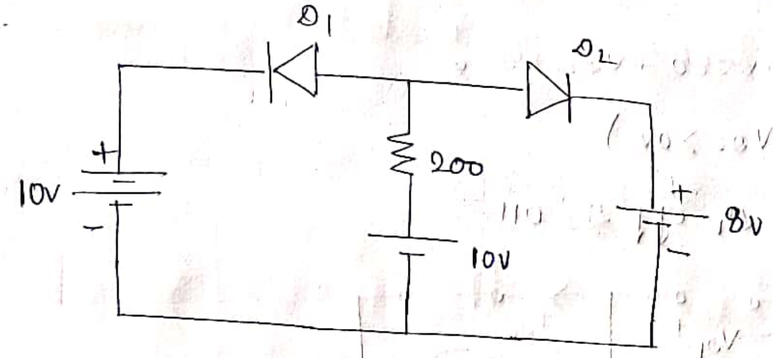
$V_i > 4.7V$ //

when $V_i = 3.7$

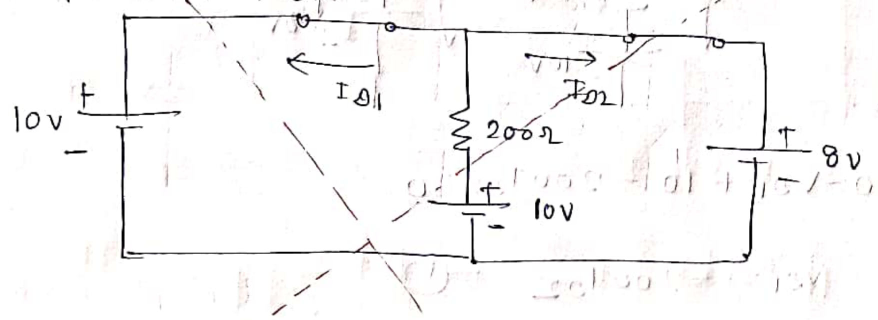
$$V_o = \frac{3.7 + 0.7}{2}$$

$$= 2.2V \; //$$

Q22.

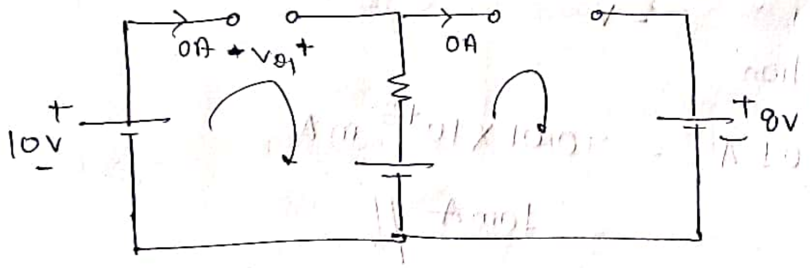


Sol :- Assume both ON.



This ckt violates KVL voltage in branches are differ (10v, 8v)

Case II :- Assume both diode are off



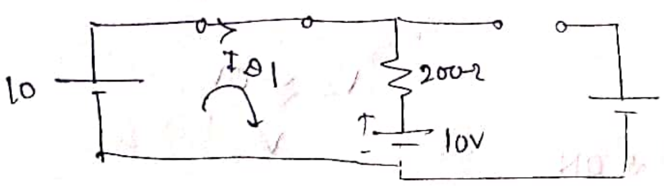
$-10v - V_{D1} + 10 = 0$

$V_{D1} = 0V$

$V_{D2} + 8 - 10 = 0$

$V_{D2} = 2V$ { $V_{D2} > 0$ wrong assumption

Case III Assume D_1 is on & D_2 is off



KVL

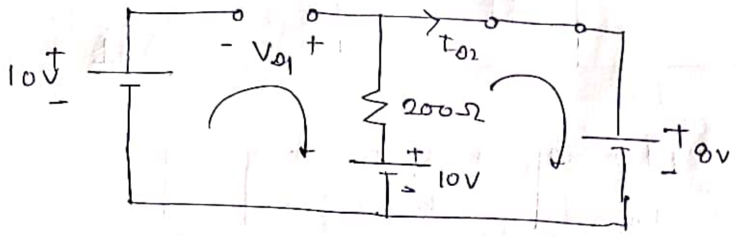
$-10 - 200 I_{D1} + 10 = 0$

$I_{D1} = 0$ A

Also, $-10 + 0 \times 200 + V_{D2} + 8 = 0$

$V_{D2} = 2V \; (V_{D2} > 0V)$

Case IV   Assume D_1 off D_2 ON



$-10 - V_{D1} + 10 - 200 I_{D2} = 0$

$V_{D1} = -200 I_{D2}$ — (i)

also, $-10 + 200 I_{D2} + 8 = 0$

$I_{D2} = \frac{2}{200}$

$I_{D2} = 0.01 A$

$V_{D1} = -200 \times 0.01$

$V_{D1} = -2V$

Correct Assumption

$I_{D2} = 0.01 A = 0.01 \times 10^{+3} mA$

$= 10mA$ //

D on

$I_D > 0A$ (P ton)

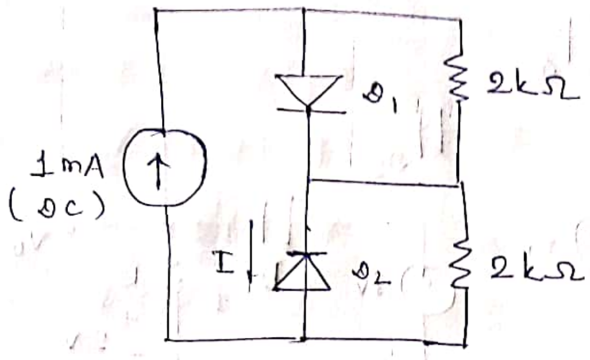
$I_D \leq 0A$ (X) wrong pred^n diode off

D off

$V_D > 0V$ P ton (X) wrong pred^n D ON

$V_D \leq 0V$ ✓

Q9. Assume D_1 D_2 are Ideal diode. The Value of I is



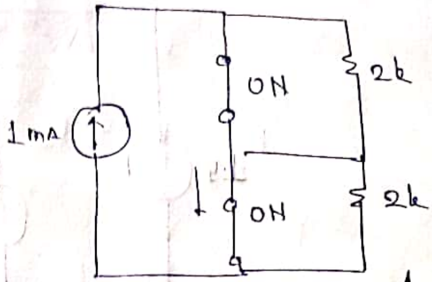


fig 1 $I = 1mA$

Sol: $D_1 = ON$ $D_2 = ON$

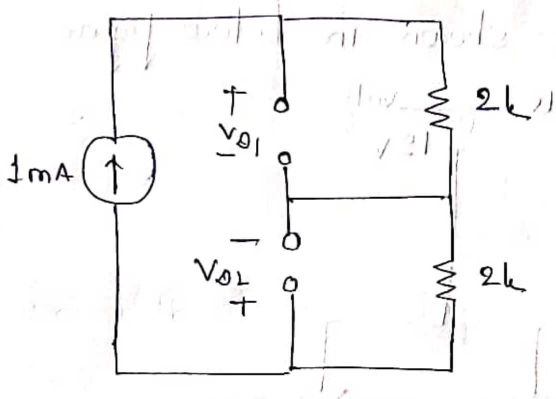


fig. $D_1 = off$
$D_2 = off$

$V_{D1} = 2V$ X

$V_{D2} = -2V$ ✓

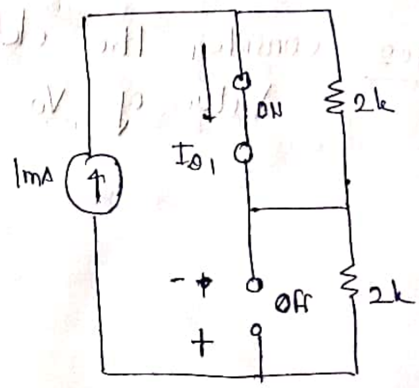
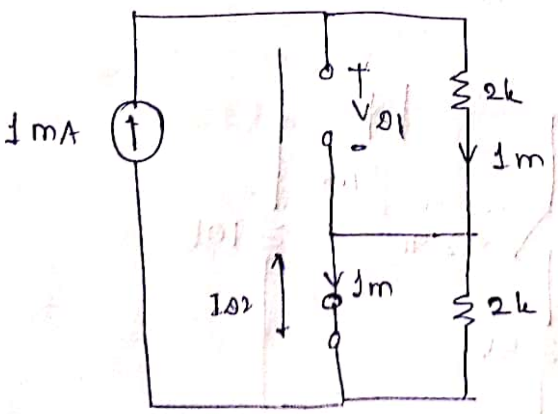


fig D_2 off
D_1 on

$I_{D1} = 1mA$ ✓

$V_{D2} = -2V$ ✓

$\boxed{I_D = 0A}$ //.



$V_{D1} = 2V$ X

$I_{D2} = -1 mA$ X

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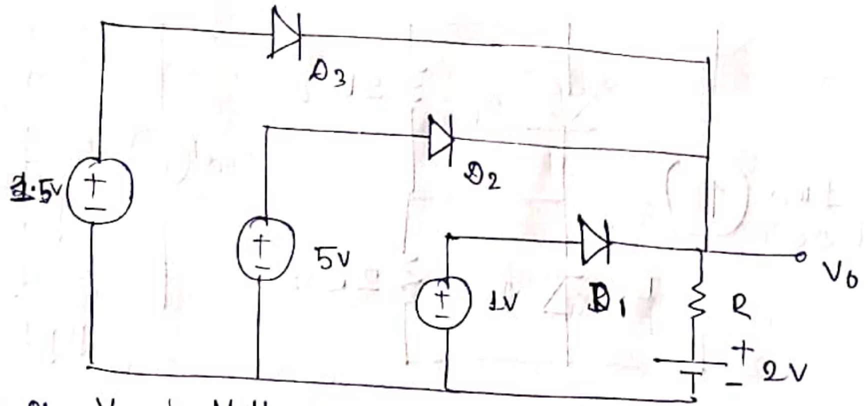
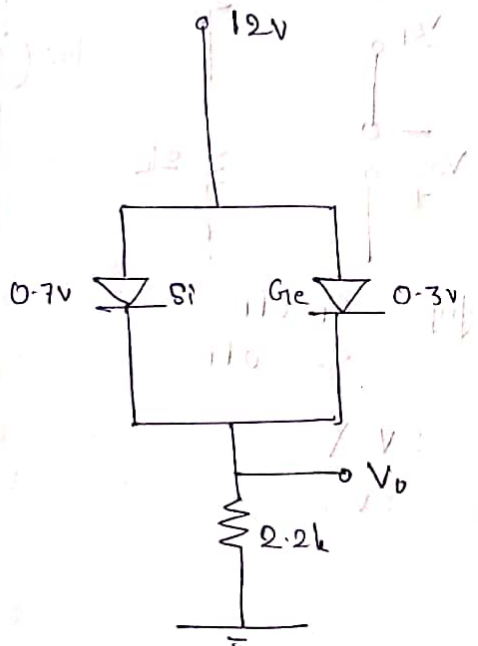
Que 1 For the Circuit shown in below figure

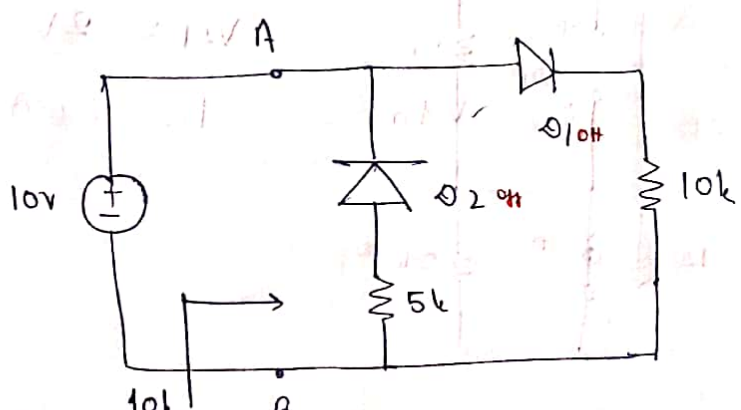


The Value of V_0 in Volt is —

Que 2 Consider the ckt shown in below figure the Value of V_0 is ______ Volt

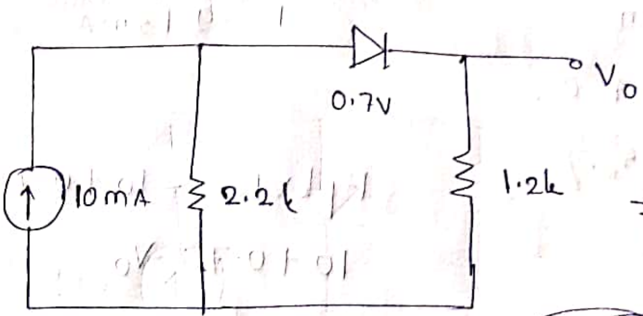


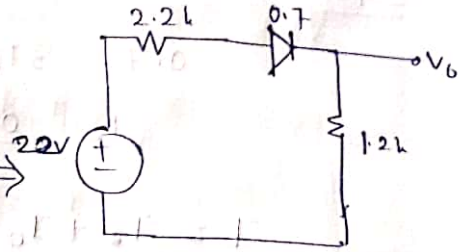
Que 3



The Impedence across AB is — 10k // .

Q4.





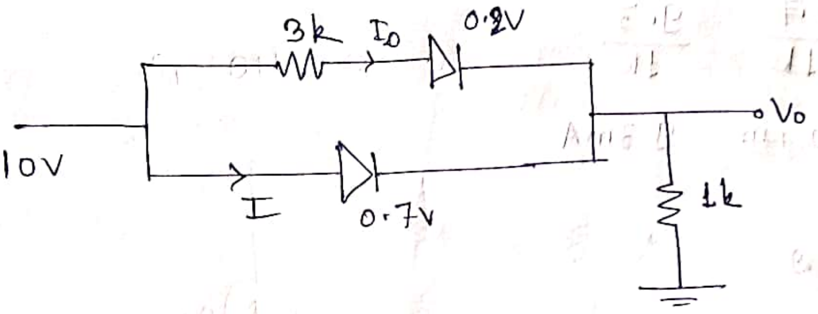
The Value of Vo is $\underline{7.51V}$.

~~$\frac{V_o - 22}{2.2} + \frac{V_o}{1.2} = 0$~~

~~$V_o + 2.2 + V_o$~~

~~$V_o = \left[\frac{10}{\frac{1}{2.2} + \frac{1}{1.2}}\right] =$~~

Q5.



The Value of I in mA is —

Sol 1 D_1 off due to 2V

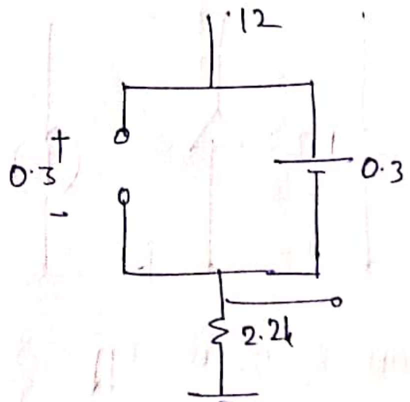
D_2 ON

D_3 off

$V_o = 5V$

Sol 2: first Ge conduct and fix 0.3V across Si diode

Hence Si never Conducts



$\Rightarrow 12 = 0.3 + V_o$

$V_o = 11.7 \text{ V}$

Sol5: Assume both on

$\boxed{I = 9.13mA}$

$0.7 = 3I_D + 0.2$

$I_D = \frac{0.5}{3} mA$ //

By KVL $-10 + 0.7 + V_0 = 0$

$-10 + 0.7 = -V_0$

$V_0 = \cancel{8}9.3$

$V_0 = +9.3\ V$

$I = I_D + I_0$

$I_0 = \frac{V_0}{1k}$

$= \frac{\cancel{10.7}}{\cancel{1k}} \quad \frac{9.3}{1k}$

$I_0 = \cancel{10.7m} \quad 9.3mA$

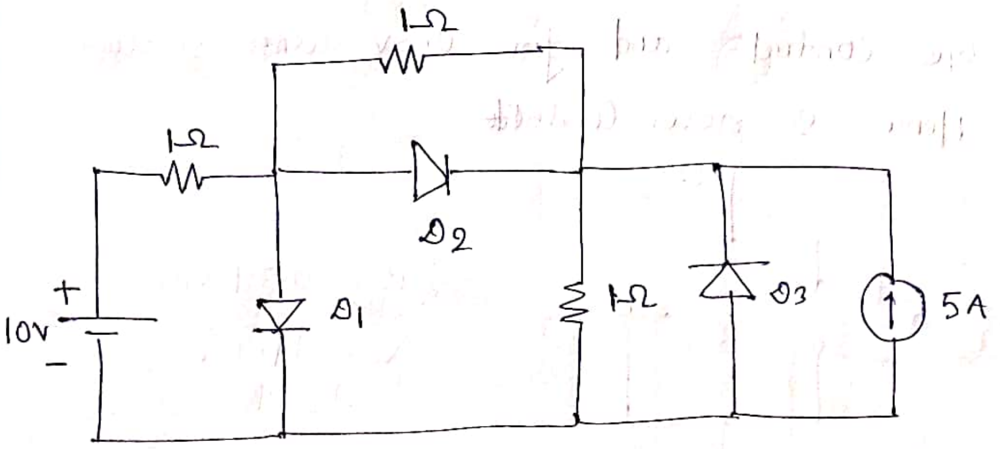
$I_0 = I + I_D$

$9.3 = I + \frac{0.5}{3}$

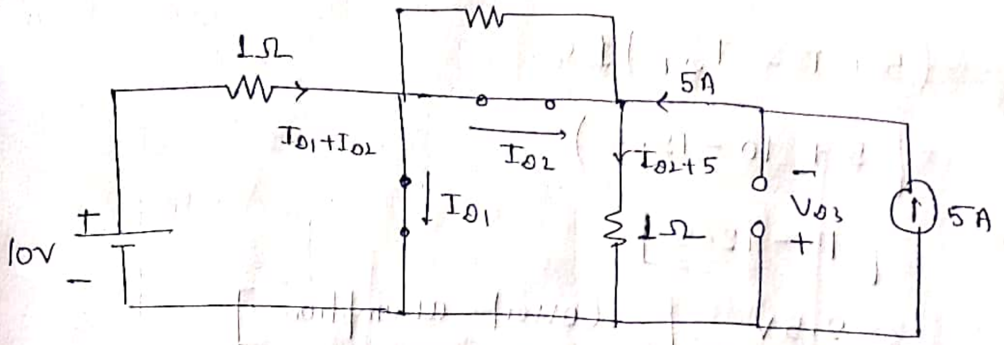
$I = 9.3 - \frac{0.5}{3}$

$I = 9.13 mA$ //

Q10. What are the states of three Ideal diode?



Sol Assume D_1 & D_2 is ON & D_3 is off { But its not in option }

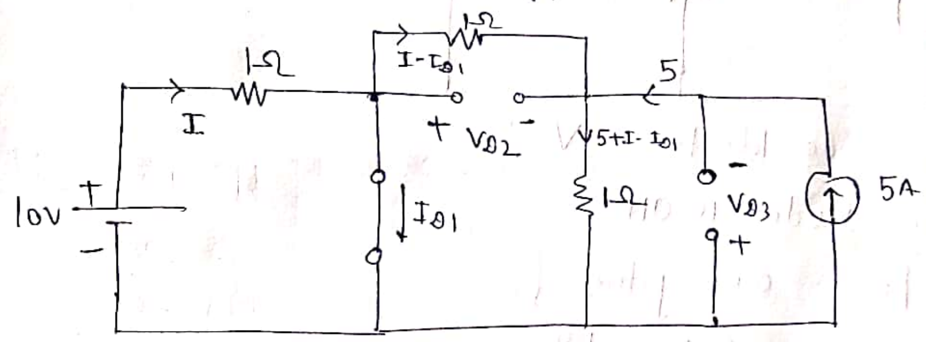


KVL $\quad (5+I_{D2})1\Omega + 0 + 0 = 0$

$I_{D2} = -5A$ (Wrong Assumption)

no need of going further

<u>Case</u>:- Assume D_1 ON D_2 off D_3 off



⇒ Apply KVL

$V_{D2} + 5 + I - I_{D1} + 0 = 0$

also,

$-10 + I + 0 = 0$

$I = 10A$

also $\quad (I - I_{D1})1 + 5 + I - I_{D1} + 0 = 0$

$10 - I_{D1} + 5 + 10 - I_{D1} = 0$

⇒ $I_{D1} = \frac{25}{2} = 12.5$ [Correct assumption]

Check other. $\qquad$ OR $(I - I_{D1})1\Omega = V_{D2}$

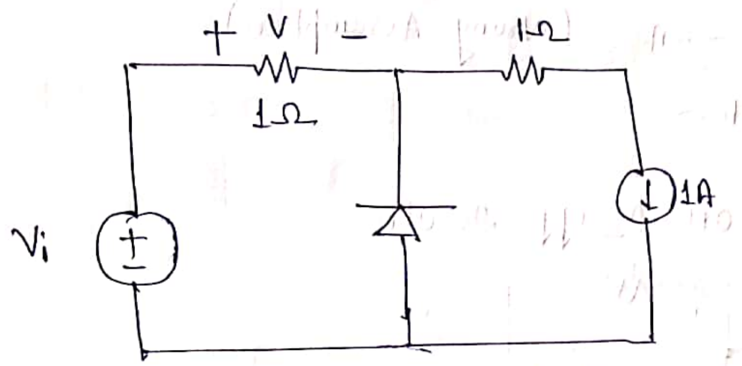
$V_{D2} = 12.5 - 10 - 5$ $\qquad 10 - 12.5 = V_{D2}$

$= -2.5$ // (Correct) $\qquad V_{D2} = -2.5$

$$V_{D3} = -(5 + I - I_{D1})\,1\Omega$$
$$= -[5 + 10 - 12.5)$$
$$= -[15 - 12.5]$$
$$V_{D3} = -2.5V \quad [\text{ Correct assumption }]$$

Hence D_1 ON D_2 off D_3 off

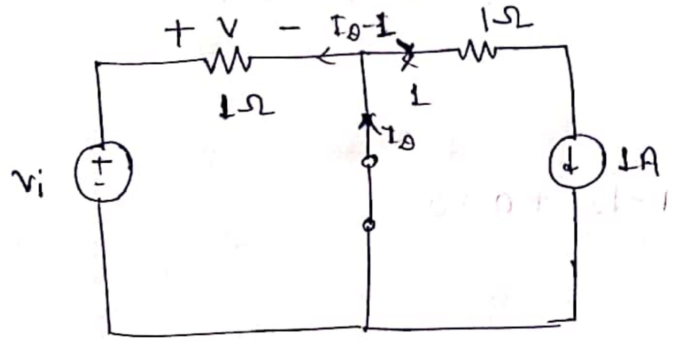
Q12.



Diode- Ideal   V= ?

Sol Assume diode is ON

{ Vi can be positive or negative }



$$-V_i + V = 0$$
$$V = V_i \quad \text{—(1)}$$

$$V = -(I_D - 1) \times 1$$
$$V = 1 - I_D \quad \text{—(2)}$$

Diode ON Condition :- $I_D > 0$

$1 - V > 0$

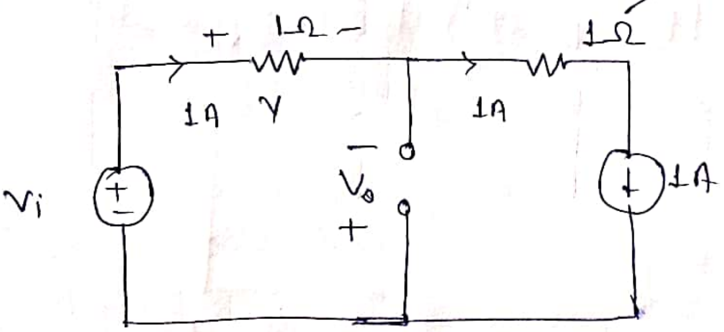
$V < 1$ Volt

Options	V	State
min$(V_i, 1)$	min$(0.5, 1) = 0.5$ V	✓
Max$(V_i, 1)$	Max$(0.5, 1) = 1$ V	X
min$(-V_i, 1)$	min$(-0.5, 1) = -0.5$ V	X
max$(-V_i, 1)$	max$(-0.5, 1) = 1$ V	X

Assume $V_i = 0.5V$

Option A

Assume diode is off



no use of 1Ω
Ideal Current Source
Series resistance
is of no use.

$V = 1V$

KVL $-V_i + V - V_D = 0$

$V_D = V - V_i$

for diode off

$V_D < 0$

$V - V_i < 0$

$V_i > 1$ Volt

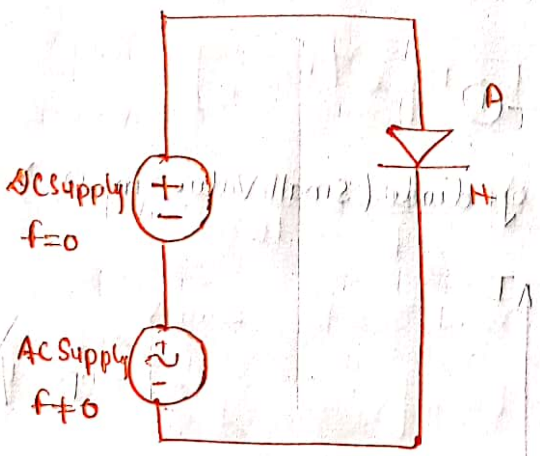
Assume $V_i = 2V$ $[V_i > 1V]$

Option	V	Statement
$\min(V_i, 1)$	$\min(2, 1) = 1V$	✓
$\max(V_i, 1)$	$\max(+2, 1) = 2V$	
$\min(-V_i, 1)$	$\min(-2, 1) = -2V$	
$\max(-V_i, 1)$	$\max(-2, 1) = 1V$	✓

now take $V_o = ON$

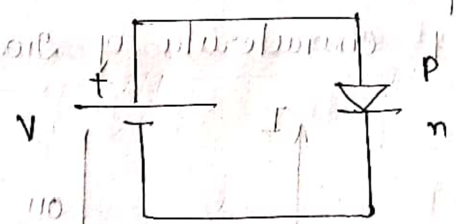
then only option A

* ## DC and AC Equivalent Circuit of Diode



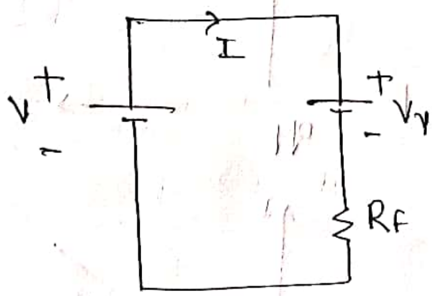
Apply Super position theorem

Step 1 Consider DC Voltage Source V [$V_{ac}=0$]



Case 1. $V \geq V_\gamma$

D = forward Biased | ON



where, V_γ = Cut-in Voltage or offset Voltage

V_γ = 0.6 to 0.7 V [Si]

V_γ = 0.2V to 0.3V [Ge]

$V_\gamma[Ge] < V_\gamma[Si]$

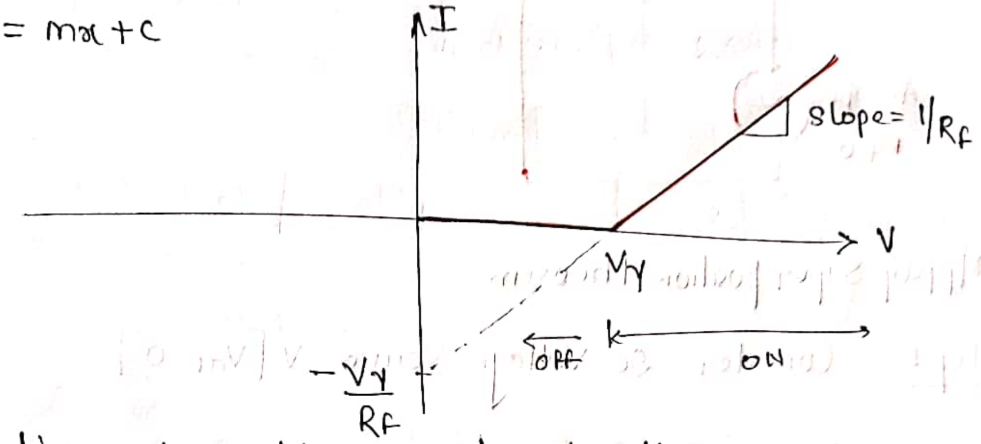
Apply KVL

$$-V + V_\gamma + I R_f = 0$$

$$I = \frac{V - V_\gamma}{R_f} \quad \text{—(1)}$$

R_f = forward bias resistance of diode (small value in Ω)

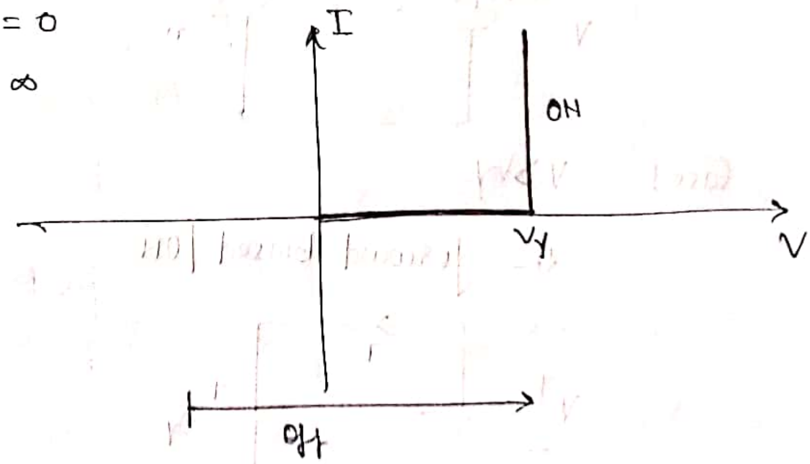
$y = mx + c$



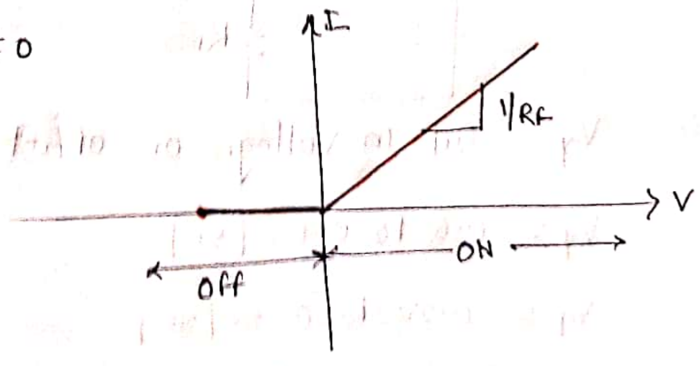
Piecewise linear forward biased characteristic of diode.

__Case 1.1__ $V_\gamma \neq 0$ $R_f = 0$

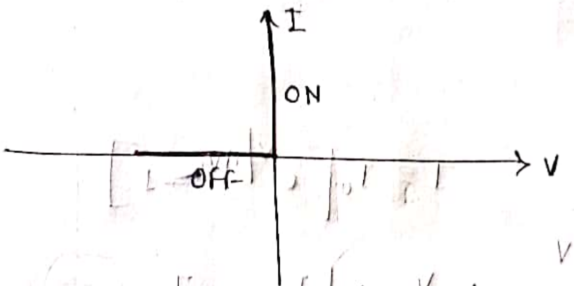
Slope = ∞



__Case 1.2__ $V_\gamma = 0$ $R_f \neq 0$



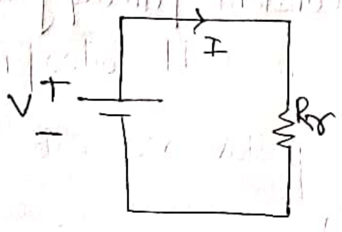
Case 1.3 $V_\gamma = 0V$ $R_f = 0$



Ideal diode characteristic

Case 2 $V < V_\gamma$

$D =$ RB ~~OC~~



$R_r =$ Reverse bias Resistance (Very High value)

Applying KVL

$$-V + R_r I = 0$$

$$I = \frac{V}{R_r}$$

$R_r \longrightarrow M\Omega$

$I \longrightarrow \mu A$

Ideally $R_r \longrightarrow \infty$

$I = 0A$ (O.C)

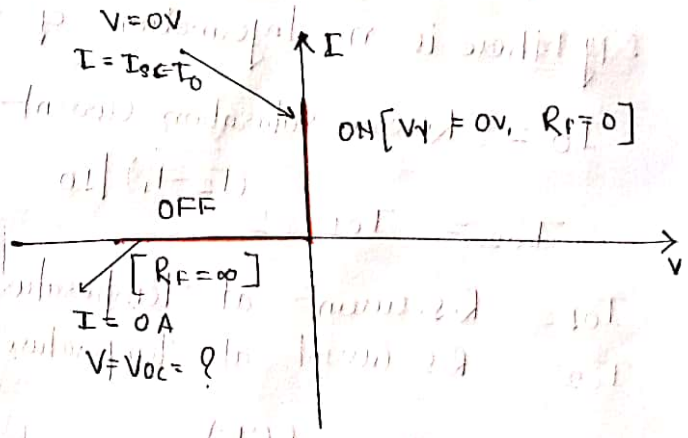
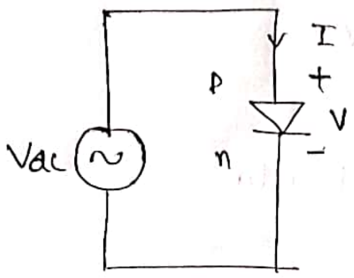


fig: Ideal charac. of Diode

Step II   Consider AC Source V_{ac}

$V_{dc} = 0$



$$I = I_0\left[e^{V/\eta V_T} - 1\right]$$

$$V_T = \frac{kT}{q} = \frac{T}{11600}$$

V_T at $300^\circ k = 26mV$

Exam $[V_T\ 300^\circ k] = 25mV$ (Max^m time)

η = Material Constant / Ideality Constant / utility factor

$$\eta = \begin{cases} 1 & Ge \\ 2 & Si \end{cases}$$ old book

$\eta = 1$ for Ge & Si new book

- If there is no information of η then by default $\eta = 1$

I_0 = Reverse Saturation Current

$$I_{02} = I_{01}\ 2^{(T_2 - T_1)/10}$$

I_{01} = R.S. current at temperature T_1

I_{02} = R.S current at temperature T_2

$I_0 = f(T)$

$I_0 \uparrow \quad T \uparrow$

$I_0 \uparrow\ 10\% / {}^\circ C \uparrow$

Dynamic Conductance of diode is given by.

$$g = \frac{dI}{dV}$$

$$g = \frac{I_0 e^{V/\eta V_T}}{\eta V_T}$$

$$g = \frac{I + I_0}{\eta V_T}$$

$$r_d = r_{ac} = r = \frac{1}{g} = \frac{\eta V_T}{I + I_0}$$

Dynamic Resistance
or
Ac Resistance

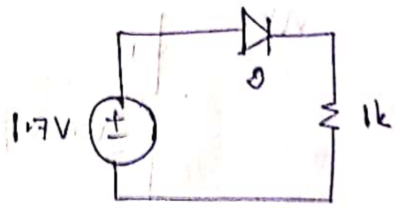
Case 1 — Forward Bias $I >> I_0$

$$r_{ac} = \frac{\eta V_T}{I}$$

Case 2 — Reverse Bias I & I_0 Comparable

$$r_{ac} = \frac{\eta V_T}{I + I_0}$$

Page 11
Q11
Sol $\eta = 1$

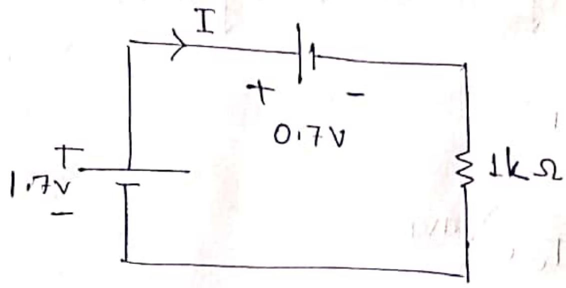


$V_\gamma = 0.7V$

$1.7V > V_\gamma$
D = FB

where, I = forward bias dc diode Current

$$r_d = r_{ac} = \frac{\eta V_T}{I}$$



Dc equivalent ckt

$$-1.7 + 0.7 + I = 0$$

$$I = 1mA$$

$$r_{ac} = \frac{1 \times 26}{1} \quad (\text{assume } 26mV = V_T)$$

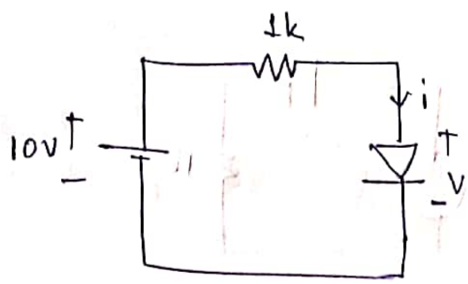
$$r_{ac} = 26\,\Omega$$

OR assume $25mV = V_T$

$$r_{ac} = 25\,\Omega$$

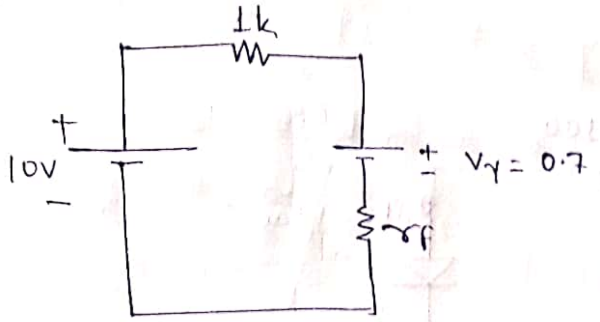
Que18.

$$i = \begin{cases} \dfrac{V - 0.7}{500} & V \geq 0.7V \\ 0A & V < 0.7V \end{cases}$$



$I = \dfrac{V - V_\gamma}{R_f}$ forward biased current

$\Rightarrow$ $V_\gamma = 0.7$ $\quad R_f = 500\,\Omega$ $\quad$ { after comparison



$$-10 + I + 0.7 + r_f I = 0$$

$$\frac{-9.3}{1k+500} = -I$$

$$I = +\frac{9.3}{1+0.5}$$

$$I = +\frac{9.3 \times 2}{3}$$

$$= +3.1 \times 2$$

$$I = 6.2mA$$

OR

$$-10 + 1000i + V = 0$$

V is Voltage across diode from question

$$-10 + 1000i + 500i + 0.7 = 0$$

$$i = \frac{10-0.7}{1500}$$

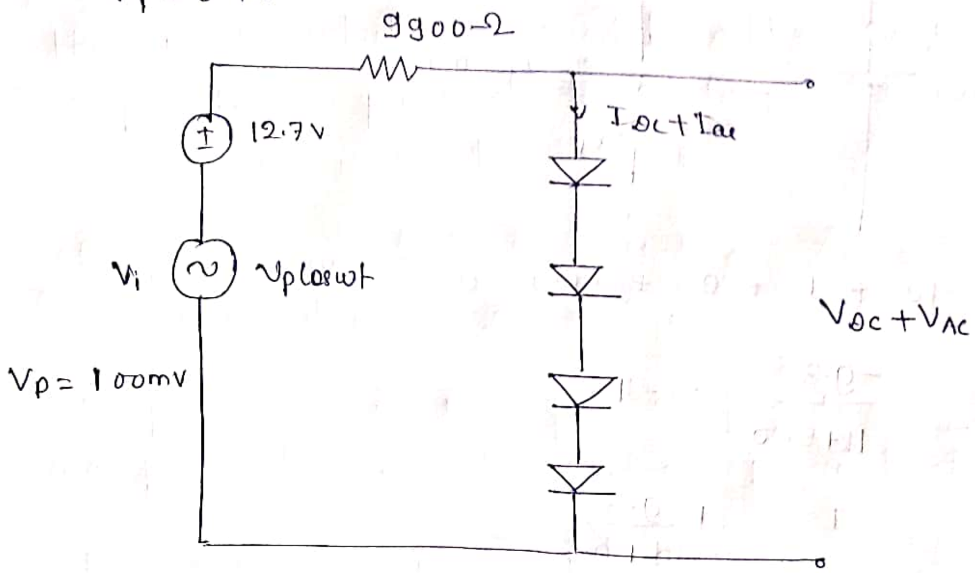
$$= \frac{10-0.7}{1500} \times 10^3$$

$$\Rightarrow \frac{9.3}{15} \times 10$$

$$\Rightarrow \frac{9.3}{3} \times 2 = 6.2mA$$

Q.15.16

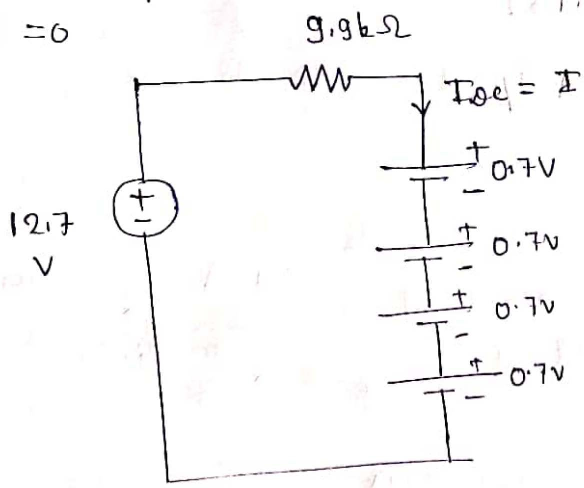
Sol $V_\gamma = 0.7V$



Sol Calculation of DC bias Current I_{DC}

DC Analysis

AC Signal = 0

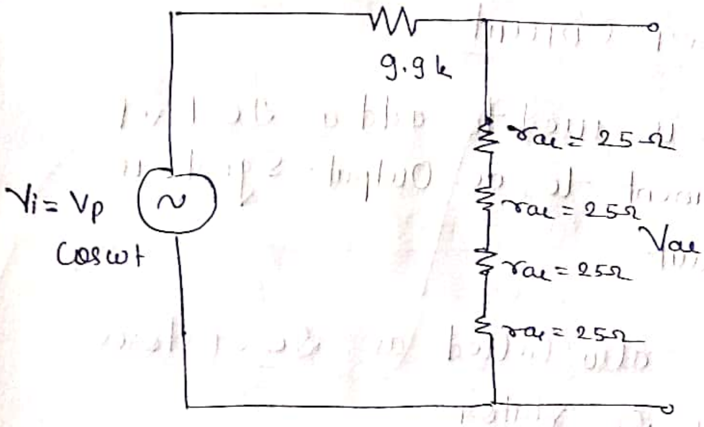


$$-12.7 + 9.9I + 2.8 = 0$$

$$I = 1mA$$ //

AC Analysis

DC Input = 0



Ac equivalent ckt of Diode

$$r_{ac} = \frac{\eta V_T}{I_{ac}}$$

$$= \frac{1 \times 25}{1}$$

$$r_{ac} = 25\Omega$$

$$V_{ac} = \frac{100 \cos\omega t \times 100}{100 + 9.9k}$$

$$= \frac{100 \cos\omega t \times 100}{10000}$$

$$V_{ac} = \cos\omega t \ mV \ //$$

$\star$ $\eta = 1$ without any Information

If $\eta = 2$

$$r_{ac} = 50\Omega$$

$$V_{ac} = \frac{100 \cos\omega t \times 200}{200 + 9900}$$

$$= \frac{1\cancel{0}\cancel{0} \cos\omega t \times 2}{101\cancel{0}\cancel{0}}$$

$$= 2\cos\omega t \ mV \ //$$

9900
100
000

Clamper Circuit

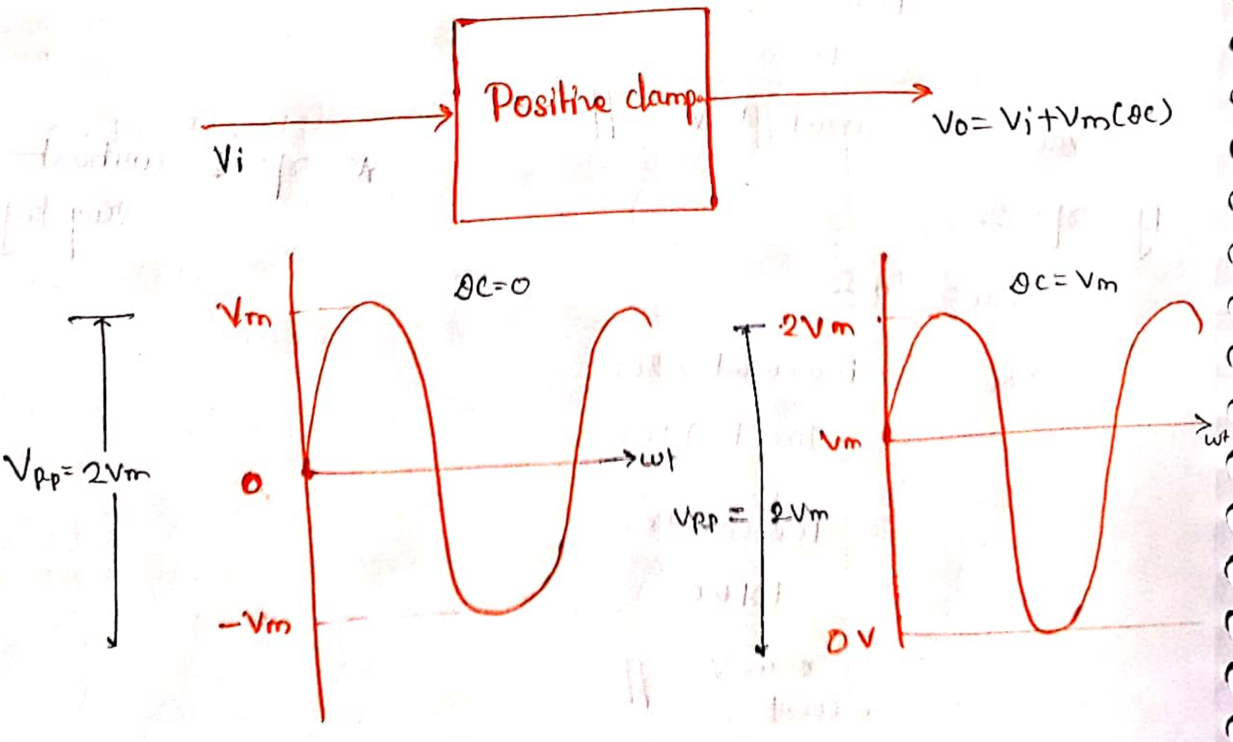
1. The Circuit which is used to add a DC level as per the requirement to ac Output Signal is Called clamper Circuit.

2. Clamper circuit is also Called as DC restores or DC Inserter or DC xlator.

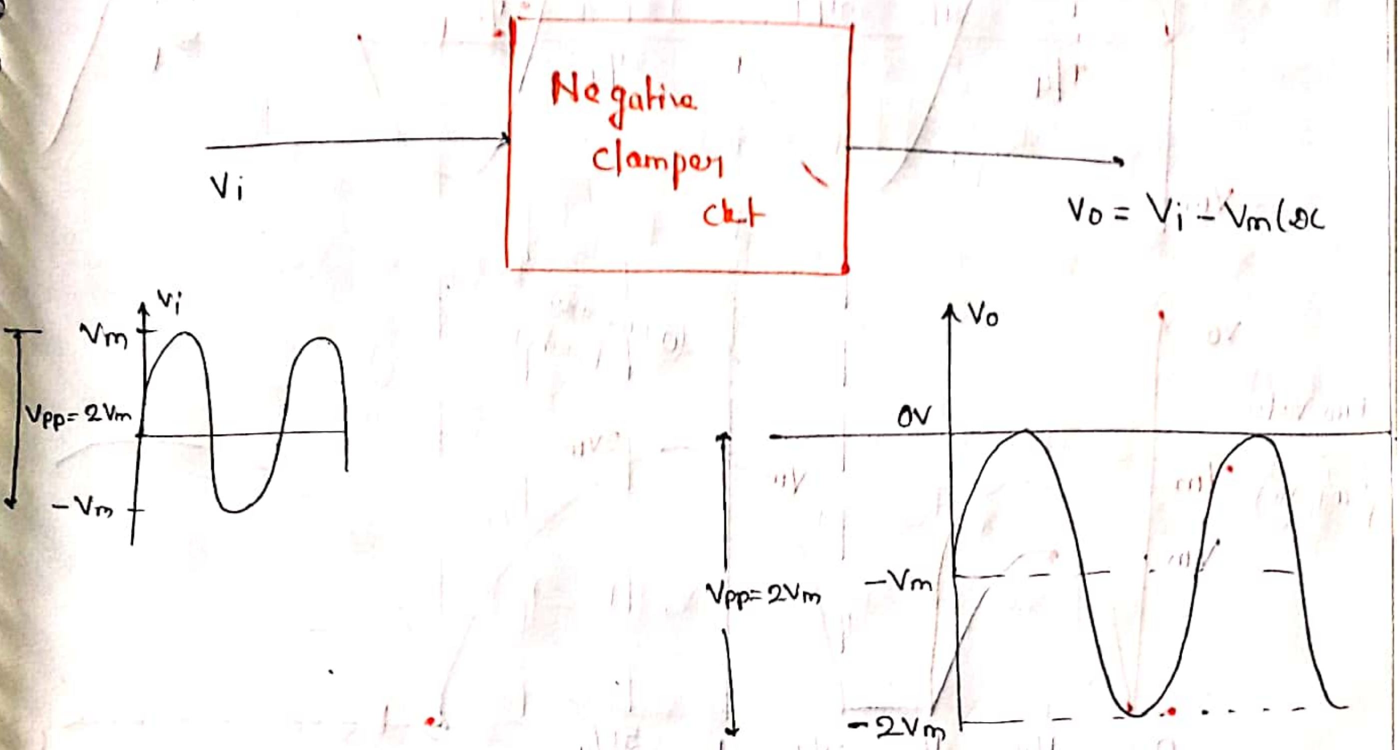
3. Clamper Circuit is Used for clamping the Complete waveform above or below zero reference level.

4. If a waveform is clamped above Zero reference Level then it is Called positive clamper and below Zero reference level is Called Negative clamper.

5. In positive clamper ckt we add positive DC level.

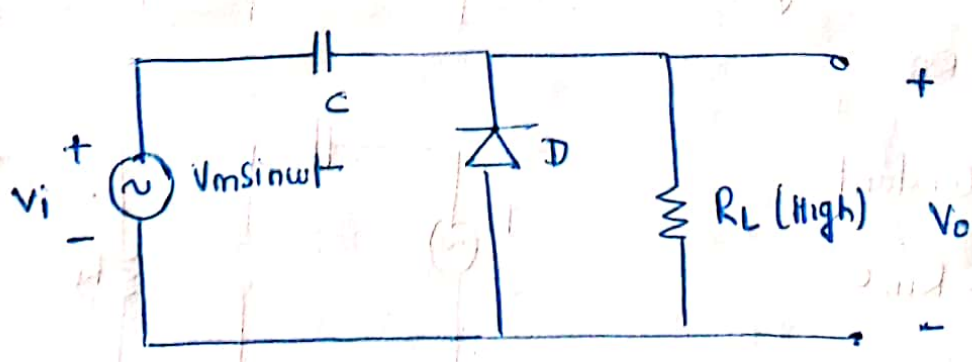


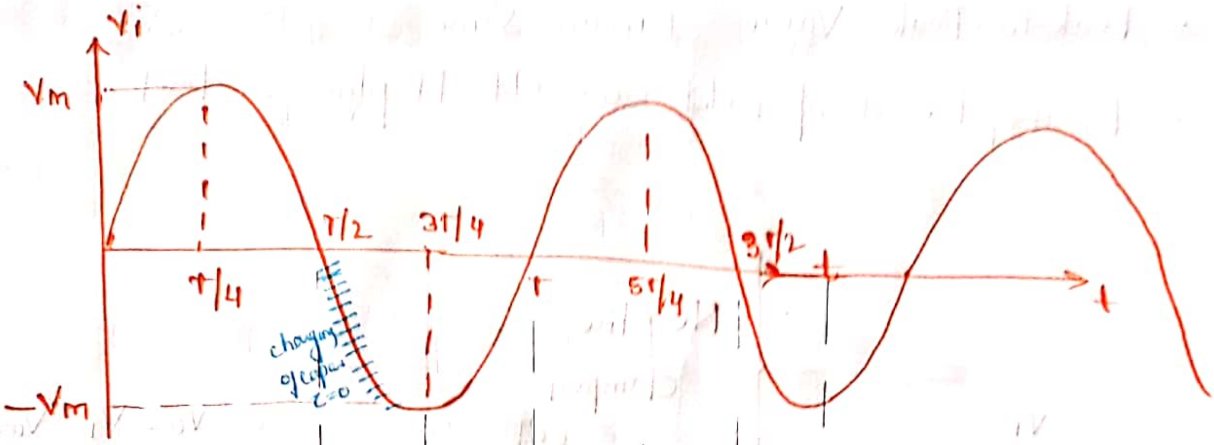
- Peak-to-Peak Value remain Same.
- In negative clamper ckt we add Negative DC level



- The Main ckt element of clamper ckt is Capacitor.
- Working of clamper ckt is based on Ideal charging and discharging of Capacitor.

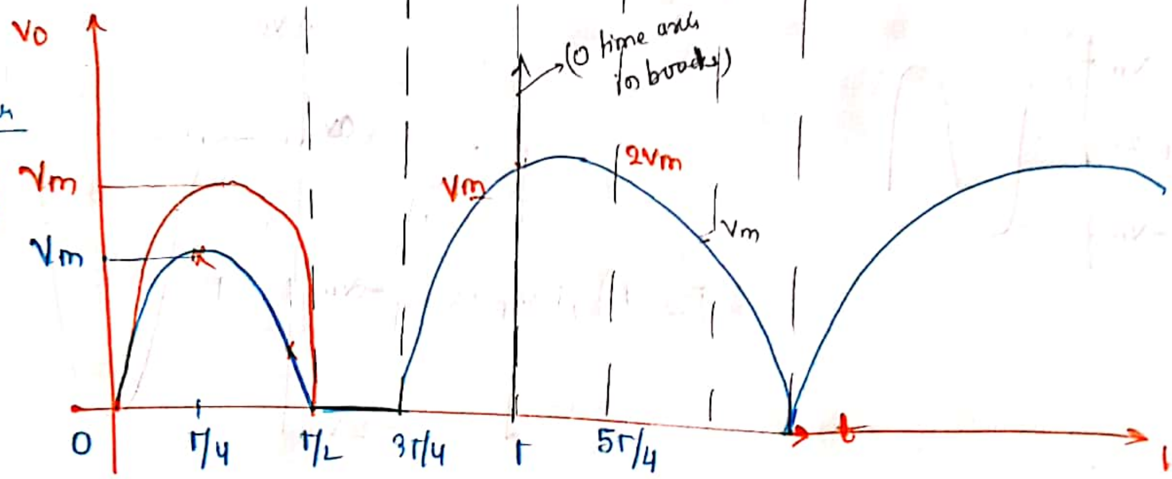
1. Positive Clamper ckt :-





Rms Value

$\sqrt{V_m^2 + \left(\frac{V_m}{\sqrt{2}}\right)^2}$



Working

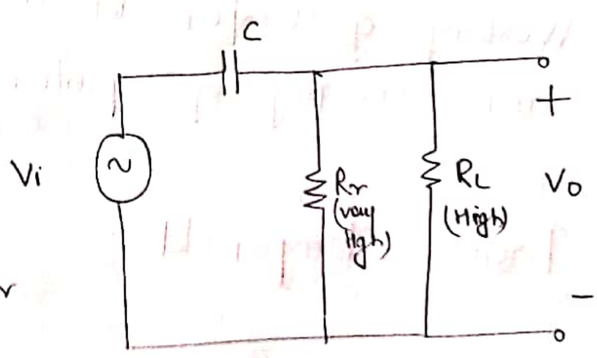
1) $0 < t < T/4$ (PHC)

$0 < V_i < V_m$

Assume, $V_c(0) = 0V$

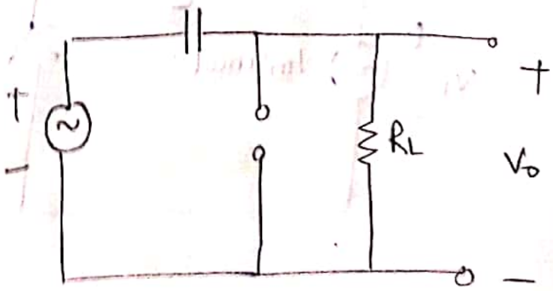
C = Uncharged Capacitor

D = RB

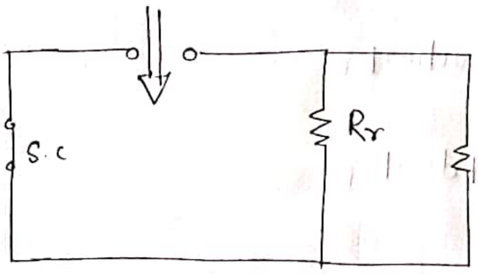


Charging time Constant

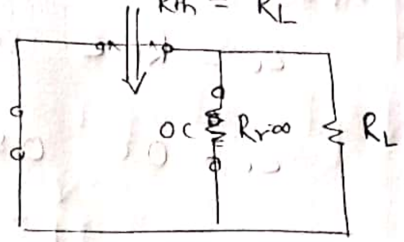
$\tau_c = R_{th} C$



$R_{th} = R_\gamma || R_L \approx R_L$



$R_{th} = R_L$



<u>Key point:</u> for proper operation of clamper ckt the value of R_LC should be higher than time period of Input s/g

$R_L C >> T$

$\therefore \quad Z_c = R_L C$

If $f = 50\,Hz$

$T = \frac{1}{50}$ sec $= 20\,mS$

$R_L C = 200\,mS$

Capacitor will not charge

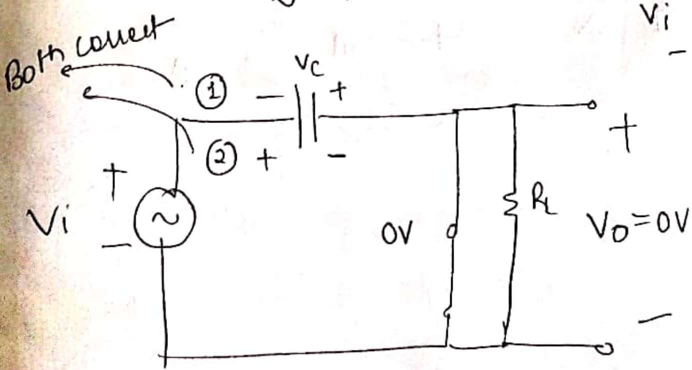
$V_c(T/4) = 0V$

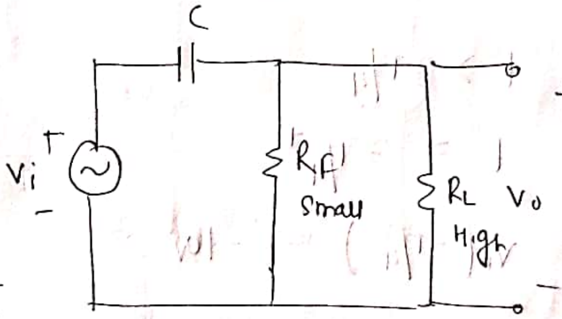
$T/4 < t < T(\text{sec})$

$V_c(T) = 0V$

II) $T/2 < t < 3T/4$ (NHC)

$D = FB$





$$\tau_c = R_{th} C$$

$$\tau_c = R_f C \text{ sec } \{\text{practical}\}$$

$$\tau_c = 0 C = 0 \text{ sec } \{\text{Ideal}\}$$

$$R_{th} = R_f \quad \{\text{Practical}$$

$$R_{th} = 0\,\Omega \quad \{\text{Ideal}$$

KVL(1) :-

$$-V_i - V_c + 0 = 0$$

$$V_c = -V_i$$

$$V_c(t = 3\pi/4) = -V_i\left(t = \frac{3\pi}{4}\right)$$

$$= -[-V_m]$$

$$V_c(t = 3\pi/4) = V_m$$

KVL(2) :- $-V_i + V_c + 0 = 0$

$$V_c = V_i$$

$$V_c(3\pi/4) = V_i(3\pi/4) = V_m$$

Both case Same (capacitor polarity can be either way)

At $t > 3T/4$

$$t = 3T/4^{+}$$

$$V_i(3T/4) = -10V$$

$$V_c(3T/4) = +10$$

$V_i(3T/4)^+ = -9.9V$

$V_c(3T/4^+) = V_c(3T/4)$

$= 10V$

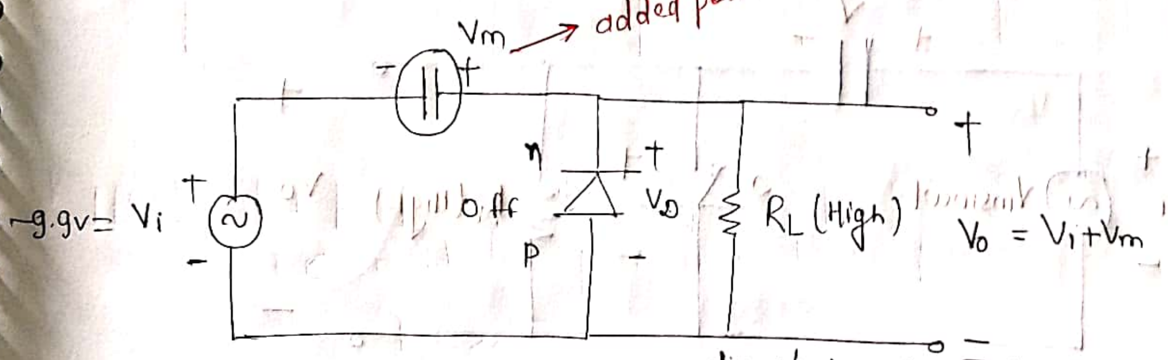


fig. $t > 3T/4$ [Steady state]

KVL: $-V_i - 10 + V_D = 0$

$V_D = V_i + 10$

$V_D = -9.9 + 10 = 0.1V$

$D = \text{off}$

Case for $D = ON$

$D = ON$

$V_D < 0V$

$-V_i - V_m + V_D = 0$

$V_i + V_m < 0V$

$V_i < -V_m$ (Not possible)

& Hence $D =$ off always

$$\boxed{V_o = V_D = V_i + V_m}$$

$t > 3T/4$

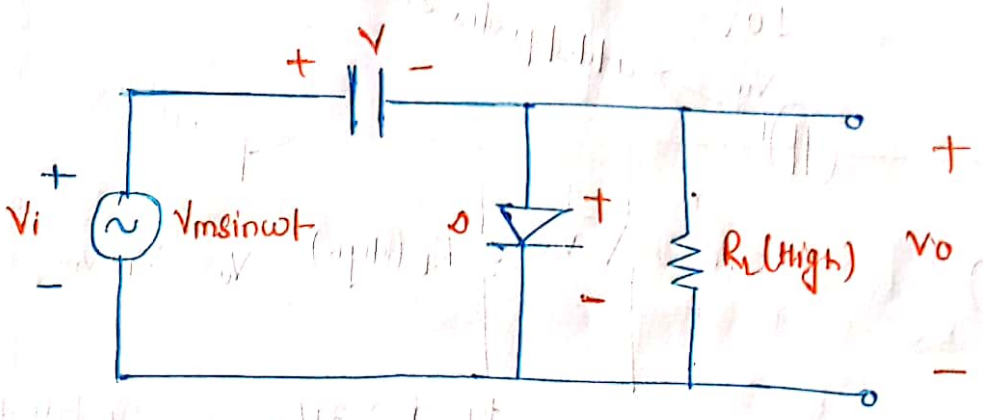
t	V_i	$V_o = V_i + V_m$
T	0	V_m
$\frac{5T}{4}$	V_m	$2V_m$
$\frac{3T}{2}$	0	V_m

Avg. Value of Input = 0

Avg. Value of o/p = V_m

$$\boxed{R_{L\,min} = \sqrt{R_f \times R_r}}$$

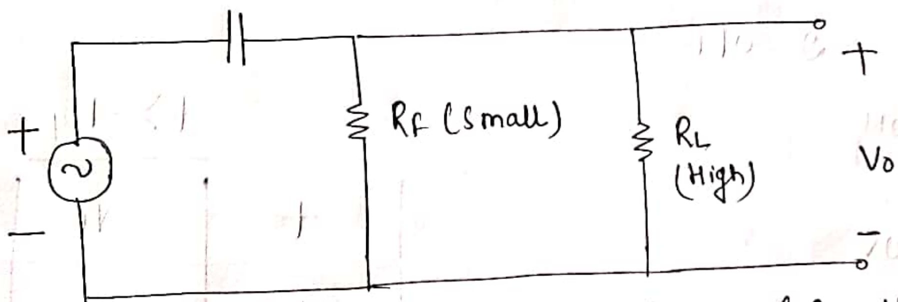
* Negative Clamper



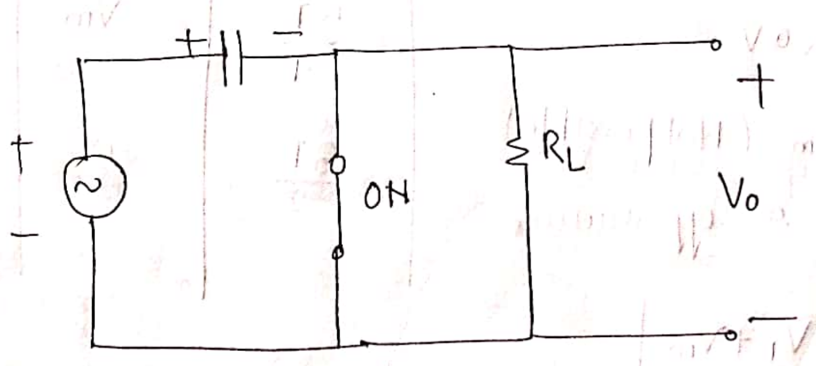
1) $0 < t < T/4$ (PHC)

$D =$ ON | FB

$V_c = 0\,V$



$\tau_c = R_{th}\,C = R_f C$ (small)



$\tau_c = R_{th}\,C$

≈ 0 sec

KVL: $-V_i + V_c = 0$

$V_c = V_i$

$t > T/4$

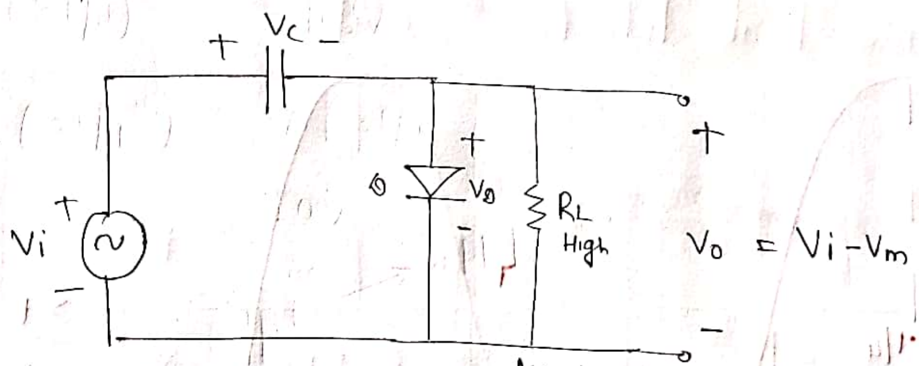


fig $t > T/4$

$-V_i + V_C + V_D = 0$

$V_D = V_i - V_C$ $\{V_C = V_m\}$

$V_D = V_i - V_m$

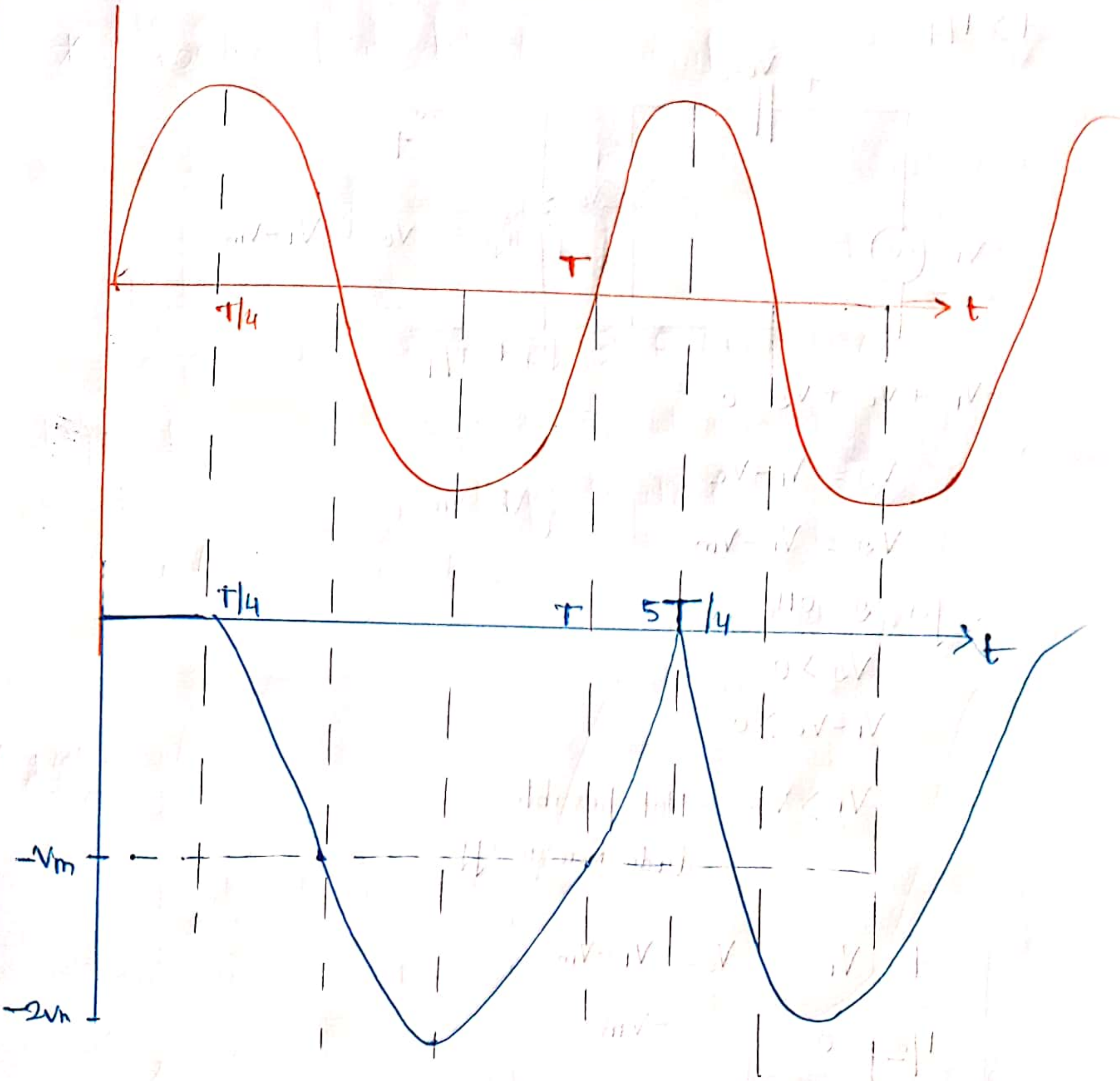
for $D = ON$

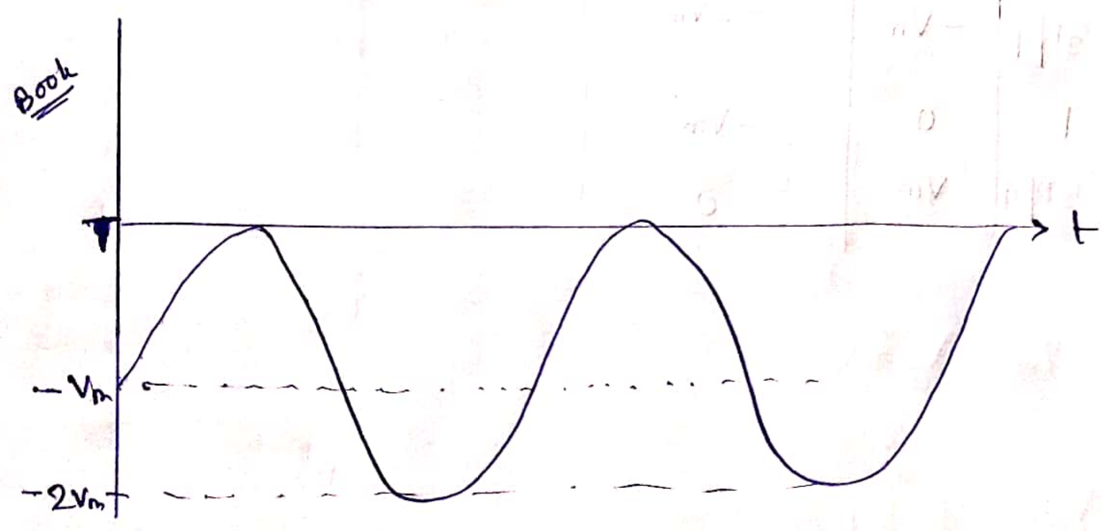
$V_D > 0$

$V_i - V_C > 0$

$V_i > V_m$ Not possible
diode Remain off

t	V_i	$V_o = V_i - V_m$
$T/2$	0	$-V_m$
$3T/4$	$-V_m$	$-2V_m$
T	0	$-V_m$
$5T/4$	V_m	0


T/4
T
t
T/4
T
5T/4
t
-Vm
-2Vm


Book
t
-Vm
-2Vm

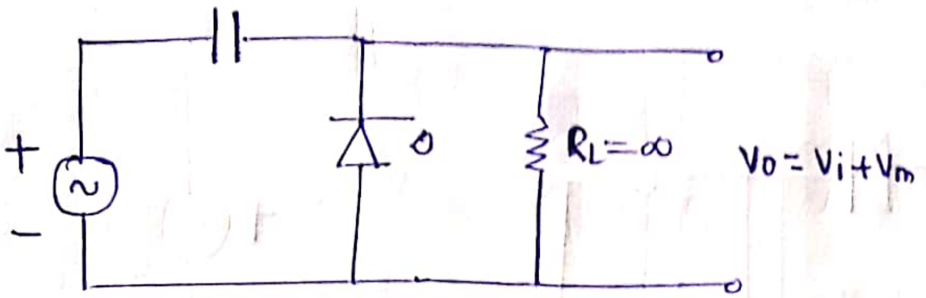


fig. Ideal positive clamper

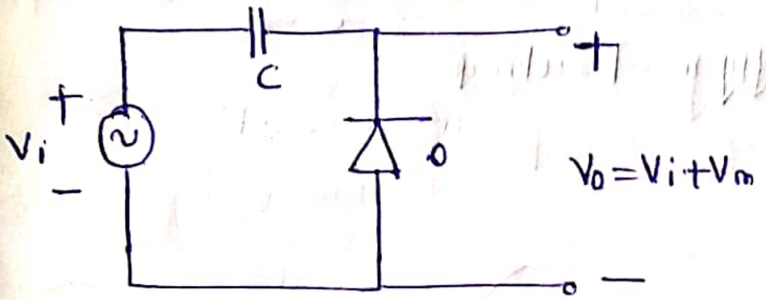


fig Ideal positive clampler

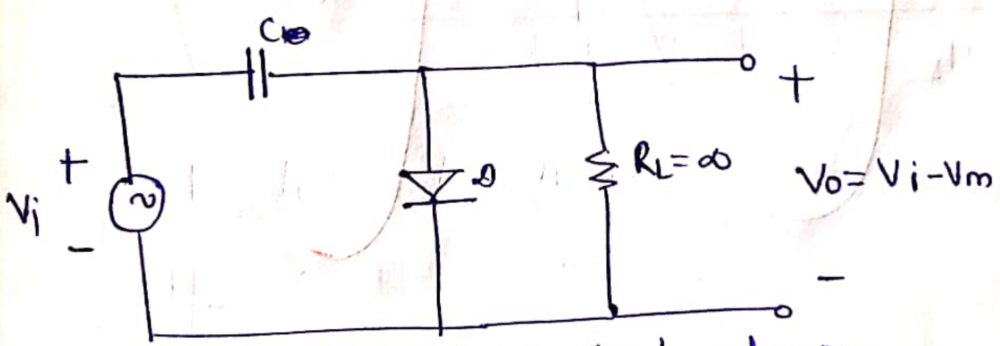


fig. Ideal Negative clamper

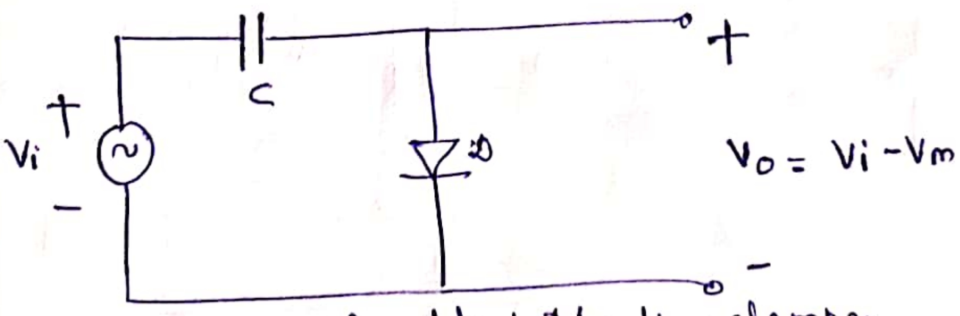


fig. Ideal Negative clamper

* Positive Peak detector Circuit

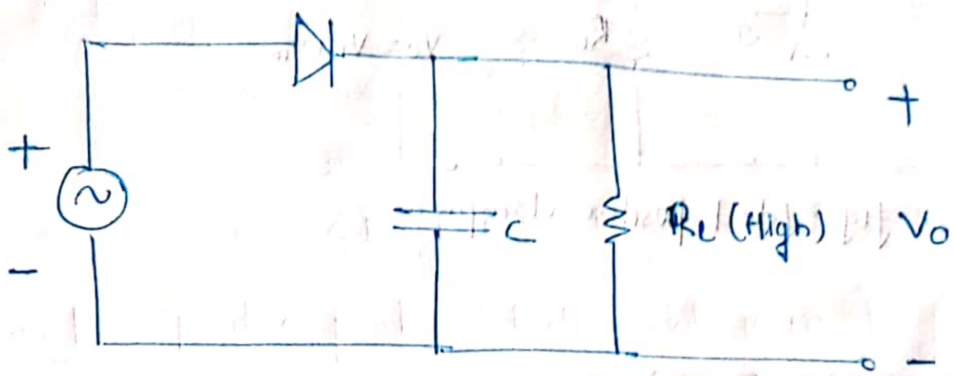
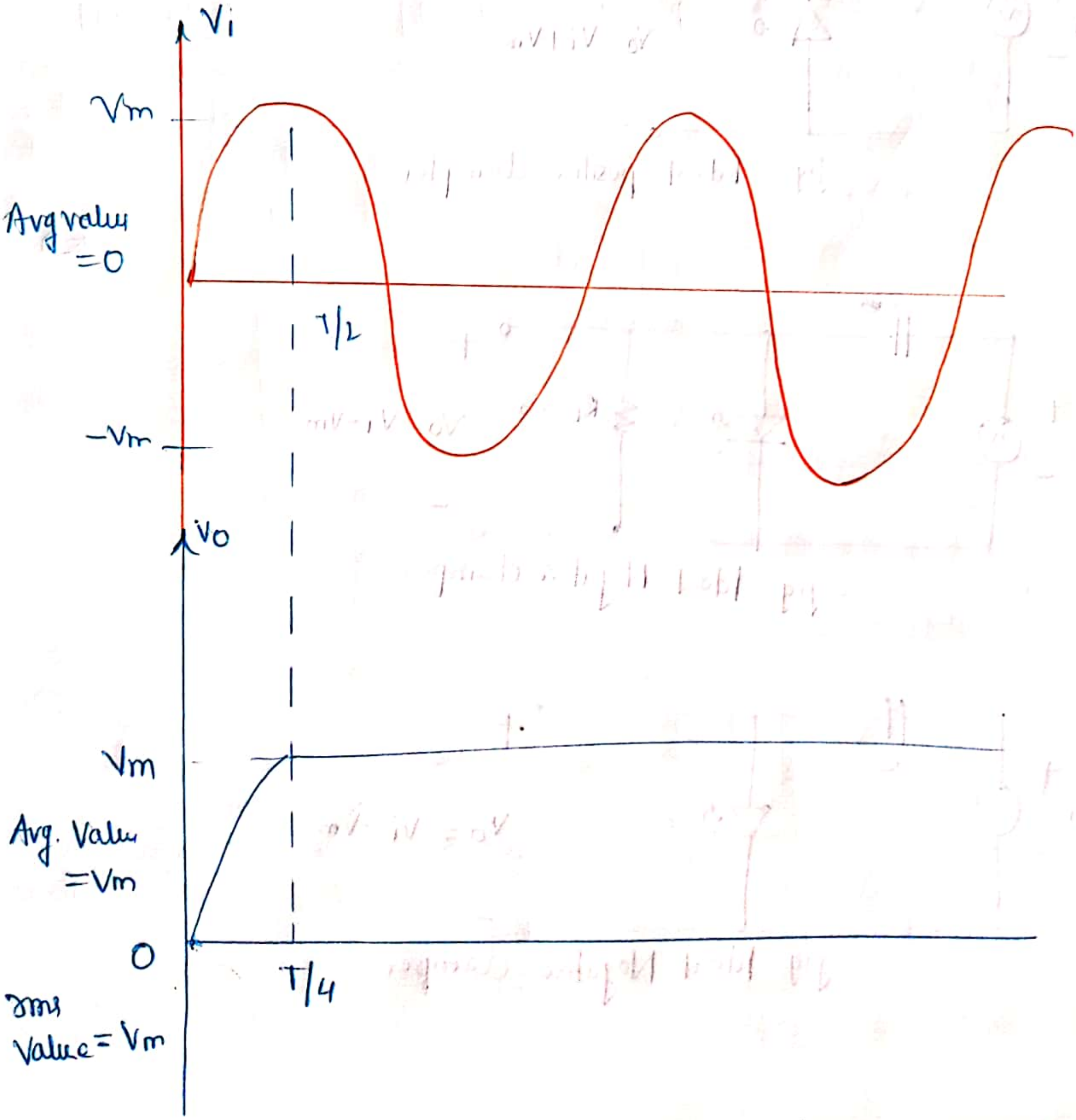


fig a Practical



i) $0 < t < T/4$ (PHC)

$V_c(0) = 0V$

D ON

Practical

$D \rightarrow R_f$

$\tau = R_f C$

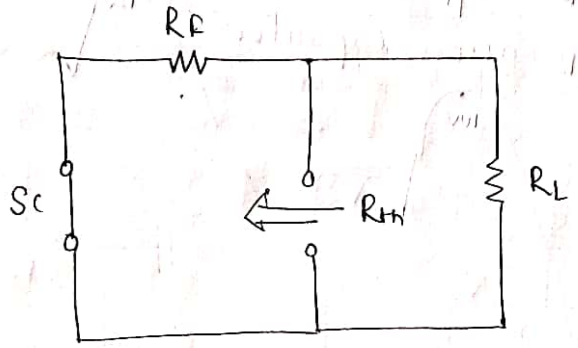
Ideal

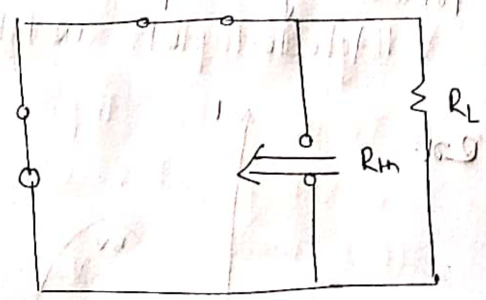
$D \rightarrow S.C$

$\tau = 0 sec$

Capacitor = Charging

$V_c = V_i = V_o$ [$V_o = 0V$]





$R_{th} = R_f \| R_L \approx R_f$

$\tau = R_{th} C$

$\tau = R_f C$ (Small)

$R_{th} = 0 \Omega$

$\tau = 0 sec$

ii) $t > T/4$

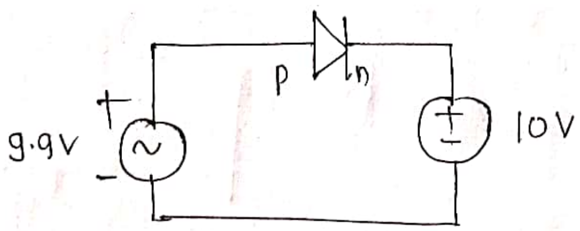
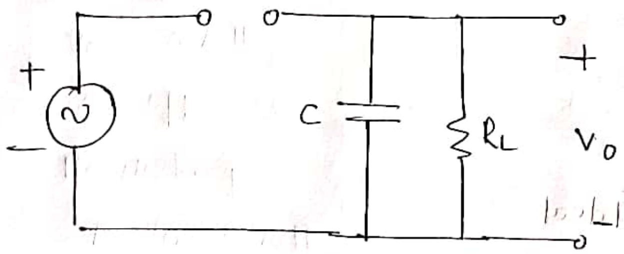


fig $t = \frac{\pi}{4}^{+}$

Now Diode Off



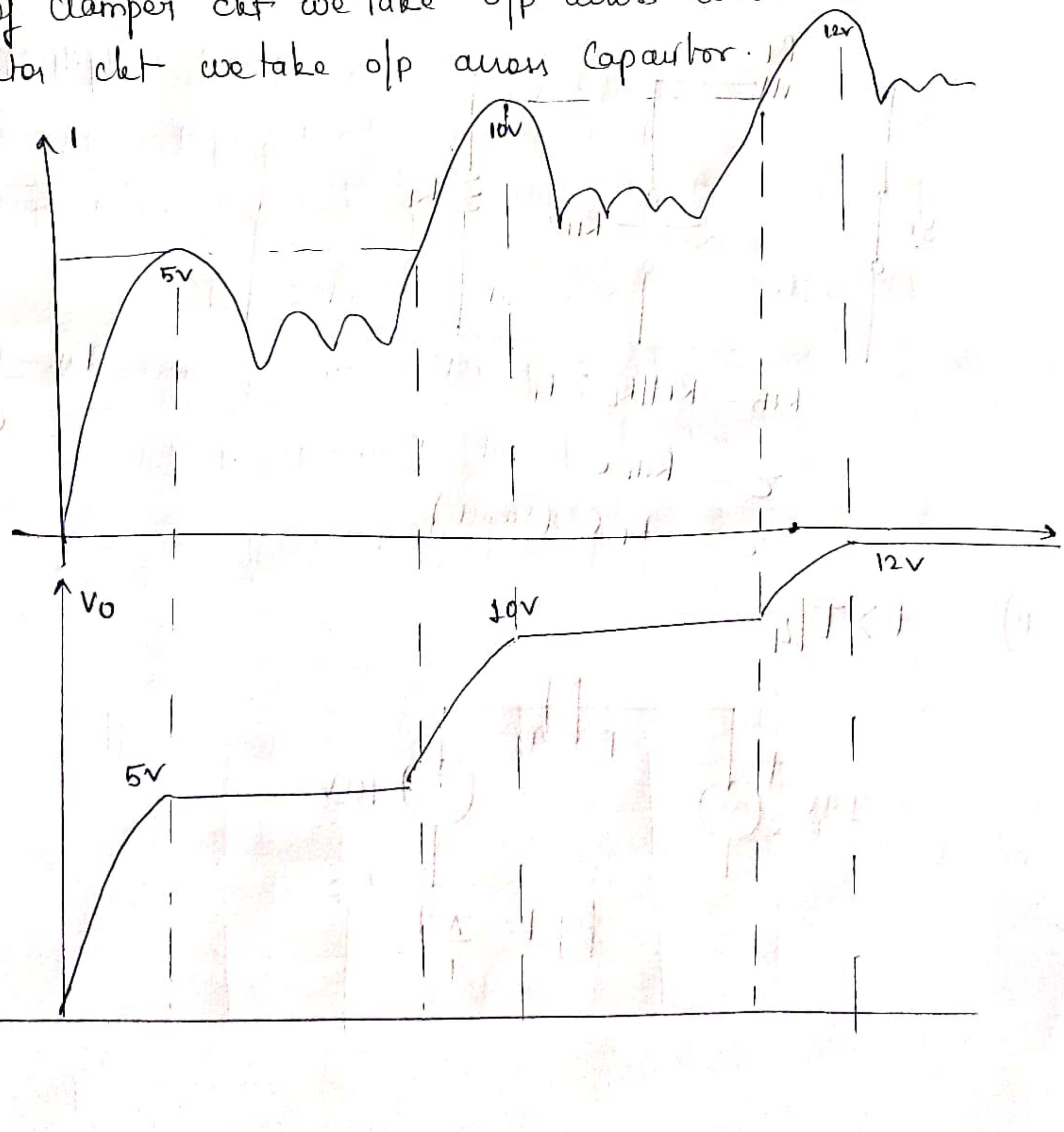
$\tau_d = R_L C$ = High

<u>keypoint</u>: Positive peak detector ckt is used for recovery of message signal from DSB-FC

This ckt is also reffered as envelope detector.

- In case of clamper ckt we take o/p across diode and in detector ckt we take o/p across capacitor.

ex.



* Negative peak Detector Circuit :-

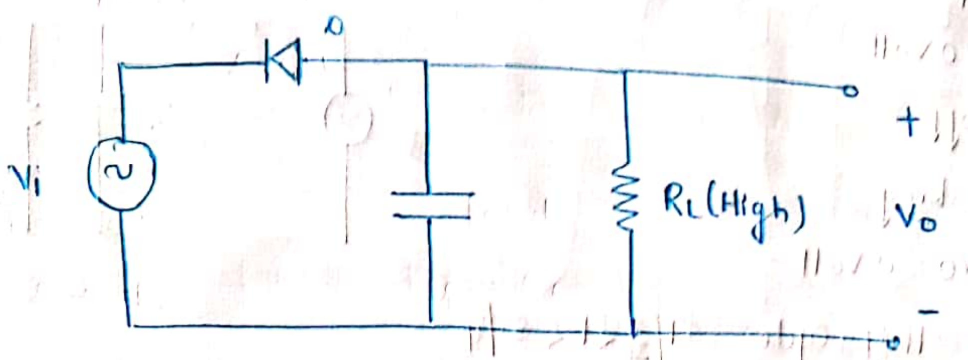


fig. RLC = High { greater than time period of i/p }

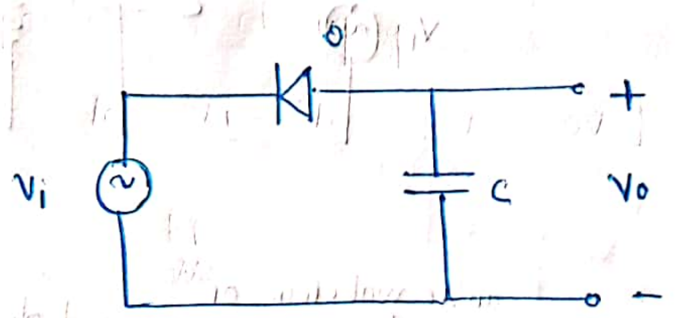
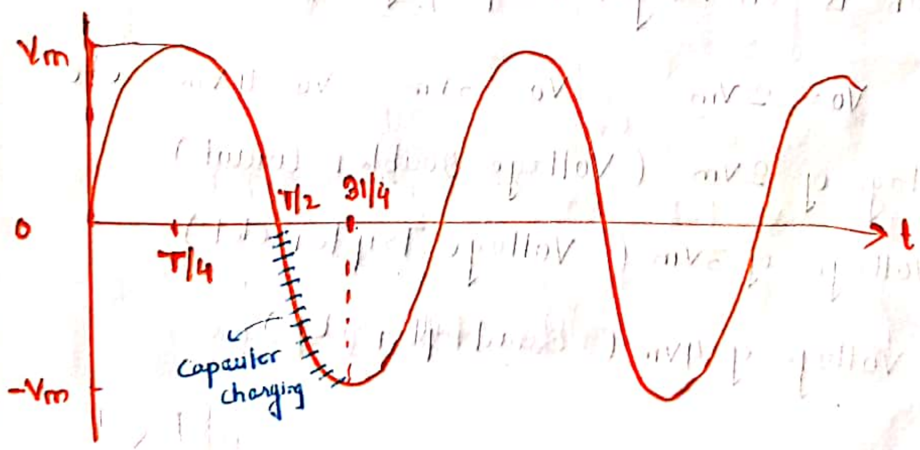
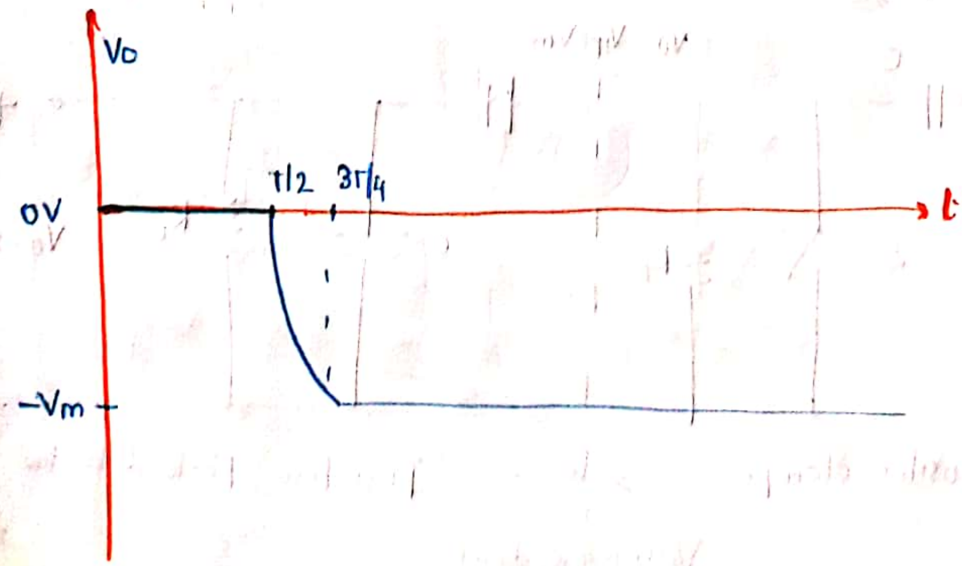


fig Ideal -ve peak detector





During positive Half Cycle $(0 < t < T/2)$

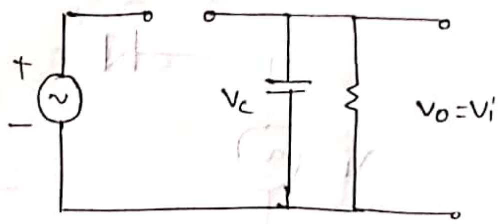
V_i = positive

V_c = 0 Volt

D = off

No working

$V_c = V_O = 0$ Volt

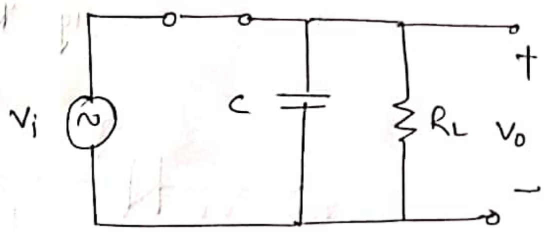


During Negative Half Cycle $T/2 < t < 3T/4$

Diode ON

$V_c = V_i$

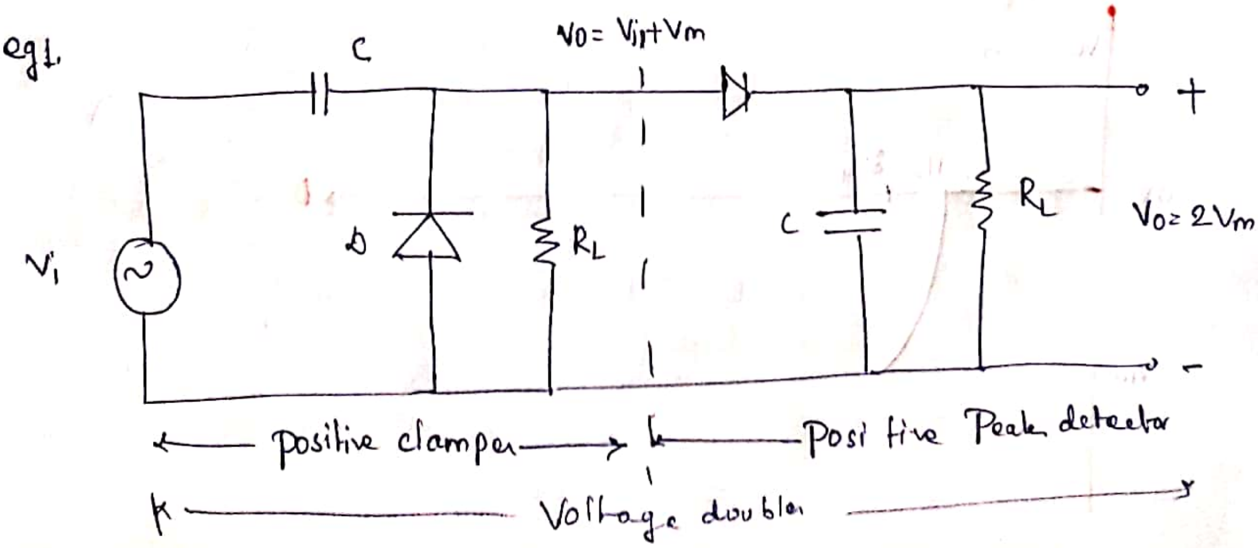
$V_O = V_c = V_i$



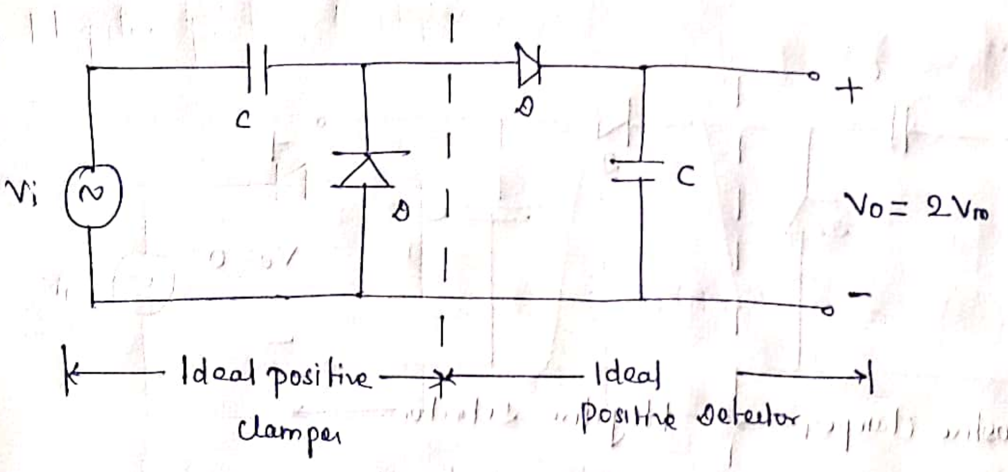
* Voltage Multiplier Circuit

- A Circuit whose input waveform is an AC wakeform of peak Value V_m and o/p is DC Voltage which is an Integer multiple of peak AC input that means, $V_o = 2V_m$, $V_o = 3V_m$, $V_o = 4V_m$ etc.
- If V_o = DC Voltage of $2V_m$ (Voltage doubler Circuit)
- If V_o = DC Voltage of $3V_m$ (Voltage Tripler Ckt).
- If V_o = DC Voltage of $4V_m$ (Quadrapler ckt)

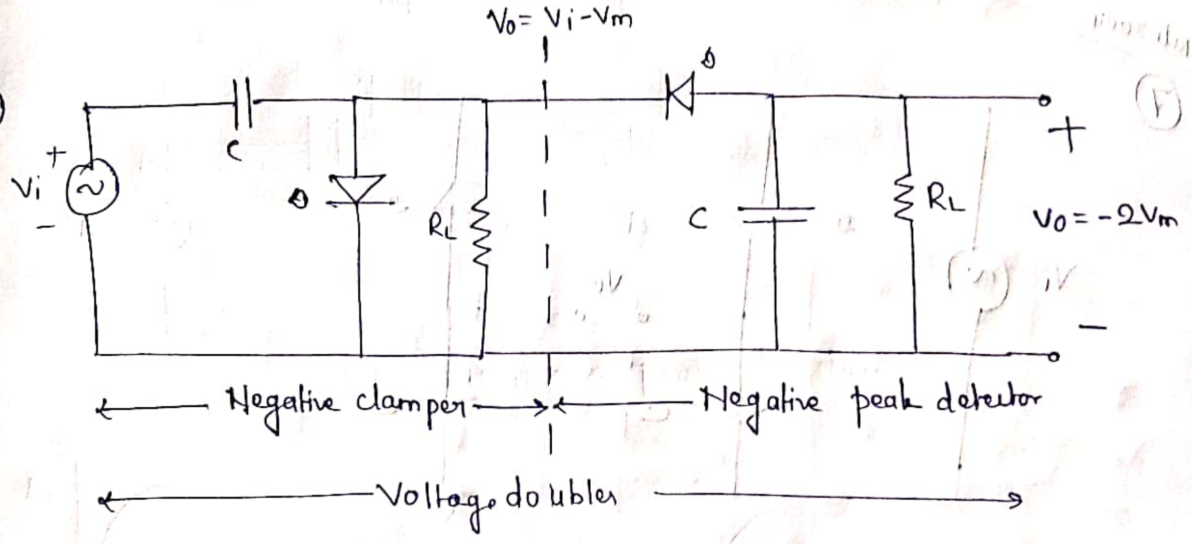
eg1.



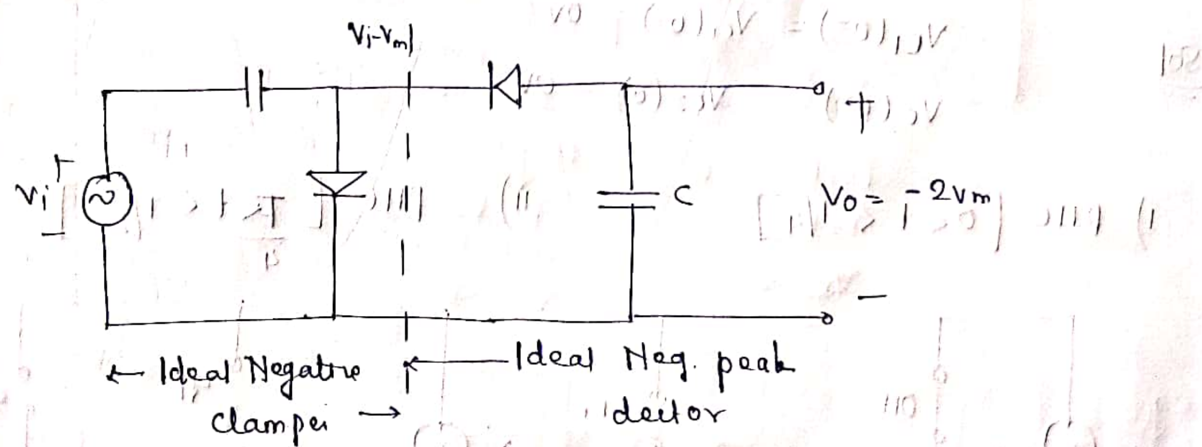
(2)


C
D
Vi
D
C
+
Vo = 2Vm
−
Ideal positive clamper
Ideal positive detector

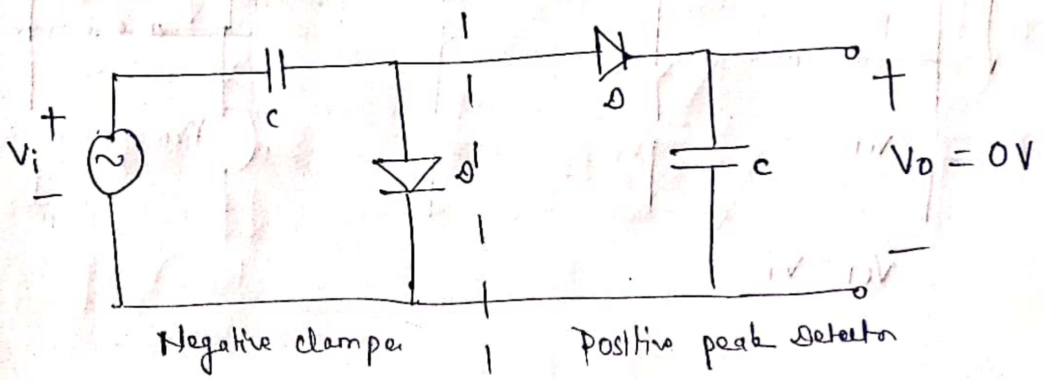
(3)


Vo = Vi − Vm
D
C
Vi
+
−
D
RL
C
RL
+
Vo = −2Vm
−
Negative clamper
Negative peak detector
Voltage doubler

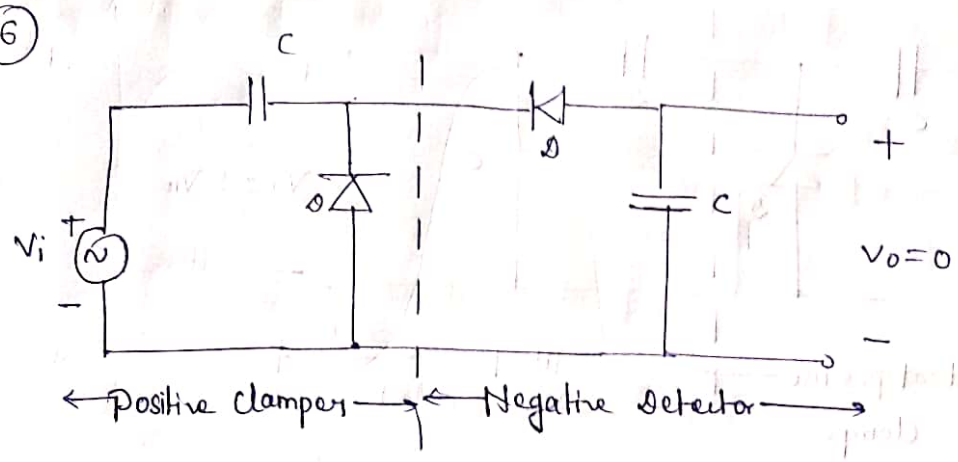
(4)


Vi − Vm
Vi
+
−
C
+
Vo = −2vm
−
Ideal Negative clamper
Ideal Neg. peak detector

(5)

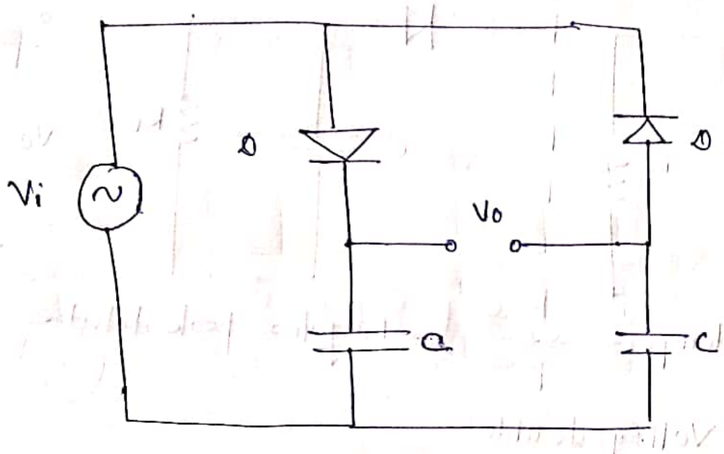

C
D
Vi
+
−
D
c
+
Vo = 0V
−
Negative clamper
Positive peak detector

(6)



Gate 2004

(7)

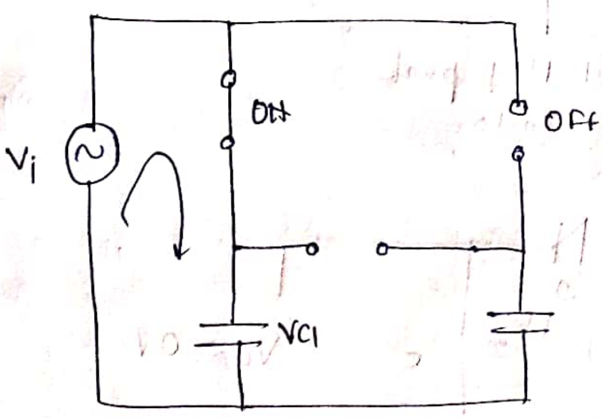


Sol

$V_{C_1}(0^-) = V_{C_1}(0) = 0V$

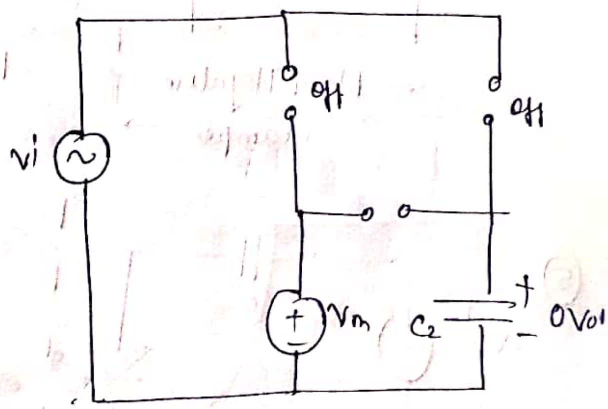
$V_{C_2}(0^-) = V_{C_2}(0) = 0V$

1) PHC $[0 < t < T/4]$



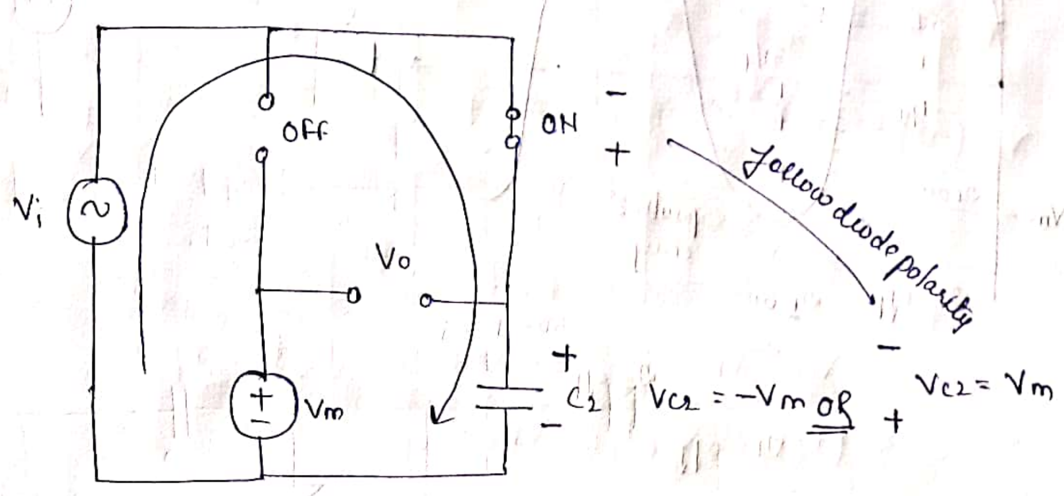
$V_{C1} = V_i$

11) PHC $[\frac{T}{4} < t < T/2]$



D_1 Can never ON because Capacitor is charged to Max^m of V_i

During Negative Half Cycle $\frac{T}{2} < t < 3T/4$



$V_{C2} = -V_m$ or $V_{C2} = V_m$

$$-V_i + 0 + V_{C2} = 0$$

$$V_{C2} = V_i$$

$$V_{C2}(3T/4) = -V_m$$

After $t = 3T/4$ V_{C2} always $-V_m$

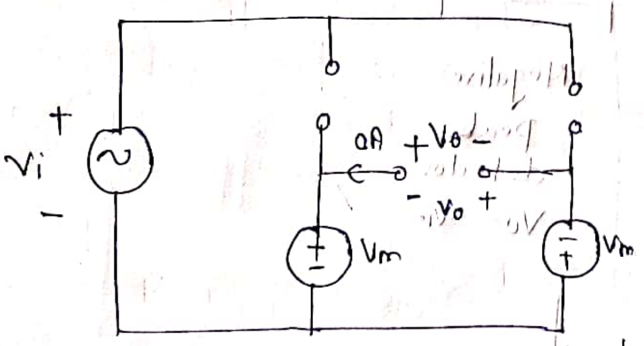
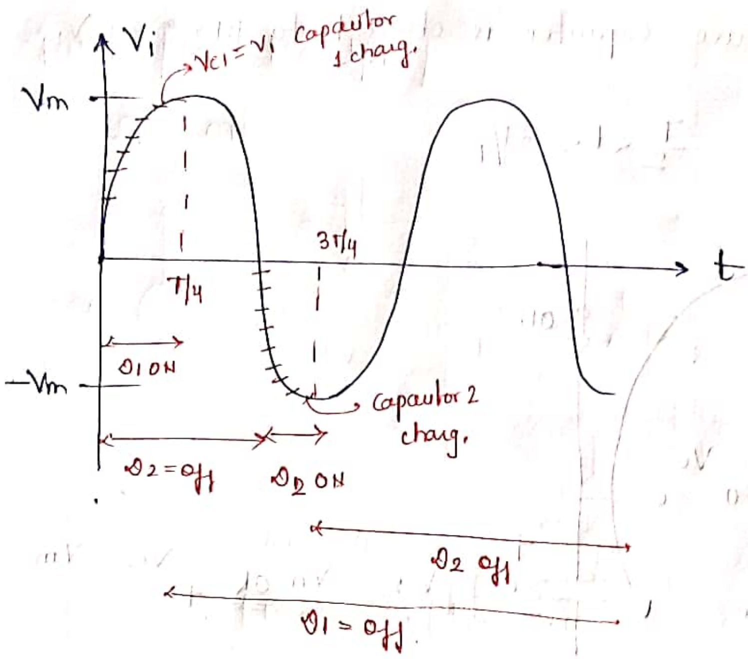


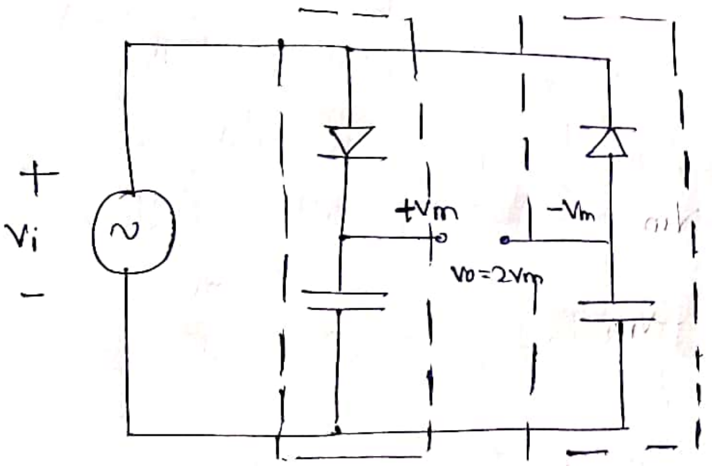
fig $t > 3T/4$ steady state figure

$$-V_m + V_o - V_m = 0$$

$$V_o = 2V_m$$

This ckt is a Voltage doubler





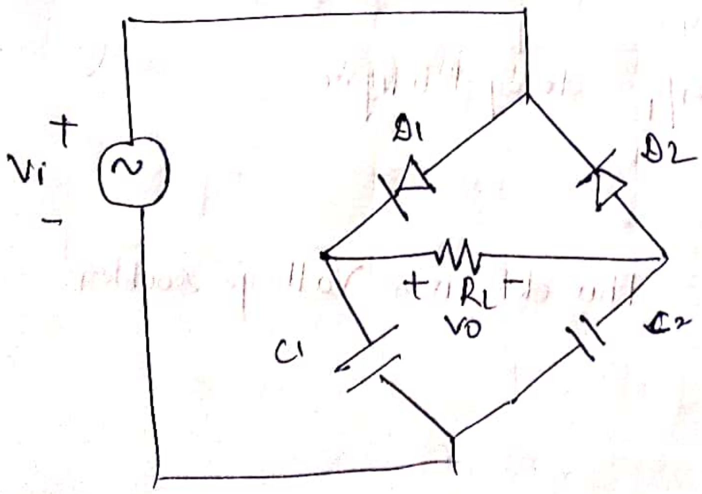
Positive peak Detector

$V_{o1} = V_m$

Negative Peak detector

$V_{o2} = -V_m$

eg(8)



Voltage doubler

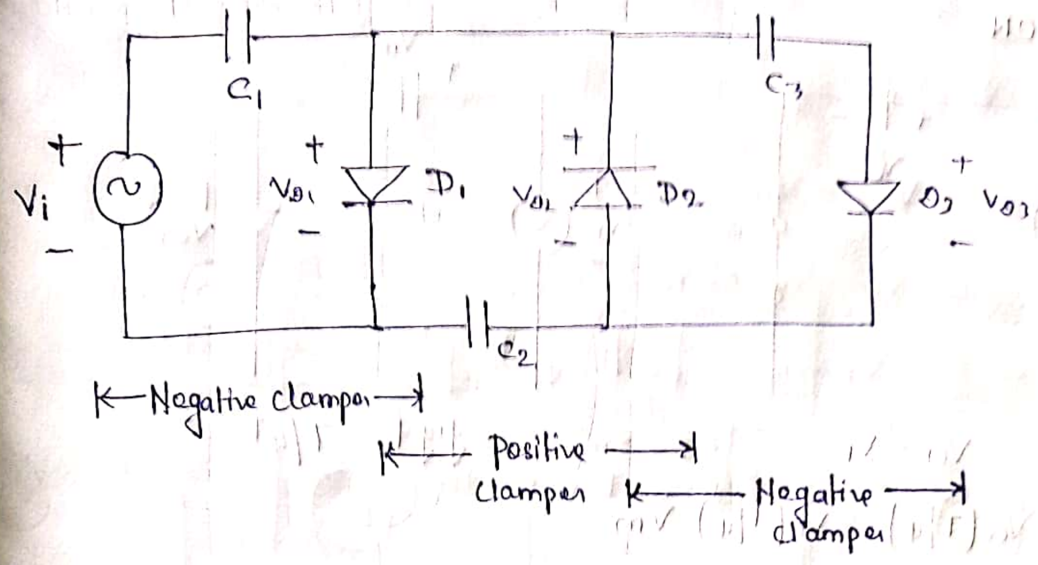
$V_o = 2V_m$

Same as previous figure

R_L Very High

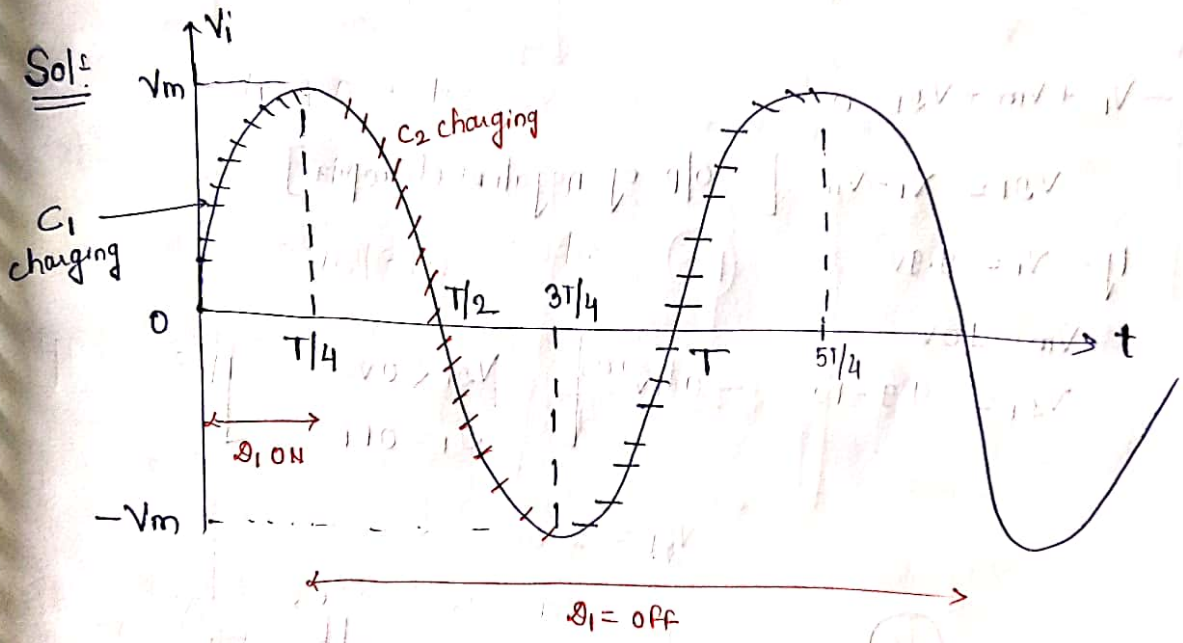
Current Very small

eg ⑨



C1
C3
C2
Vi
V01
D1
V02
D2
D3
V03
← Negative clamper →
← Positive clamper →
← Negative clamper →

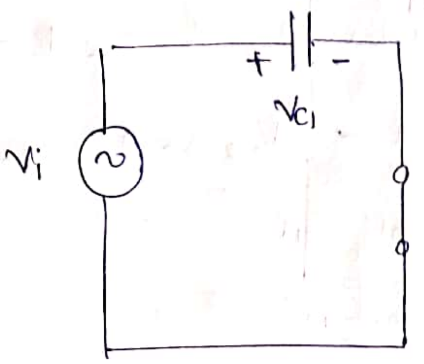
Sol:

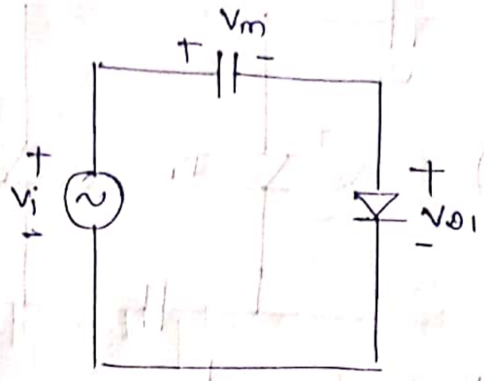


Vi
Vm
C2 charging
C1 charging
0
T/4
T/2
3T/4
T
5T/4
t
D1 ON
-Vm
D1 = OFF

PHC $[0 < t < T/4]$

$D_1 = ON$





$V_{C1} = V_i$

fig $t = T/4^{+}$

$V_{C1}(T/4) = V_i(T/4) = V_m$

$-V_i + V_m + V_{D1} = 0$

$V_{D1} = V_i - V_m$ [o/p of negative clamper]

If, $V_i = 9.9V$

$V_m = 10V$

$V_{D1} = 9.9 - 10 = -0.1V$ [$V_{D1} < 0V$, $D_1 = Off$]

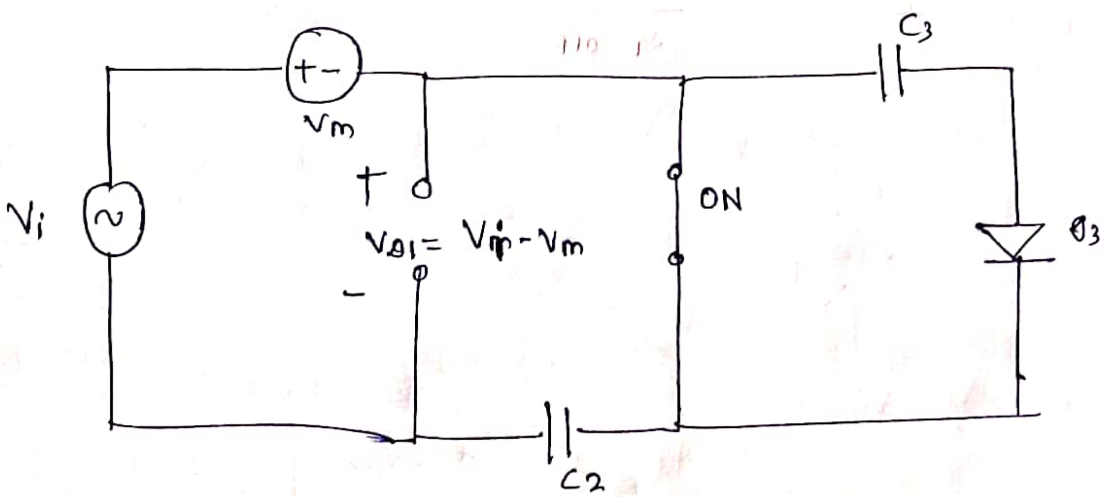


fig $t > T/4$

$\frac{T}{4} < t < 3T/4$

$-V_{D1} + 0 - V_{C2} = 0$

$V_{C2} = -V_{D1}$

$\Rightarrow V_{C2} = V_m - V_i$

$V_{C2}(T/4) = V_m - V_i(T/4)$

$= V_m - V_m$

$= 0V$

$V_{C2}(3T/4) = V_m - V_i(3T/4)$

$= V_m - (-V_m)$

$= 2V_m$

At $t = 3T/4^+$

$-V_{D1} + V_{D2} - V_{C2} = 0$

$V_{D2} = V_{D1} + V_{C2}$

$= V_i + V_m + 2V_m$

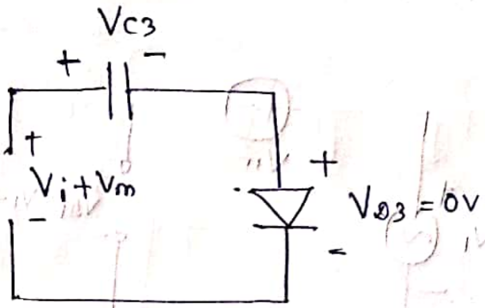
$V_{D2} = V_i + V_m$

At $t > 3T/4$

$V_{D3} = V_{D2}$

$D_3 = ON$, $D_2 = off$

C_3 is charging



$-(V_i + V_m) + V_{C3} + V_{D3} = 0$

$V_{C3} = V_i + V_m$

$V_{C3}(5T/4) = V_m + V_m$

$= 2V_m$

Scanned by CamScanner

At $t = \frac{5T}{4}^{+}$

$$-V_{O2} + V_{C3} + V_{O3} = 0$$

$$V_{O3} = V_{O2} - V_{C3}$$

$$V_{O3} = V_i + V_m - 2V_m$$

$$V_{O3} = V_i - V_m$$ [o/p of Negative clamper ckt]

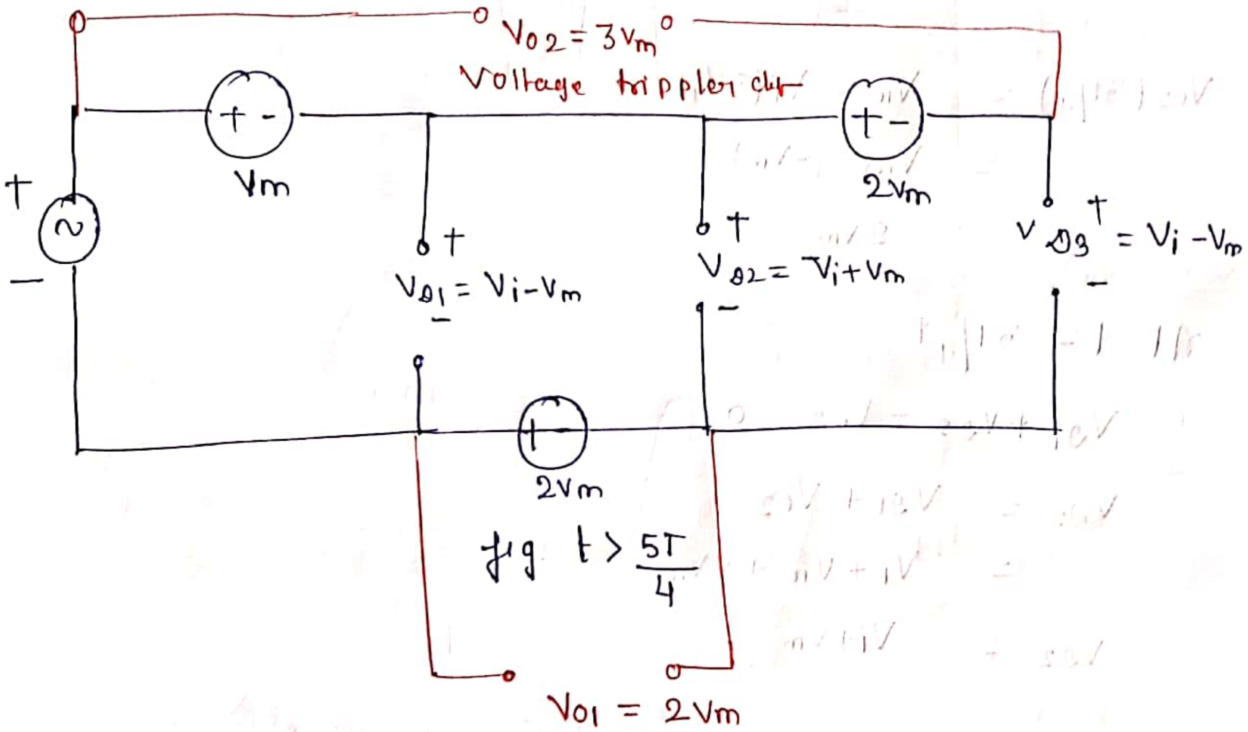
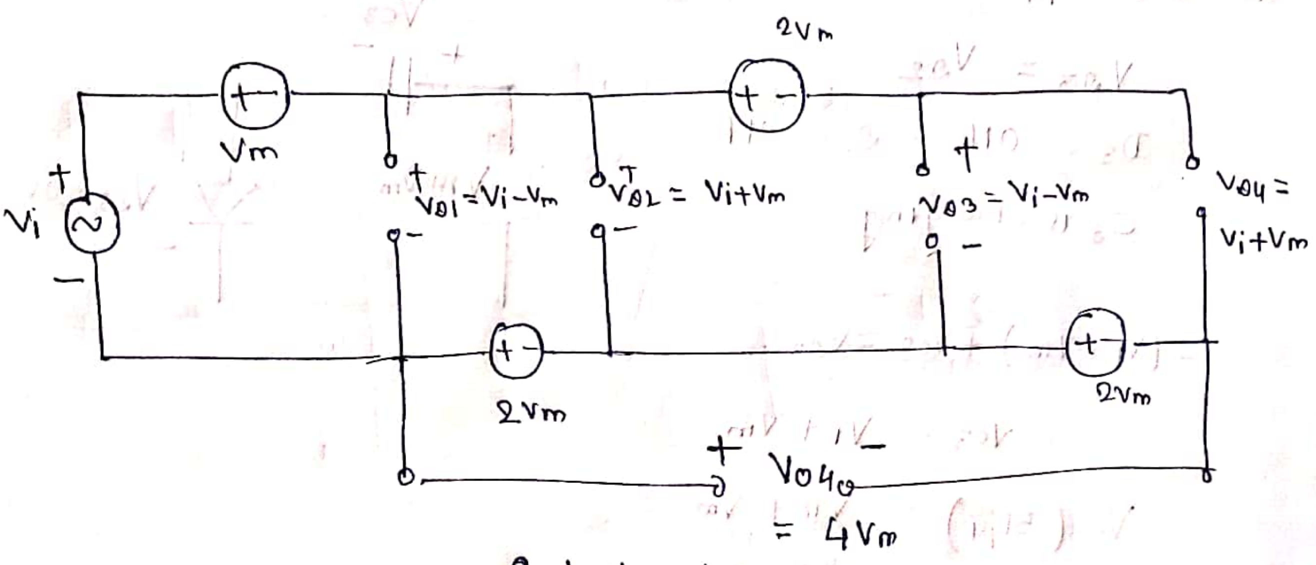


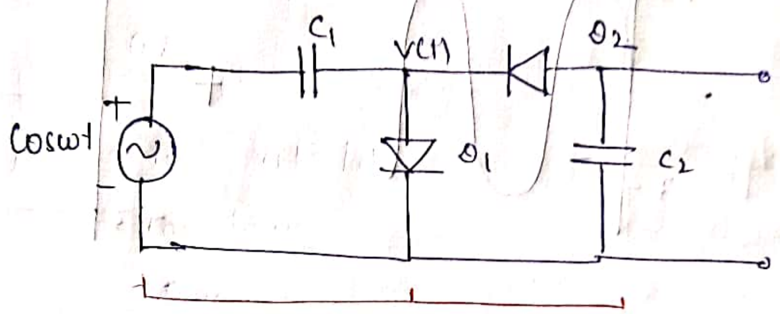
fig $t > \frac{5T}{4}$



Qudrpler ckt

Q7.
Sol $RC >> T$

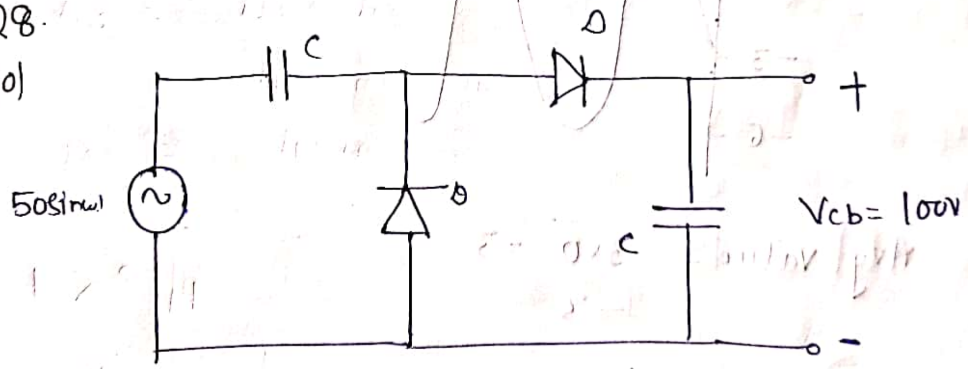
Q6.
Sol The diode and Capacitors in the ckt shown are Ideal.
The Voltage $v(t)$ across D_1 is



Negative clample Negative peak detector

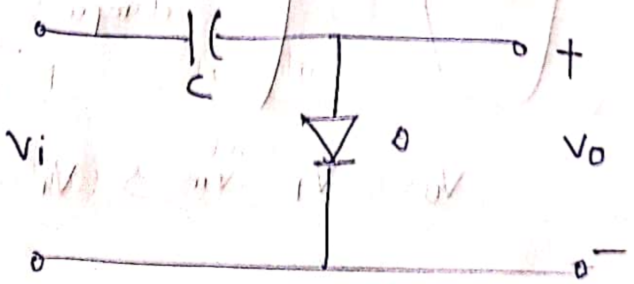
$v(t) = \cos\omega t - 1$ $\{ V_i - V_m \}$

Q8.
Sol



positive clamper Positive peak Detector
$V_{01} = 50\sin\omega t + 50$

Q2.
Sol $V_i = 4 + 3\sin\omega t$



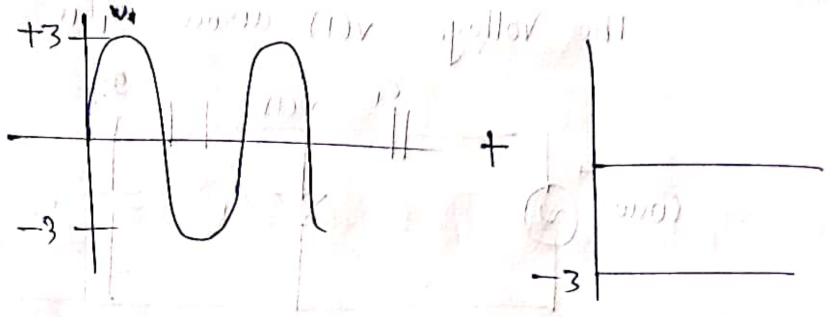
By Concept 1) :- Capacitor blocks 4v dc

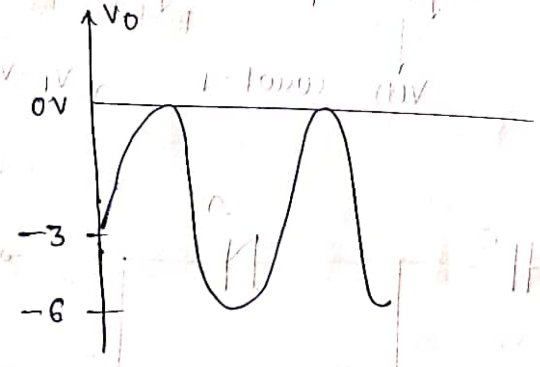
$V_i = 4 + 3\sin\omega t$

The ckt is negative clamper

$V_o = V_i - V_m$

$V_o = 3\sin\omega t - 3$



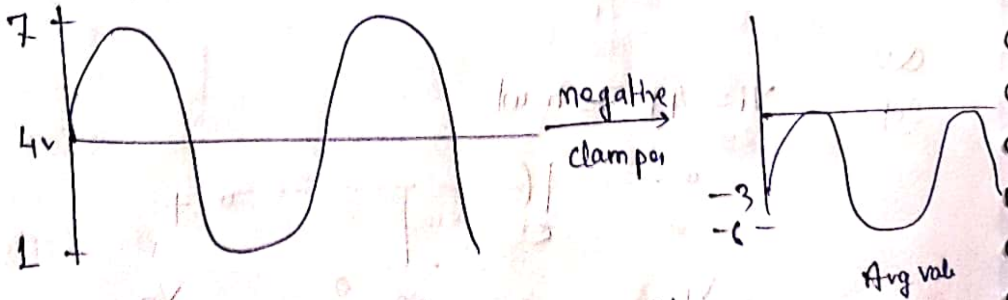


Avg value $= 3\times 0 - 3$

$= -3$

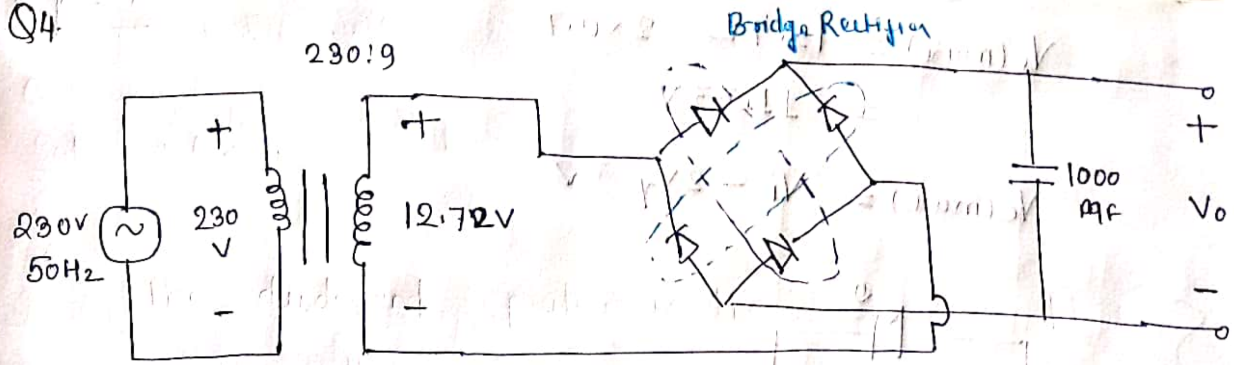
By Concept 2) without blocking 4v dc

$V_i = 4 + 3\sin\omega t$



$V_o = V_i - V_m \Rightarrow V_i - 7$

Q4.



$V_p(rms) = 230V$

$$\frac{V_p(rms)}{V_s(rms)} = \frac{230}{9}$$

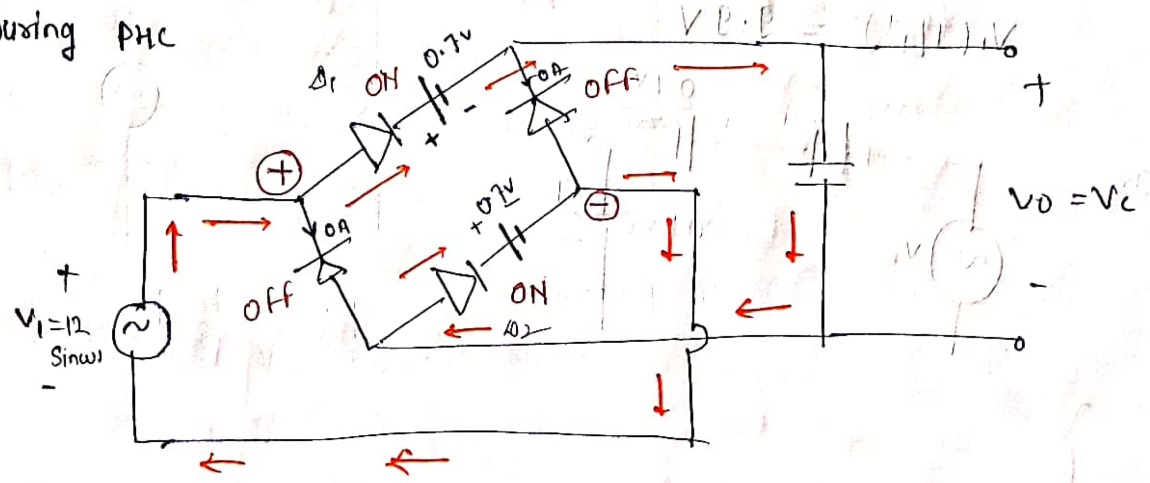
$$\frac{230}{V_s(rms)} = \frac{230}{9}$$

$$V_s(rms) = 9$$

$$V_s(peak) = 9\sqrt{2} = 12.72 \text{ Volt}$$

Given :- Diode Cut-in Voltage 0.7V

1) During PHC



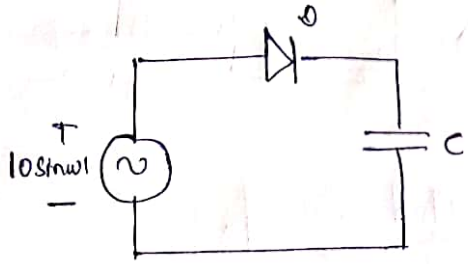
$$-V_i + 0.7 + V_c + 0.7 = 0$$

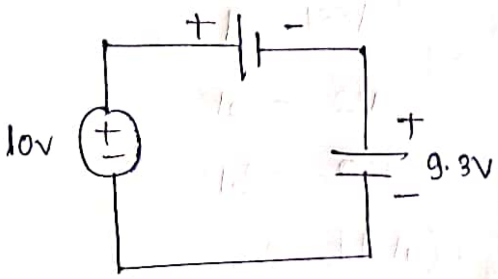
$$V_i = V_c + 1.4$$

$$V_c = V_i - 2V_\gamma$$

$$V_{c(max)} = 12.72 - 2 \times 0.7$$
$$= 11.33\,V$$

$$V_{c(max)} = V_i - 2V_\gamma \quad ✓$$



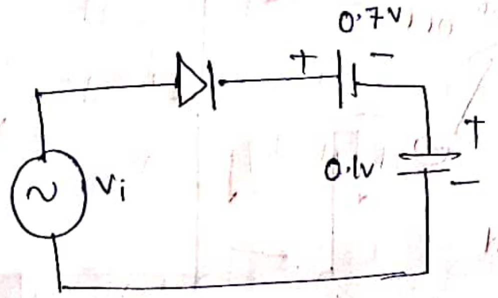


$$V_c(T/4) = 9.3V$$

$$V_c(T/4)^+ = 9.3\,V$$

$$\Rightarrow \quad V_i(T/4^+) = 9.9\,V$$

or



$$t = \frac{T}{4}^+$$

$$V_c(T/4) = 11.33\,V$$

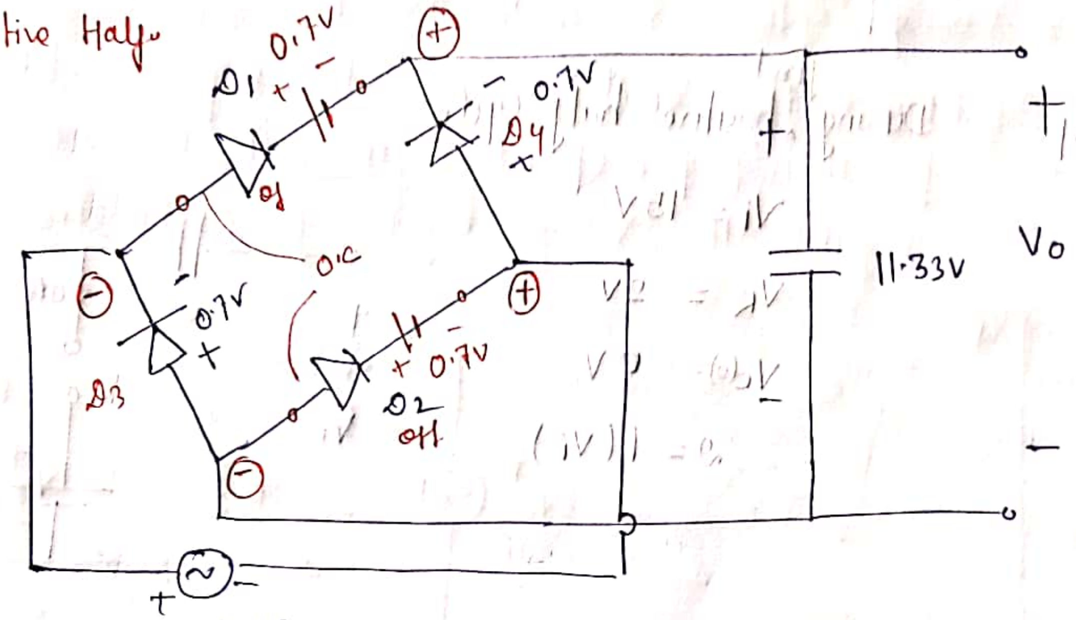
$V_i(T/4^+) = 12.69V$

$V_i(T/4^+) > V_c(T/4^-)$

D_1 = ON X

D_2 = ON X

During Negative Half cycle



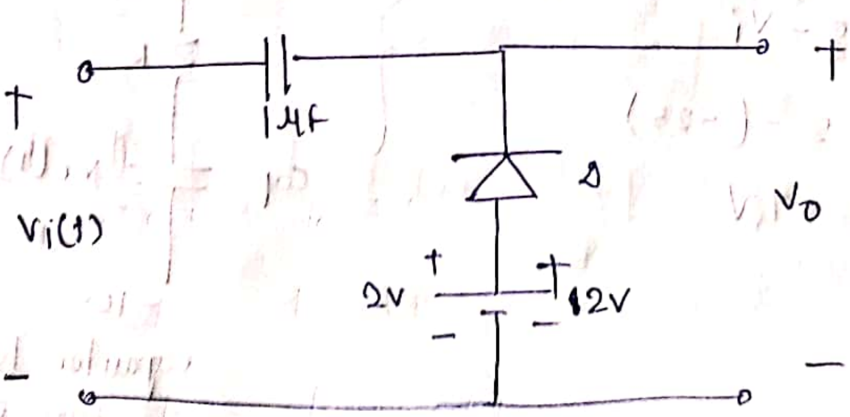
D_1 - Capacitor - D_2 are in Series

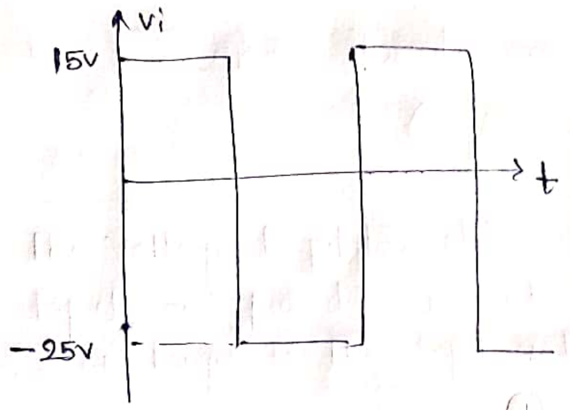
$0.7 + 11.33 + 0.7 = 12.72$

Diode D_3 & D_4 will not Conduct

$V_0 = 11.33$ V

Que. Draw o/p wave for for given below figure





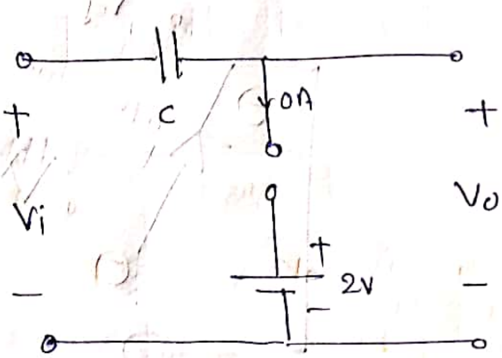
Sol: During first positive half cycle

$V_i = 15V$

$V_R = 2V$

$V_c(0) = 0V$

$\theta = f(V_i)$



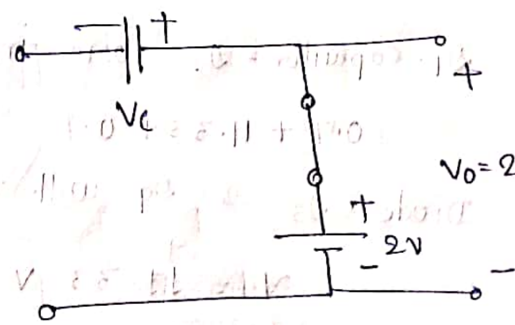
During first NHC

$V_i = -25V$

$V_R = 2V$

$V_c(T/2) = 0V$

$\theta = f(V_i / V_R)$

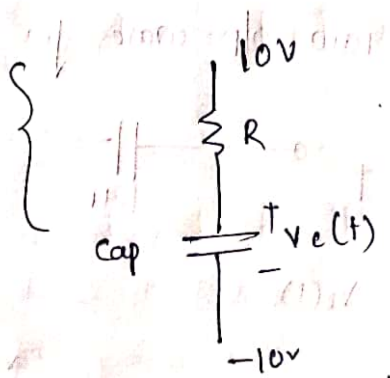


$-V_i - V_c + 2$

$V_c = 2 - V_i$

$V_c = 2 - (-25)$

$= 27V$



$V_c = 20V$

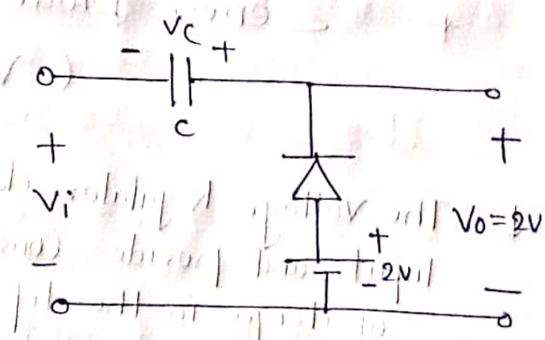
Capacitor take charge from every possible source.

During Second PHC

$$-V_i - V_c + V_o = 0$$

$$-15 - 27 + V_o = 0$$

$$V_o = 42\,V$$



After $V_o = 42$

D = off

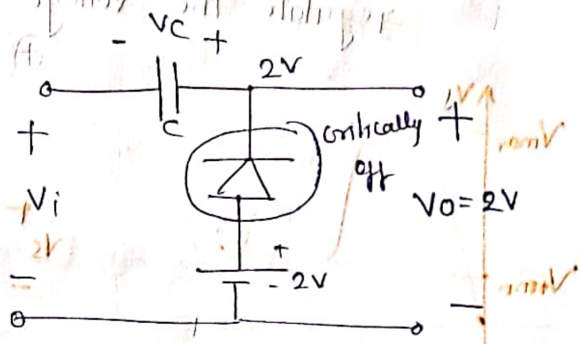
Second Negative Half Cycle

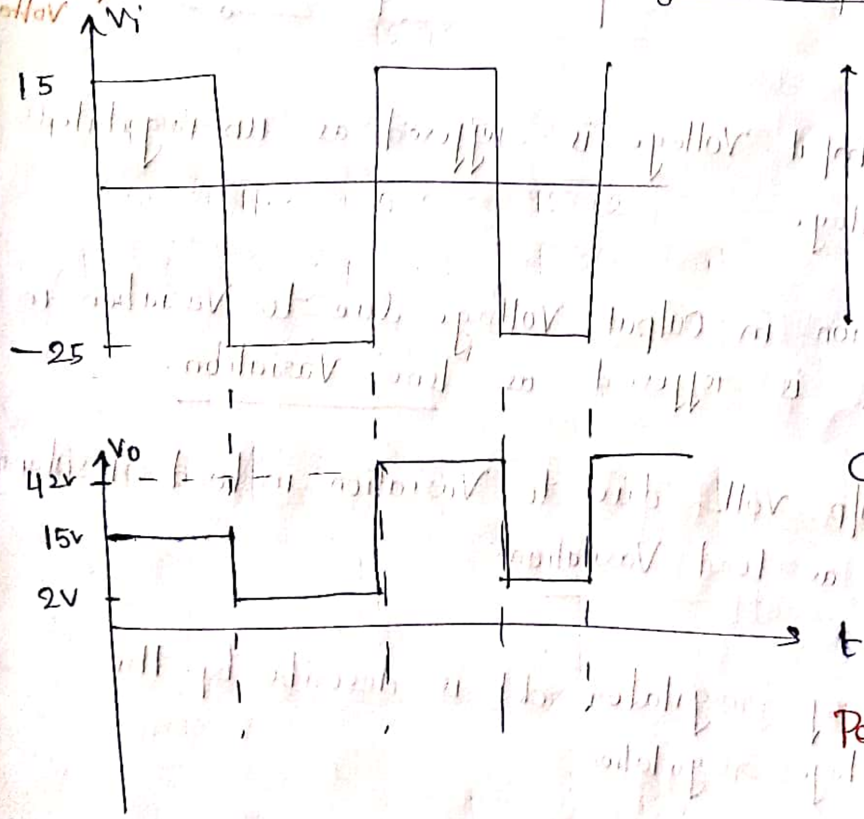
$$-V_i - V_c + V_o = 0$$

$$V_o = V_i + V_c$$

$$V_o = -25 + 27$$

$$V_o = 2V$$





Peak to peak 40V

Clamper o/p

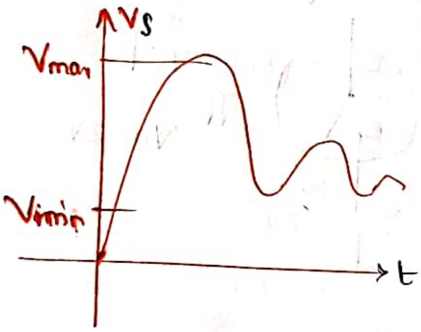
Peak to Peak 40V

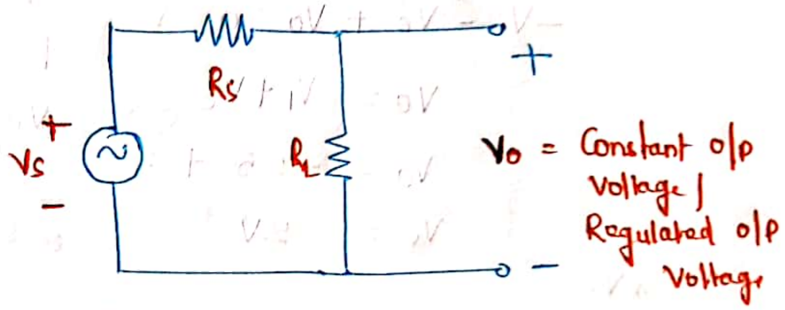
Peak to peak same in clamper ckt

* Zener Diode as a Regulator Circuit (Voltage Regulator)

1. The Voltage Regulator ckt accept unregulated DC as an Input and provide Constant DC Output Voltage Irrespective of changes in the Input Voltage and Load Current.

2. Most of the electronic Circuit require stable DC Voltage for their proper operation. Hence it is necessary to regulate the Voltage before giving into the electronic ckt.





3. Time Varying Input Voltage is reffered as unregulated DC Supply Voltage.

4. ~~Vary~~ Variation in Output Voltage due to Variation in Input Voltage is reffered as <u>line Variation</u>.

5. Variation in o/p Volt due to Variation in load resistance is reffered as <u>Load Variation</u>.

6. Performance of regulator ckt is describe by the percentage regulation.

7. Percentage Regulation is defined by :-

$$\%R = \frac{V_o[NL] - V_o[FL]}{V_o[FL]} \times 100$$

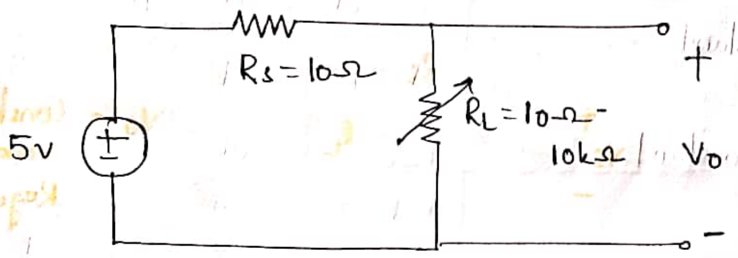
$V_o[NL]$:- $R_L = \infty$

$I_L = 0A$

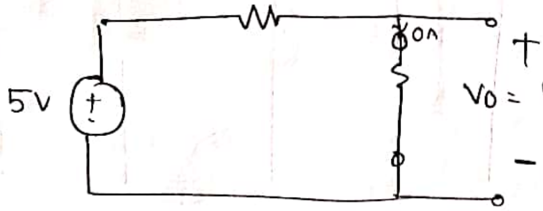
$V_o[FL]$:- $R_{L\,min}$

$I_L = max$

eg

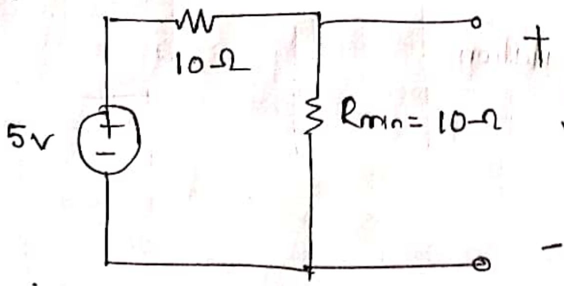


$V_o[NL]$:-



$V_o = 5V = V_o(max)$

$V_o[FL]$:-



$V_o = \frac{5 \times 10}{20} = 2.5V$

$$\%R = \frac{V_o(NL) - V_o(FL)}{V_o(FL)} \times 100$$

$$= \frac{5 - 2.5}{2.5} \times 100 = 100\%$$

Percentage Regulatⁿ $\% R$

8. For better performance of a Regulator ckt $\% R$ should be as Low as possible.

Ideally $V_o[FL] = V_o[NL]$

$$\% R = 0\%$$

* Concept of line Regulation:

i) $R_L =$ fixed

ii) $V_{in} =$ Variable

iii) $V_o = I_L R_L$

$V_o =$ Constant

$\downarrow$

$I_L =$ Constant

Line Regulation

i) $V_{in} =$ Variable

ii) $V_o =$ Constant

Line Variation

i) $V_{in} =$ Variable

ii) $V_o =$ Variable

* Concept of Load Regulation:

i) $R_L =$ Variable

ii) $V_{in} =$ fixed

iii) $V_o = I_L R_L$

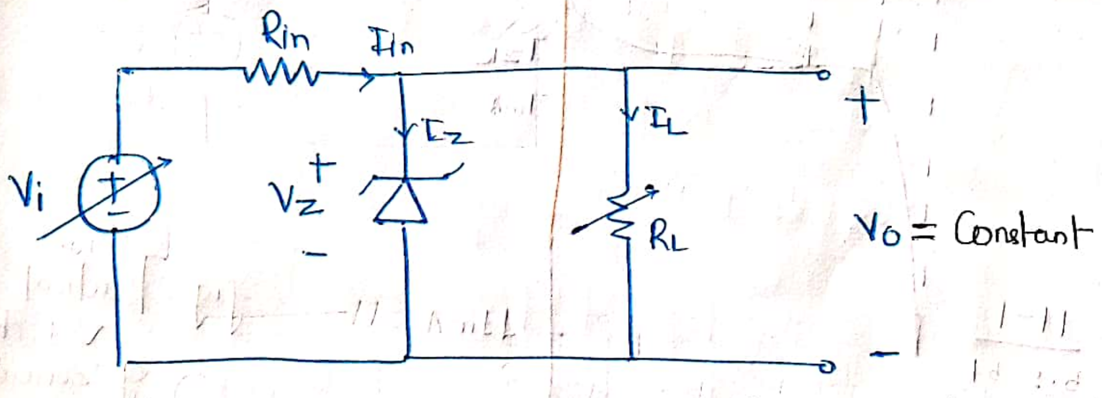
$V_o =$ Const

$R_L \uparrow \; I_L \downarrow$ $\qquad$ $R_L \downarrow \; I_L \uparrow$

Types of Voltage Regulator

- Zener Diode Voltage Regulator
- BJT Voltage Regulator
  - BJT Series Voltage Regulator
  - BJT Shunt Volt. Regulator
- IC Regulator
  - 78 Series (positive Reg.)
  - 79 Seri. (Neg. Reg.)

* Zener Diode Voltage Regulator Circuit :-



- Zener diode is Called Voltage Regulator diode if it maintain Constant Voltage across load.
- Zener diode is used in reverse bias region under this Condition the Current through Zener diode is Very Small when Sufficient Voltage is applied the Zener breakdown occurs. (Zener diode Conducts) and the large Current flow through the Zener diode.
- Zener knee Current I_{ZK} represent Minimum Zener Current which is required to breakdown the Zener diode.

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- The Voltage at which Zener diode Conducts is Called Zener Voltage V_Z. Under this Condition Voltage across Zener is Constant and it is equal to V_Z.
- As V_Z is Connected across the load and load Volt. V_o is equal to Zener Voltage. So Zener diode act as a Voltage Regulator $(V_o = V_Z)$
- V_Z is almost Constant but not exactly Constant.

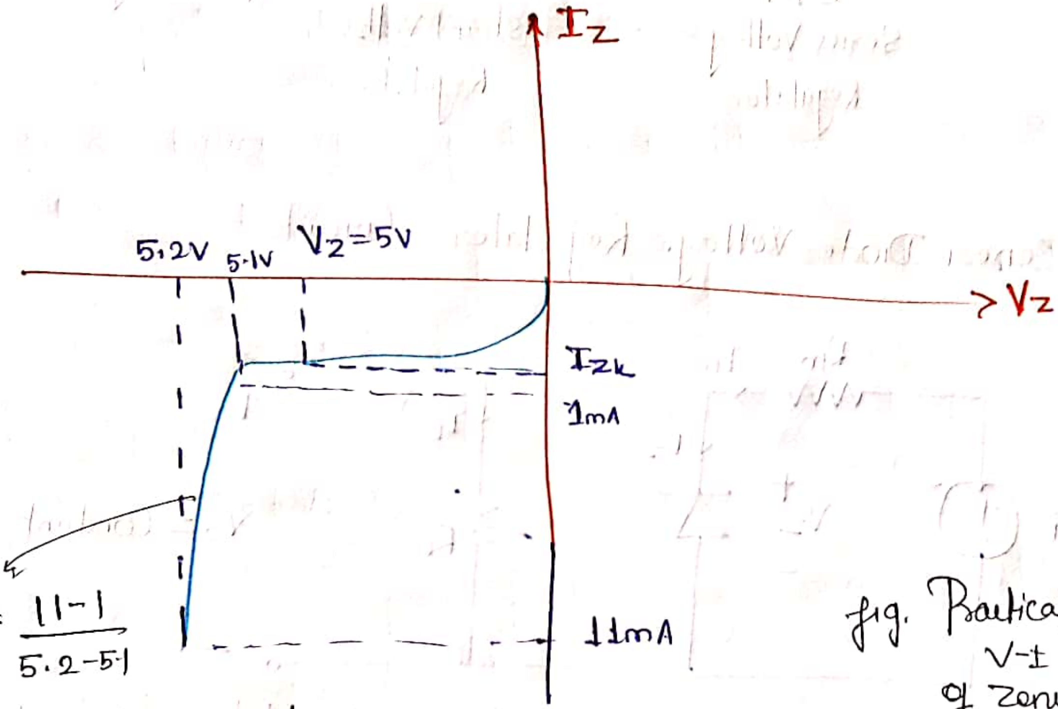


fig. Practical V-I charc. of Zener diode

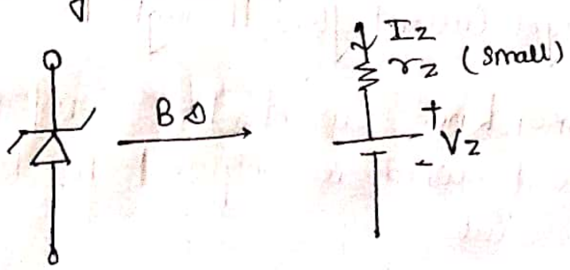
$$\text{slope} = \frac{11-1}{5.2-5.1}$$

$$\text{slope} = 100\,mA/V = 1/r_Z$$

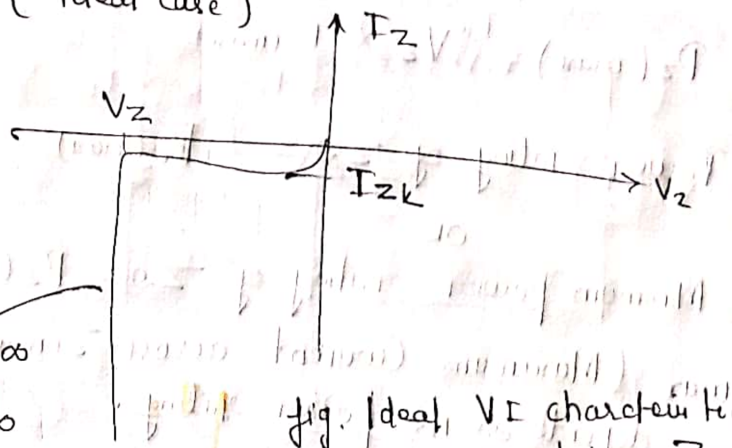
r_Z = Zener Resistance in BD region

$$r_Z = \frac{1}{\text{slope}} = \frac{1}{100} = \frac{1000}{100} = 10\,\Omega \text{ (small)}$$

- Practical equivalent ckt of Zener diode in break down region is given by -



- If Zener Resistance R_Z is not given then assume $R_Z = 0\,\Omega$ (Ideal Case)



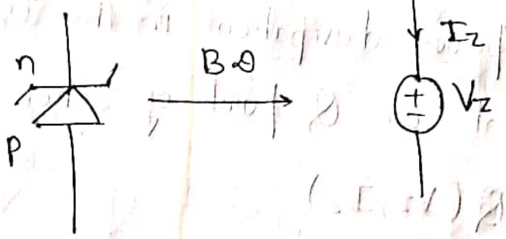
slope $= \infty$

$\frac{1}{r_Z} = \infty$

$r_Z = 0$

fig. Ideal VI characteristic of Breakdown Zener diode

- Ideal equivalent ckt of Zener diode in breakdown Region is given by



<u>Range of parameter</u> :-

$I_{Lmin} < I_L < I_{Lmax}$

$I_{Zmin} < I_Z < I_{Zmax}$

$R_{Lmin} < R_L < R_{Lmax}$

$V_{in\,min} < V_{in} < V_{in\,max}$

* If I_{Zmin} is not given then we can assume $I_{Zmin} = I_{ZK} = 0A$
* If I_{Lmin} is not given then we can assume $I_{Lmin} = 0$ (conditional)

- Power dissipation across Zener diode is given by

$$P_Z = V_Z I_Z \text{ W}$$

$$P_{z(min)} = V_z \times I_{z(min)}$$

$$P_z(max) = V_z \times I_{z(max)}$$

Power rating of ZD = $P_z(max)$

OR

Minimum power rating of ZD = $P_z(max)$

- I_z max (Maximum Current across Zener diode) depends on its power rating.

- The power Rating of any device is Maximum allowed Power dissipation.

- For any device minimum power rating should be equal to Maximum power dissipation in the device.

- Operating point or Q point of zener diode is given by $Q(V_z, I_z)$

- Zener diode is a special purpose diode having greater power handling capablity.

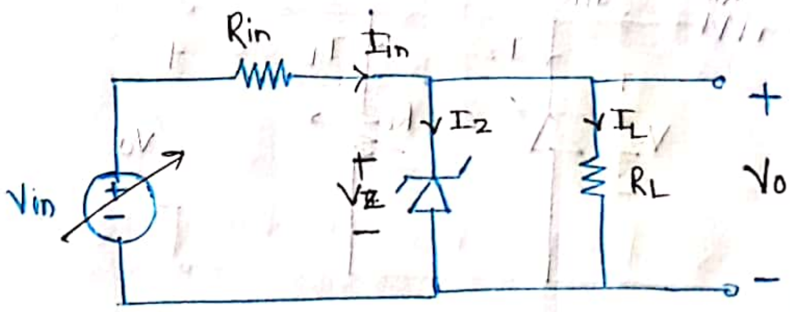
- Heavily doped Zener diode have low breakdown Voltage and breakdown occur with Zener process.

- Lightly doped Zener diode have high breakdown Volt & breakdown occur with Avalanche process.

- Since Zener diode and ~~Z~~ Load resistance is Connected in shunt So Circuit is known as shunt Regulator.

- In Zener diode shunt Regulator ckt Rin represent Current limiting resistance which prevent flow of Heavy Current through Zener diode

Case I Line Regulation (V_{in} = Varying, R_L = fixed)



$$I_{in} = \frac{V_{in} - V_Z}{R_{in}} \quad \text{——} (1)$$

$$I_{in} = I_L + I_Z \quad \text{——} (2)$$

$$\frac{V_{in} - V_Z}{R_{in}} = I_Z + I_L \text{ (fixed)} \quad \text{——} (3)$$

$$\frac{V_{in(min)} - V_Z}{R_{in}} = I_{in(min)} = I_{Z(min)} + I_{L(fix)} \quad \text{——} (4)$$

$$\frac{V_{in(max)} - V_Z}{R_{in}} = I_{in(max)} = I_{Z(max)} + I_{L(fix)} \quad \text{——} (5)$$

Points:- 1) It is a process of Maintaining DC output Voltage Constant irrespective of Variation in Line Voltage.

ii) In Line Regulation, Load Current is assumed to be Constant.

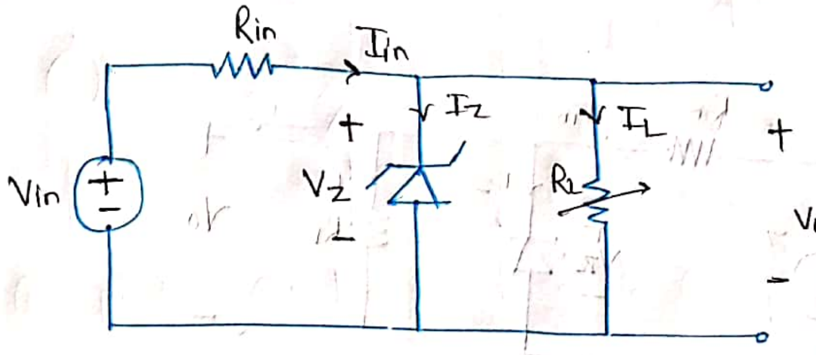
iii) Minimum Input Voltage provide Minimum Input Current and Minimum Input Current provide Minimum Zener Current

iv) Max. I/p Volts provide Max I/p current & Max I/p current provide Max. Zener Current.

v) In Case $I_{Z(min)}$ is not given then assume

$$I_{Zmin} = 0$$

Case II Load Regulation (V_{in} = fixed, R_L = Variable)



$$I_{in} = \frac{V_{in} - V_z}{R_{in}} \quad \text{--- (1)}$$

$$I_{in} = I_z + I_{L(var)} \quad \text{--- (2)}$$

$$\frac{V_{in} - V_z}{R_{in}} = I_z + I_{L(var)} \quad \text{--- (3)}$$

$$\frac{V_{in(fix)} - V_z}{R_{in}} = I_{in(fix)} = I_{z(max)} + I_{L(min)} \quad \text{--- (4)}$$

$$\frac{V_{in(fix)} - V_z}{R_{in}} = I_{in(fix)} = I_{z(min)} + I_{L(max)} \quad \text{--- (5)}$$

Keypoint :- i) It is the process of Maintaining DC o/p Voltage Constant irrespective of Variation in Load Current

ii) In Load Regulation line Voltage or i/p voltage is assumed to be Constant.

iii) $V_o = I_L R_L$ = constant

$$I_L = \frac{V_o}{R_L}$$

$$I_{L\,min} = \frac{V_o}{R_{L(max)}} \qquad I_{L\,max} = \frac{V_o}{R_{L(min)}}$$

In Case of no Load Condition $R_L = \infty$ that means

$I_{Lmin} = 0$

* Concept of Breakdown :-

Initially Z = Reverse bias | O.C

$$V_o = V_{in} \frac{R_L}{R_{in}+R_L}$$

when $V_o > V_Z$

Z = B.D

$$V_{in} \frac{R_L}{R_{in}+R_L} > V_Z$$

$$\Rightarrow V_{in} > V_Z \left[\frac{R_{in}+R_L}{R_L}\right]$$

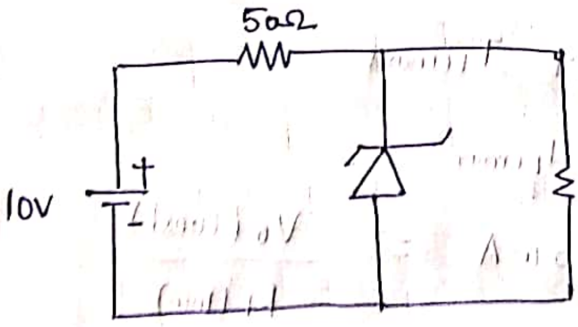
Ckt designing

① $R_L >> R_{in}$ $\Rightarrow$ $V_{in} > V_Z$

② $R_L = \infty$ $\Rightarrow$ $V_{in} > V_Z$

GEC 92

Que1.



6V zener diode

knee Current 5mA

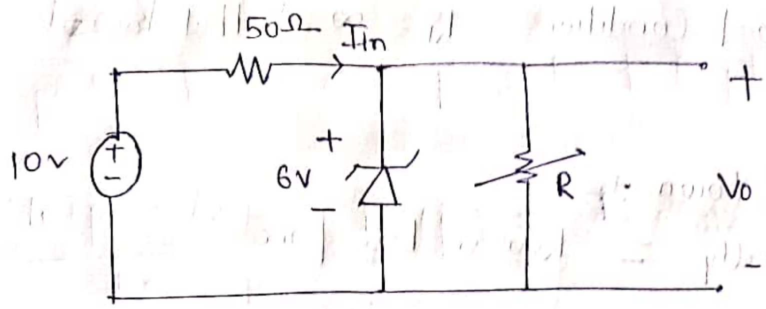
Sol Given, $r_Z = 0$

Zener knee Current = Min knee Current = 5mA

$V_Z = 6V$

Min. value of R for

output Volt. = 6V (Constant)



This Concept is Question is based on Concept of Load Regulatn.

$$\frac{V_{in(fix)} - V_Z}{R_{in}} = I_{in(fix)} = I_{Z(max)} + I_{L(min)}$$

$$\frac{V_{in(fix)} - V_Z}{R_{in}} = I_{in(fix)} = I_{Z(min)} + I_{L(max)}$$

$$I_{in(fix)} = \frac{V_{in(fix)} - V_Z}{R_{in}}$$

$$= \frac{10 - 6}{50} = \frac{4}{50} = 0.08\ A$$

$$I_{in(fix)} = 80mA$$

$$80 = I_{Z(min)} + I_{L(max)}$$

$$= 5 + I_{L(max)}$$

$$I_{L\,max} = 75mA = \frac{V_o\ (const)}{R_{L(min)}}$$

$$R_{L(min)} = \frac{V_o\ (const)}{75mA}$$

$$= \frac{6}{75mA} = \frac{6000}{75}$$

$$R_{L(min)} = 80\Omega$$ //.

Concept:

$$V_{in} > V_Z \left[\frac{R_L + R_{in}}{R_L} \right]$$

$$V_{in} > V_Z \left[\frac{80 + 50}{80} \right]$$

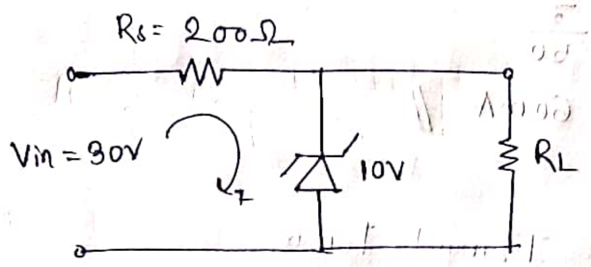
$$V_{in} > 9.75$$

R_L Cannot be Less than 80Ω for Zener diode to work as a Regulator

If $R_L = 50\,\Omega$

$V_o = 5\,\Omega$ (Z = RB) that means no Regulation

Q.2

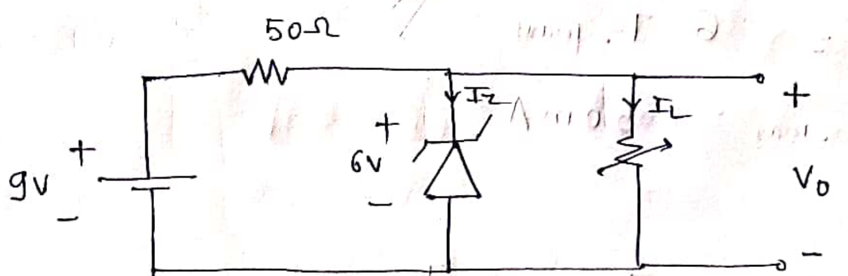


Sol No information of R_L. Assume $R_L = \infty$ Z = BD

$$I = \frac{30 - 10}{200} = \cancel{0.01}\ 0.1$$

$$P = I^2 R = 0.01 \times 200 = 2W$$

Q3.



$I_Z\ min = 5mA$

Max allowed power dissipation of Zener diode = 300mW

$P_Z(max) = 300mW$

$V_Z = V_0 = 6V$

This question based on Concept of Load Regulation

$$\frac{V_{in}(fix) - V_Z}{R_{in}} = I_{in}(fix) = I_{Z(max)} + I_{L(min)}$$

$$\frac{V_{in}(fix) - V_Z}{R_{in}} = I_{in}(fix) = I_{Z(min)} + I_{L(max)}$$

$$I_{in}(fix) = \frac{9-6}{50}$$

$$= \frac{3}{50}$$

$$= 60mA \;//$$

from 2nd eqn

$$60mA = I_{Zmin} + I_{Lmax}$$

$$60 = 5 + I_{Lmax}$$

$$I_{Lmax} = 55mA \;//$$

$$P_{Z(max)} = V_Z \, I_{Z(max)}$$

$$300 = 6 \, I_{Zmax}$$

$$I_{Zmax} = 50mA$$

from (1)

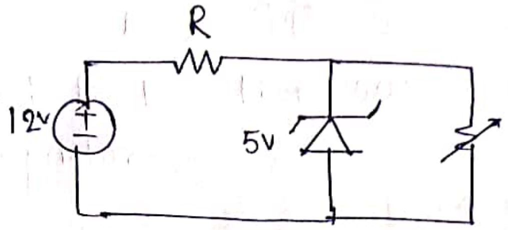
$$I_{in} = I_{Zmax} + I_{Lmin}$$

$$60 - 50 = I_{Lmin}$$

$$I_{Lmin} = 10mA \;//$$

Concept: If P_Z was not given,
then Consider no Load i.e $R_L = \infty$
i.e $I_L(min) = 0\,mA$
Hence In this Case, I_L vary $0\,mA$ to $50\,mA$

Que 6



Variable load 100 to 500 mA

Load Regulation

Sol $I_{Lmin} = 100\,mA$ $I_{Lmax} = 500\,mA$

$r_Z = 0$ $I_Z =$ negligible

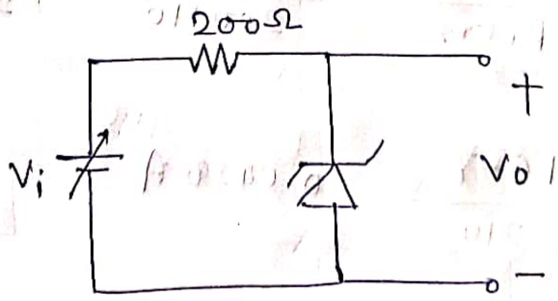
$R = ?$

$I_{in}(fix) = I_{Zmin} + I_{Lmax}$

$\frac{12-5}{R} = 0 + 500$

$R = \frac{12-5}{500\,mA} = \frac{7}{500\,mA} = 14\,\Omega$ //

Que 8



Given $V_i = 10$ to $16\,V$

$R = 200\,\Omega$

$Z = 7V$ (B.D)

Question is based on line Regulation becaz Var i/p Volt

$V_Z = 7V$ $\qquad$ $I_{Z\,min} = 0$

$r_Z = 10\,\Omega$

from fig., $R_L = \infty$ (No load condition)

$R_{L(max)} = \infty$

$I_L = I_{L(min)} = 0\,A$

$$\frac{V_{in} - V_0}{R} = I_{in}$$

$$\frac{V_{in(var)} - V_0}{R} = I_{in(var)}$$

$$I_{in(var)} = I_{Z(var)} + I_{L(fix)}$$

$$I_{in(min)} = I_{Z(min)} + 0$$

$$I_{in(max)} = I_{Z(max)} + 0$$

$$I_{in(min)} = \frac{V_{in(min)} - V_0}{200}$$

$$I_{in\,min} = \frac{V_{in} - V_Z}{R_{int} + r_Z} = \frac{10 - 7}{200 + 10} = \frac{3}{210} = 0.014A$$

also $\quad I_{in\,max} = \dfrac{16 - 7}{210} = 0.0428\,A$

$$V_0 = I_Z \cancel{R}r_Z + V_Z$$

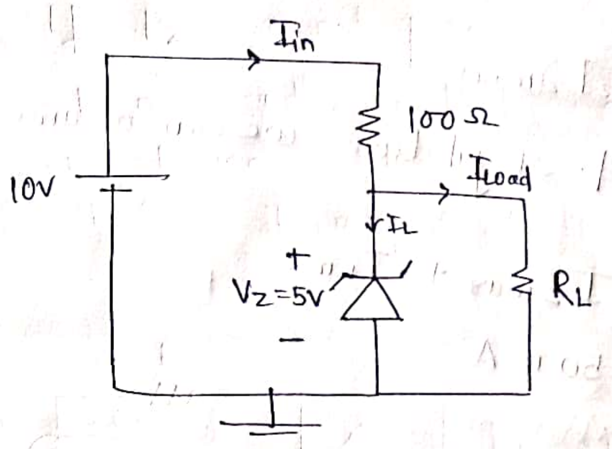
$V_{0min} = 0.014 \times 10 + 7 = 7.14V$

$V_{0max} = 0.042 \times 10 + 7 = 7.428\,V$

Variation due to r_Z

$\underline{\underline{B}}$

Q10.



$I_{Zmin} = 10mA$

$V_0 = 5V$ R_L min = ? & Power Rating of Zener diode in mW

Sol Given $V_Z = 5V$

Load Regulation

$I_{in} = \frac{10-5}{100}$

$I_{in(fix)} = 0.05\ A$

Vin (fix) -

$I_{in\,min} = I_{L_{max}} + I_{Z\,min}$

$0.05 = I_L + 0.010$

$I_{in\,max} = I_Z + I_{L\,max}$ $I_{L\,max}$ $0.05 - 0.010 = 40\,mA$

$V_0 = 5V$

$I_L = \frac{V}{R}$

$R_{min} = \frac{5}{I_{L\,max}} = \frac{5 \times 1000}{40} = 125\Omega$

ii) $P_{Z\,min} = V_Z\, I_{Z\,min}$

$P_{Z\,max} = V_Z\, I_{Z\,max}$

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$P_{z\,max} = V_z I_{z(max)}$

In case of Load regulation we can assume $I_{L\,min} = 0$

$I_{in} = I_{z\,max} + I_{L\,min}$

$I_{z\,max} = 50\ mA$

$P_{z\,max} = 5 \times 50$

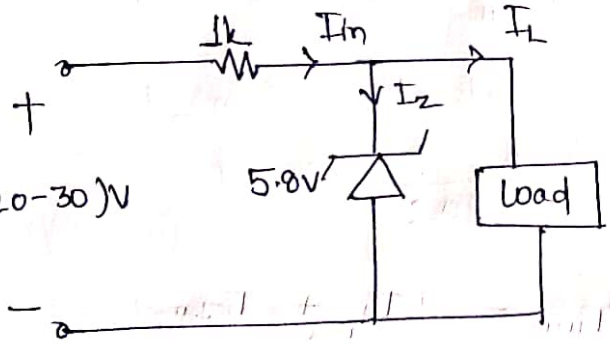
$= 250\,mW$ //.

concept

{ min power of zener diode = $P_{z\,min} = I_{z\,min} V_z$

min power rating of zener diode = $P_{z\,max} = I_{z\,max} V_z$ }

Que7.



Sol $V_z = 5.8\,V$

$I_{z\,min} = 0.5\,mA$

$V_{in} = 20$ to $30\,V$ $\qquad I_{L\,max} = ?$

Line Regulation

$$\frac{V_{in}(var) - 5.8}{1k} = I_{in}$$

$$\frac{V_{in}(min) - 5.8}{1k} = I_{in\,min} = \frac{20 - 5.8}{1k} = 14.2\,mA$$

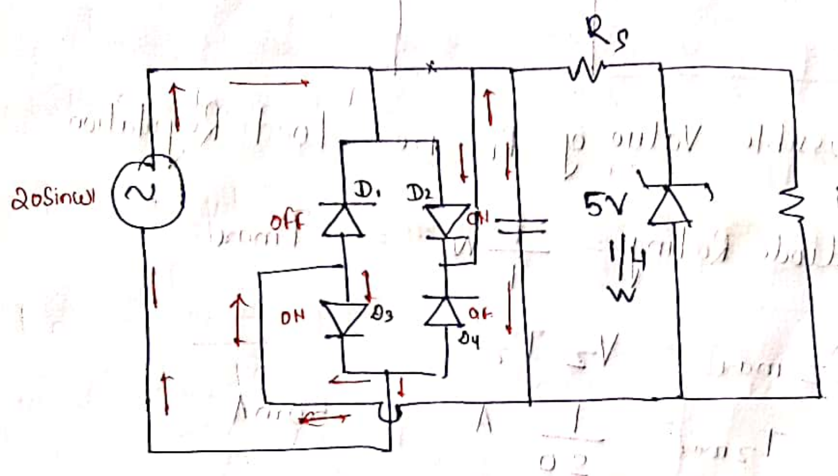
$$\frac{V_{in(max)} - 5.8}{1k} = I_{in(max)} = 24.2\,mA$$

$$I_{in(min)} = I_{zmin} + I_{Lfix} \Rightarrow I_{Lfix} = 14.2 - 0.5 = 13.7\,mA$$

$$I_{in(max)} = I_{zmax} + I_{Lfix}$$

There is no I_{zmax} Hence it can only asked as simply Load current because Load current is fix.

Q11.



At $\frac{T}{4}^{+}$

$$V_c(T/4^{+}) = V_c(T/4) = 20V$$

$$V_{in}(T^{+}/4) \neq V_{in}(T/4)$$

$$V_{in}(T^{+}/4) < 20V$$

D_2 off due to V_c

D_3 off due to V_c

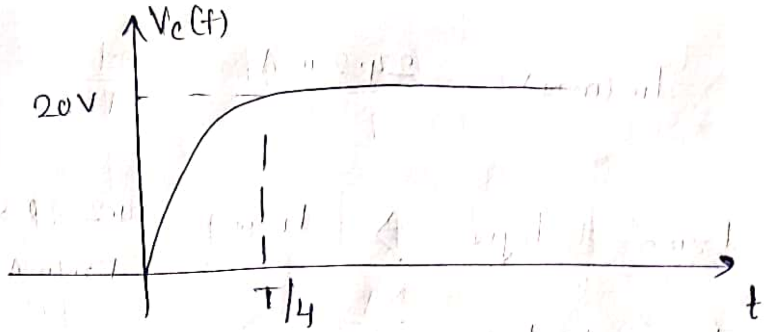
At $T > T/4$ all diode are off.

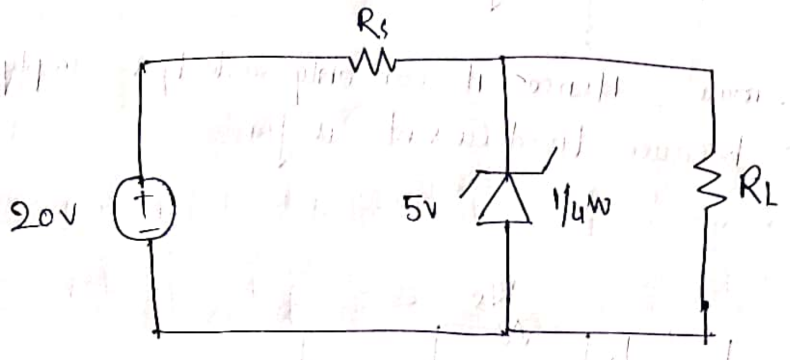
D_1 = off $\quad D_3$ = off

D_2 = off $\quad D_4$ = off

$V_c(\infty) = 20V$

Positive peak detector ckt





consider all possible value of R_L i.e Load Regulation

Zener diode Rating = $\frac{1}{4}$ W = P_{max}

$P_{Z\,max} = V_Z I_Z$

$I_{Z\,max} = \frac{1}{20}$ A = 50mA

$I_{in}(fix) = I_{Z\,min} + I_{L\,max}$

$I_{in}(fix) = I_{Z(max)} + I_{L\,min}$ ✓

$R_L \rightarrow 0$ to $\infty \rightarrow (I_{L\,min}) = 0$

$I_{in}(fix) = I_{Z\,max} + I_{L\,min}$

$= 50mA + 0$

$I_{in}(fix) = 50\,mA$

$\frac{V_{in}(fix) - V_Z}{R_s} = 50\,mA \Rightarrow R_s = \frac{20-5}{50}$

$R_s = 300\,\Omega$ //

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