MODULE-3

14/02/2020

Non-linear ckt — Signal processing ckt

Amp linear ckt = −ve feedback

Non-linear ckt = +ve feedback

Op-amp as Non-linear Circuits:-

1) +ve feedback
2) i/p voltage {Differential i/p}
3) $+V_{sat} \longrightarrow +V_{cc}-1$

   $-V_{sat} \longrightarrow -V_{EE}+1$

   } o/p switches btwn +Vsat & −Vsat

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

$$V_{i\,(diff)\,min} = \frac{\pm V_{cc}}{M_{min}} = \frac{\pm 15V}{50000} = 300\mu V$$

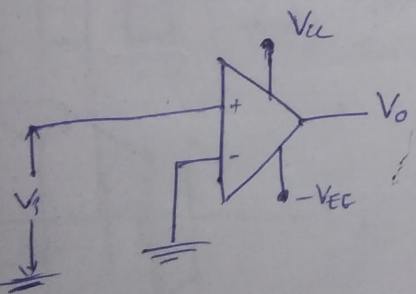
$V_{i(diff)max}$ {depends on supply} $= 2 \times V_{cc}$

1) comparator
2) Schmit Trigger
3) Astable Multivibrator
4) Mono stable Multivibrator

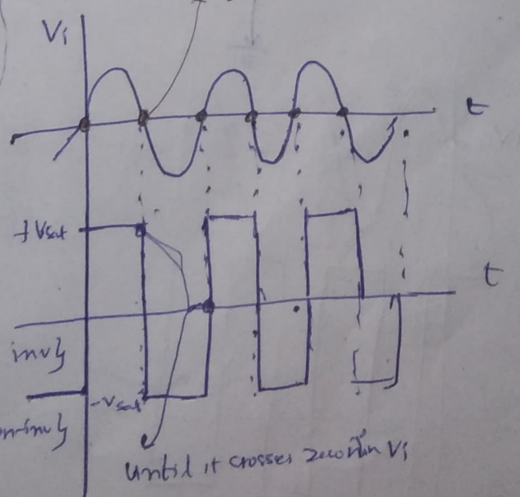
* Comparator:

① Non-inverting zero crossing Detector {ZCD}
② Inverting ZCD.
③ Voltage level detector
④ Capacitor coupled crossing detector

1) Non-inverting ZCD:



Waveform:

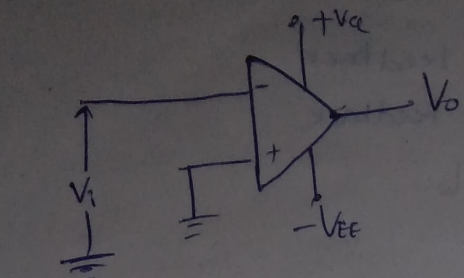


if $V_i > 0$ & $V_i < 0$

$V_i > 0$ $+V_{sat} = V_o$ {non inv > inv}

$V_i < 0$ $-V_{sat} = V_o$ {inv > non-inv}

Inverting ZCD:



if $V_i > 0$

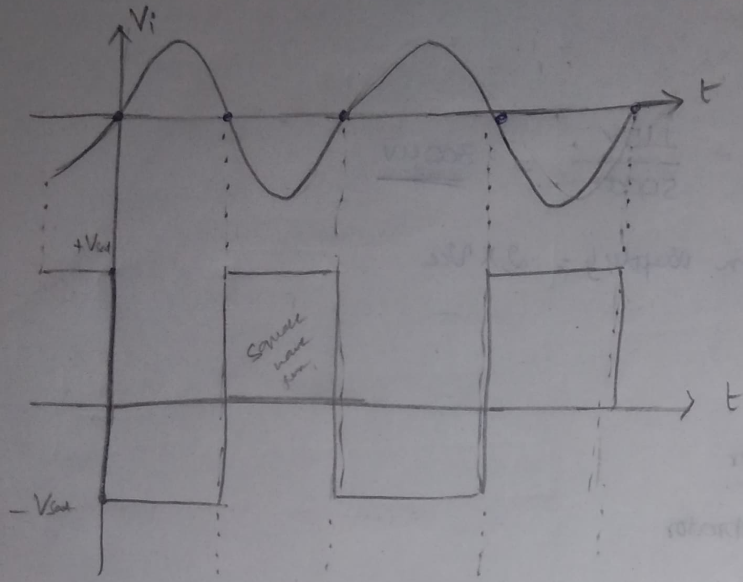
$V_o = -V_{sat}$

if $V_i < 0$

$V_o = +V_{sat}$

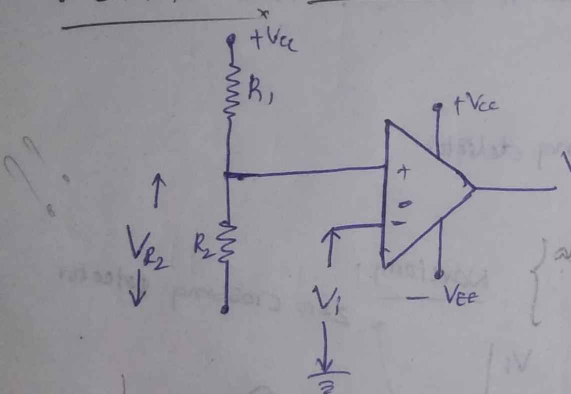
Wave Forms:

• zero crossing detecting



1) Diagram
2) condition (explain)
3) waveform

3) VOLTAGE LEVEL DETECTOR:



1) $V_i > V_{R_2}$

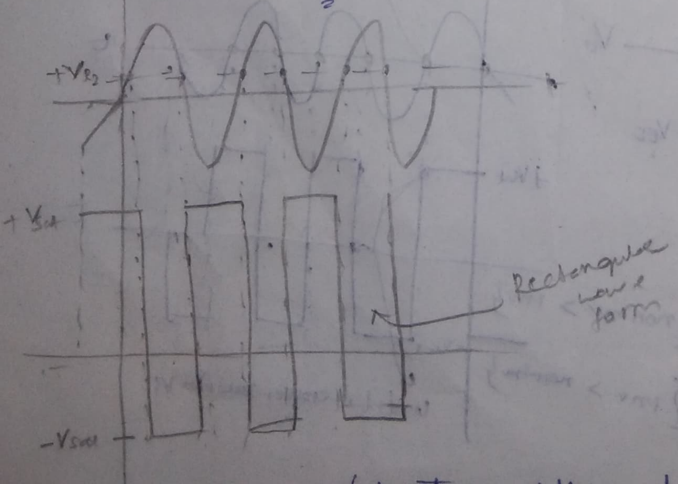
$V_o = -V_{sat}$

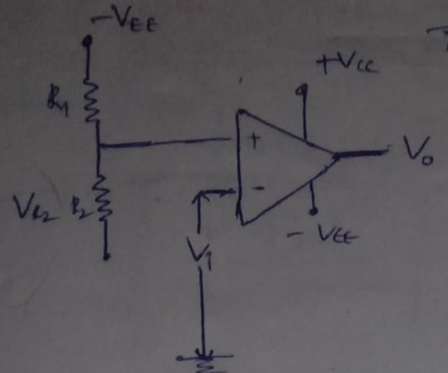
2) $V_i < V_{R_2}$

$V_o = +V_{sat}$

as connected to +Vcc; V_{R_2} is +ve voltage

$V_{R_2} = \frac{V_{cc}}{R_1 + R_2} \times R_2$





1) $V_i > V_{R_2}$

$V_o = -V_{sat}$

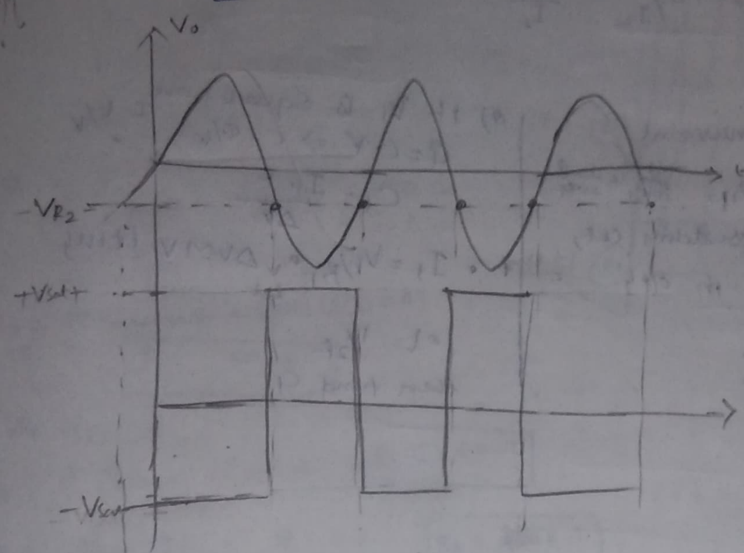
2) $V_i < V_{R_2}$

$V_o = +V_{sat}$

V_i { Applied to inverting terminal

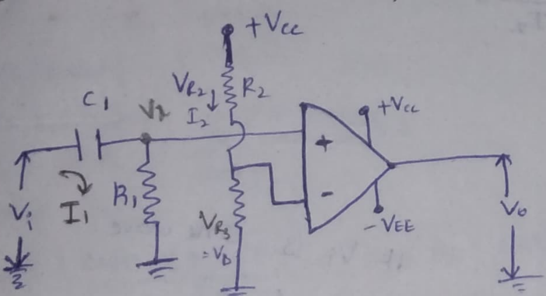
$$V_{R_2} = \left(\frac{-V_{EE}}{R_1+R_2}\right)(R_2)$$

V_{R_2} = -ve Reference voltage



18/Feb/20

4) Capacitor Coupled crossing detector:

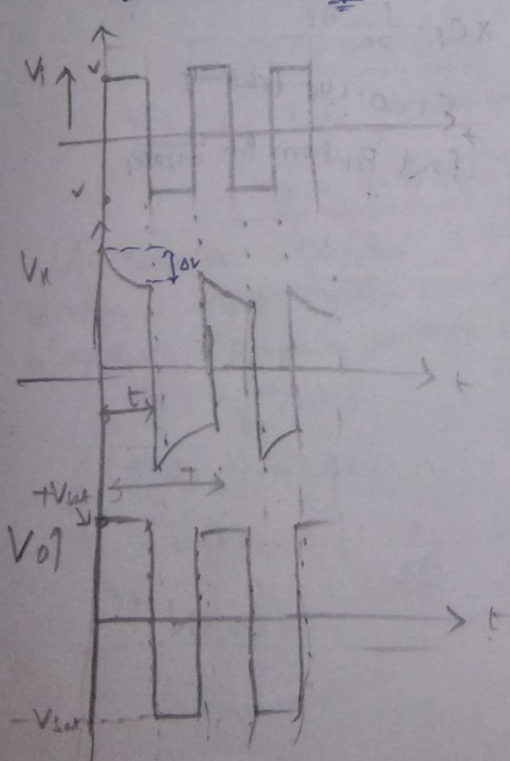


$V_i < V_B$,	$V_o = -V_{sat}$
$V_i > V_B$,	$V_o = +V_{sat}$

$+V_{sat} = +V_{cc} - 1V$

$-V_{sat} = -V_{EE} + 1V$

immediate change capacitor act as short ckt.



$T = 2t$
$t = T/2$
$t = 1/2f$

$T = 1/f$

DESIGN {741}

1) $R_1 = \frac{0.1\,V_{BE}}{I_{B\,Max}}$

2) Let $I_2 = 100\,I_{B\,max}$

3) Assume $V_{R3} = V_B = 0.1V$

4) $R_3 = V_{R3}/I_2 = V_B/I_2$

5) $R_2 = \frac{V_{cc} - V_{R3}}{I_2} = V_{cc} - V_B/I_2 = \frac{V_{R2}}{I_2}$

6) To find C_1

1) if V_i is sinusoidal

$X_{C1} = \frac{1}{20} R_1 \quad \frac{1}{2\pi f C_1} = \frac{1}{20} R_1$

{since it is switching ckt, to avoid phase shift in o/p}

$C_1 = \frac{1}{0.1\pi f R_1}$

2) if V_i is square wave

$Q = C.V \Rightarrow C = Q/V = I.t/V$

$C_1 = \frac{I_1 . t}{\Delta V}$

• $I_1 = V_i/R_1$ • $\Delta V \simeq 1V$ {Let}

• $t = 1/2f$

then find C_1

BIFET:

1) Let $R_2 = 1M\Omega$

$R_2 = \frac{V_{R2}}{I_2} \qquad \frac{V_{R_2}}{I_2} = \frac{V_{cc} - V_B}{I_2}$

$I_2 = \frac{V_{cc} - V_B}{R_2}$

2) $R_3 = \frac{V_B}{I_2} = \frac{V_{R3}}{I_2}$

3) To find C_1

if V_i is Square wave

$\frac{V_i}{R_1} = I_1$ Choose $C_1 = 0.1\mu F$

find I_1 from $\{C_1 = I_1 t/\Delta V\}$

where $\Delta V = 1V$ $t = 1/2f$

* find R_1

$R_1 = \frac{V_i}{I_1}$

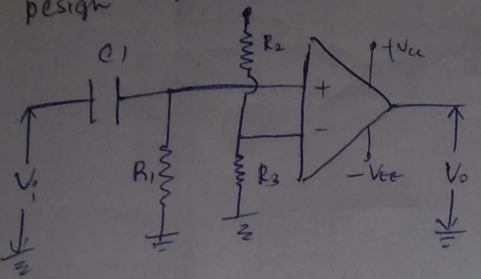
if V_i is sine wave

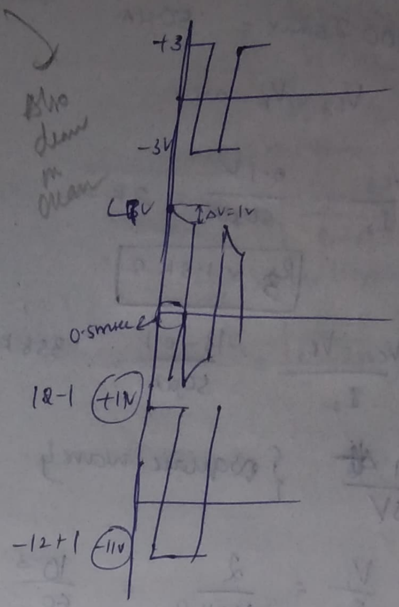
$X C_1 = \frac{1}{20} R_1$

$C_1 = 0.1\mu F$ {choosing}

find R_1 from $R_1 = \frac{1}{0.1 \cdot 2\pi f C_1}$

A Capacitor coupled crossing detector is to handle 1 KHz square wave i/p with peak - peak 6V Design a suitable ckt using 741 op-amp with ±12V supply.





$f = 1KHz$

$t = 1/2f = 0.5$ msec

$V_{sat} = \pm 11V$

1) $R_1 = \frac{0.1 V_{BE}}{I_{B max}} = \frac{(0.1)(0.7)}{500nA} = 140K\Omega$

$R_1 = 120K\Omega$

2) $I_2 = 100 I_{Bmax} = (100)(500nA)$

$I_2 = 50\mu A$

3) $V_{R_3} = V_B = 0.1V$

4) $R_3 = 0.1/50\mu A = 2K\Omega$ $R_3 = 1.8K\Omega$

5) $R_2 = \frac{V_{cc} - V_{R_3}}{I_2} = \frac{12 - 0.1}{50\mu A}$ $R_2 = 220K\Omega$

$R_2 = 238K\Omega$

6) square wave {V_i}

$t = 0.5$ msec

$I_1 = V_i/R_1 = \frac{3V}{120K\Omega} = 25\mu A$

$\Delta V = 1V$

$C_1 = \frac{(25\mu A)(0.5 msec)}{1} = 12.5nF = 0.0125\mu F$

If C_1 is higher "ΔV" get effected & "t" Also get change

so, C_1 take approx value of "C_1"

$C_1 = 0.012\mu F$

A capacitor coupled crossing detector is to provide an o/p voltage approximately ±17V when a 3KHz with ±2V square wave is applied. Design a suitable detector using bipolar op-amp → 741

±17V {V_{sat}}

±2V {$V_i = 2V$}

$f = 3KHz$ $\frac{1}{2f} = \frac{1}{6KHz} = 0.1667$ msec

$V_{cc} = \pm 18V$

1) $R_1 = \frac{0.1 V_{BE}}{I_{Bmax}} = 140 k\Omega$ $\boxed{R_1 \simeq 120 k\Omega}$

2) $I_2 = 100 I_{Bmax} = 50 \mu A$

3) Assume $V_{R3} = V_B = 0.1V$

4) $R_3 = \frac{V_{R3}}{I_2} = \frac{0.1V}{50\mu A} = 2k\Omega$

$\boxed{R_3 \simeq 1.8 k\Omega}$

5) $R_2 = \frac{V_{cc} - V_{R3}}{I_2} = \frac{18 - 0.1}{50\mu A} = 358 k\Omega$ $\boxed{R_2 = 330 k\Omega}$

6) $C_1 = \frac{I_1 \Delta t}{\Delta V}$ {square wave}

$I_1 = \frac{V_i}{R_1} = \frac{2}{120 k\Omega} = \frac{10^{-3}}{60}$

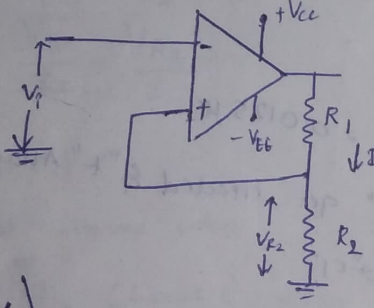
$C_1 = \frac{\left(\frac{10^{-3}}{60}\right)\left(\frac{10^{-3}}{6}\right)}{(1)} = \frac{10^{-6}}{360} = 2777 pF$

$\boxed{C_1 = 2700 pF}$

21/Feb/20

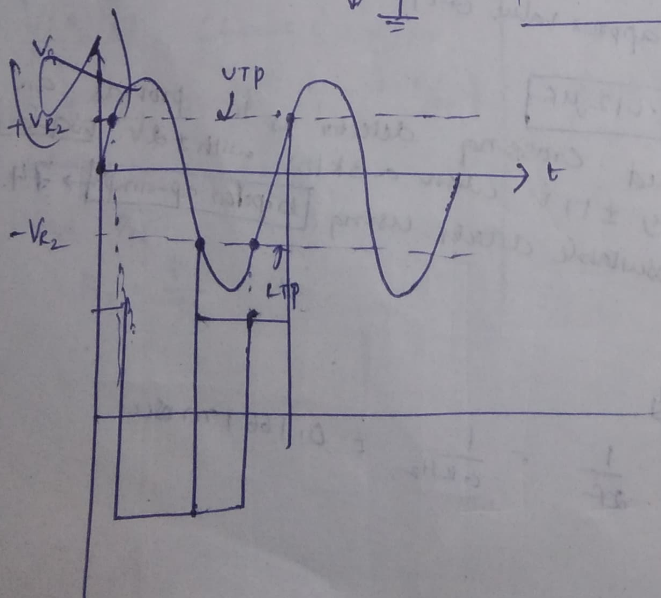
Inverting Schmitt trigger (or) Regenerative comparator (or) sine to square wave converter.

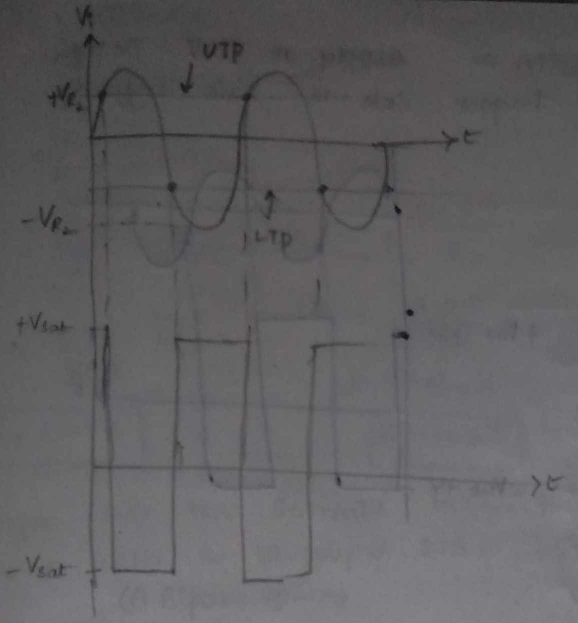
- Uses +Ve feedback
- Symmetrical



$+V_{sat} = V_{cc} - 1V$

$-V_{sat} = -V_{cc} + 1V$





$$V_{R_2} = \left(\frac{V_o}{R_1+R_2}\right) R_2$$

if $V_i < V_{R_2}$

$V_o = +V_{sat}$

if $V_i > V_{R_2}$

$V_o = -V_{sat}$

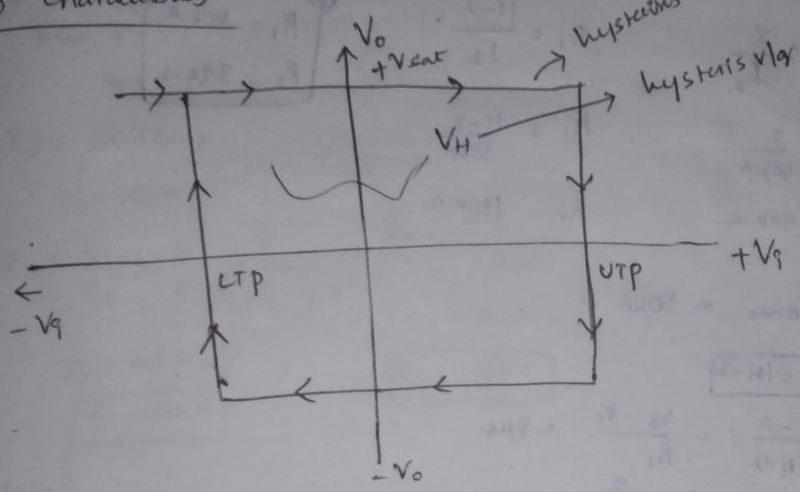
UTP {upper triggering point}

$$V_{R_2} = \left(\frac{+V_{sat}}{R_1+R_2}\right) R_2 \rightarrow UTP$$

LTP {lower triggering point}

$$V_{R_2} = \left(\frac{-V_{sat}}{R_1+R_2}\right) R_2 \rightarrow LTP$$

I/O Characteristics



V_H = UTP − LTP

$$= \left[\left(\frac{+V_{sat}}{R_1+R_2}\right) R_2\right] - \left[\frac{-V_{sat}}{R_1+R_2} \times R_2\right]$$

Design {741}

Let $I_2 = 100\, I_{B\,Max}$

$$R_2 = \frac{\text{Triggering Voltage}}{I_2}$$

$$R_1 = \frac{V_o - \text{Triggering voltage}}{I_2}$$

{BIFET / LF353}

Choose $R_1 = 1M\Omega$

find I_2.

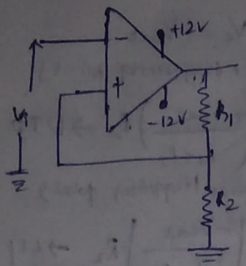
find R_2

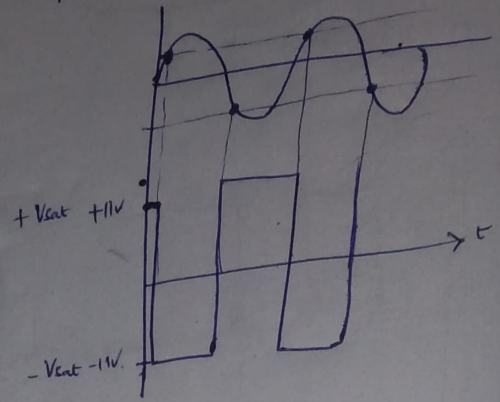
$$R_2 = \frac{\text{Triggering voltage}}{I_2}$$

Numericals

① Using 741 op-amp with a supply of ±12V. Design an inverting Schmitt trigger ckts to have triggering points ±2V.

A)





$+V_{sat} = V_{cc} - 1 = 12 - 1 = 11V$

$-V_{sat} = -V_{cc} + 1 = -12 + 1 = -11V$

Let $I_2 = 100\, I_{B\,max}$ $= (100 \times 500nA)$

$I_2 = 50\mu A$

$R_2 = \frac{2}{I_2}$

$= \frac{2}{50\mu A}$

$R_2 = 40k\Omega$

$R_1 = \frac{11-2}{I_2}$

$R_1 = \frac{11-2}{50\mu A}$

$R_1 = 180k\Omega$

P.S.V

$R_1 = 180k\Omega$
$R_2 = 39k\Omega$

BIFET:

$I_2 = 100 I_{B\,max} = 50\mu A$

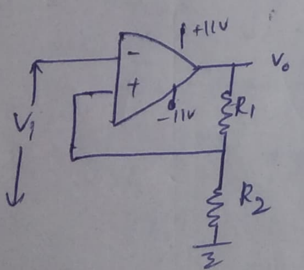
Choose $R_1 = 1M\Omega$

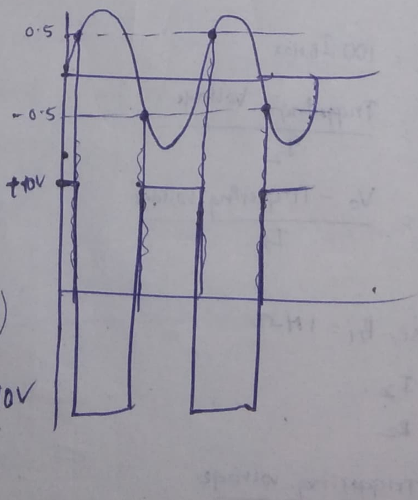
$I_2 = \frac{11-2}{1M\Omega} = \frac{V_o - V_T}{R_1} = 9\mu A$

$R_2 = \frac{V_T}{I_2} = \frac{2}{9\mu A} = 222.22k\Omega$

$R_2 = 220k\Omega$

② Using Bipolar op-amp design an inverting Schmitt trigger to trigger at ±0.5V & to produce the o/p approximately ±11V.





$+V_{sat} = V_{cc} - 1V = 11 - 1 = (10V)$

$-V_{sat} = -V_{cc} + 1V = -11 + 1 = (-10V)$ -10V

Let $I_2 = 100 I_{Bmax}$

$= (100)(500nA)$

$I_2 = 50\mu A$

$R_2 = \frac{0.5}{I_2}$

$= \frac{0.5}{50\mu A}$

$R_2 = 10k\Omega$

$R_1 = \frac{10-0.5}{I_2}$

$R_1 = \frac{10-0.5}{50\mu A} = \frac{9.5}{50\mu A}$

$R_1 = 190k\Omega$

$R_1 = 180k\Omega$

(3) Design an inv Schmitt trigger to have a trigging point of $\pm 4V$. with a supply of $\pm 15V$ using

(1) Bipolar op amp

(2) BIFET op-amp

(A) $+V_{sat} = V_{cc} - 1V = 15 - 1 = 14V$

$-V_{sat} = -V_{cc} + 1V = -15 + 1 = -14V$

$V_T = \pm 4V$

$I_2 = 100 I_{Bmax}$

$I_2 = 50\mu A$

$R_2 = \frac{V_T}{I_2} = \frac{4V}{50\mu A}$

$R_2 = 80k\Omega$

$R_2 = 68k\Omega$

$R_1 = \frac{+14-4V}{50\mu A}$

$= 200k\Omega$

$R_1 = 180k\Omega$

BIFET:

Choose $R_1 = 1M\Omega$

$R_1 = \frac{V_o - V_{Triggering}}{I_2} \Rightarrow I_2 = \frac{V_o - V_{Triggering}}{R_1}$

$I_2 = \frac{14-4}{1M\Omega}$

$I_2 = 10\mu A$

$R_2 = \frac{V_T}{I_2} = \frac{4}{10\mu A} = 400k\Omega$

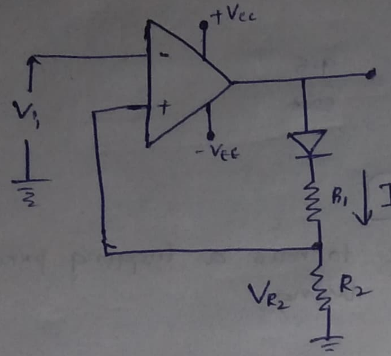
$R_2 = 390k\Omega$

28/02/2024

Asymmetrical Schmit trigger:

Symmetrical {UTP = -LTP}

Case : 1



- Ckt diagram
- eqns
- waveforms
- Design

if $V_i < V_{R_2}$ $V_o = +V_{sat}$

When $V_o = +V_{sat}$

Diode acts as forward bias {short ckt}

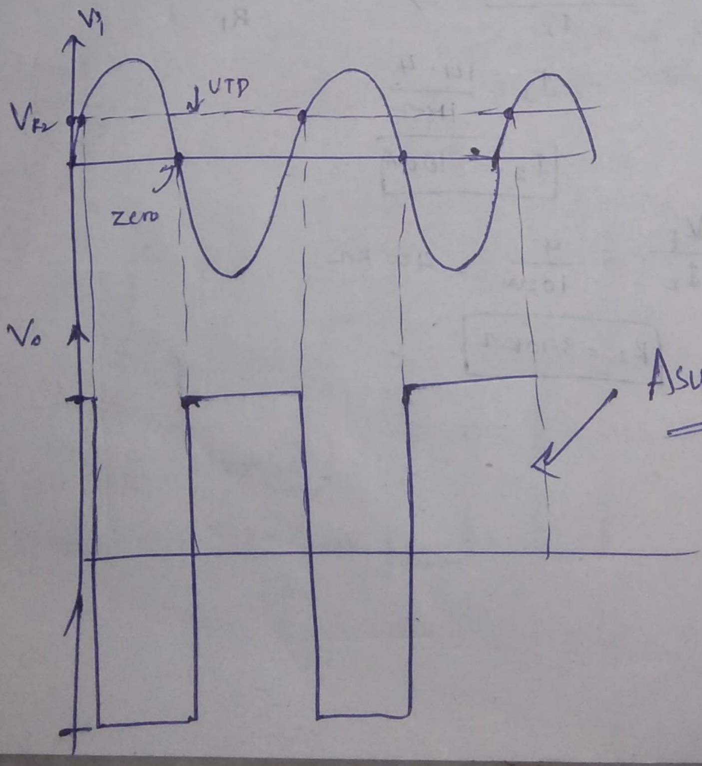
$$V_{R_2} = UTP = \left[\frac{(+V_{sat} - V_F)}{R_1 + R_2} \cdot R_2\right]$$

if $V_i > V_{R_2}$ $V_o = -V_{sat}$

when $V_o = -V_{sat}$

Diode act as Reverse bias {open ckt}

$V_{R_2} = 0.$



Asymmetrical

Design:

1) 741 / Bipolar op-amp

** when Diode is their in ckt

then $I_2 = 500\ \mu A$

↑ Choose current;

Becos to handle diode forward current.

$$R_2 = \frac{UTP}{I_2}$$

to find R_1

$$UTP = \frac{+V_{sat} - V_F}{R_1 + R_2} \cdot R_2 \quad \{\text{find } R_1\}.$$

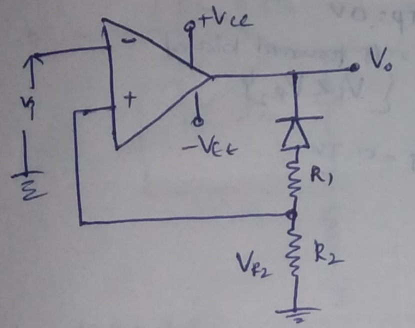
2) BIFET:

Choose $R_1 = 1M\Omega$

To find R_2 use $UTP = \left[\frac{+V_{sat} - V_F}{R_1 + R_2} \cdot R_2\right]$

Case: 2

NOW; Diode is Reversed.

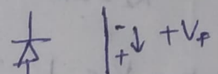


If $V_i < V_{R_2}$ $V_o = +V_{sat}$

Diode: Reverse biased {open ckt}

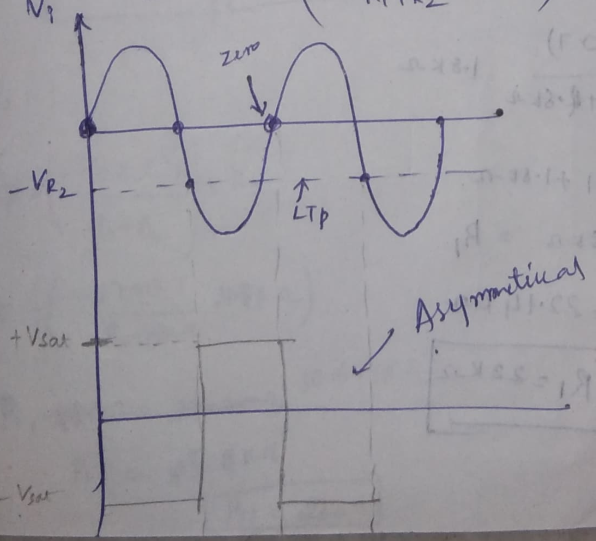
$V_{R_2} = 0$

If $V_i > V_{R_2}$ $V_o = -V_{sat}$



Diode: forward biased

$$-V_{R_2} = LTP = \left(\frac{-V_{sat} + V_F}{R_1 + R_2} \cdot R_2\right)$$



Design : since the Diode ...

(141)

* Choose $I_2 = 500\mu A$

* $R_2 = \frac{LTP}{I_2}$

* $-V_{R_2} = LTP = \frac{(-V_{sat} + V_F)}{R_1 + R_2} \times R_2$ ← find R_1

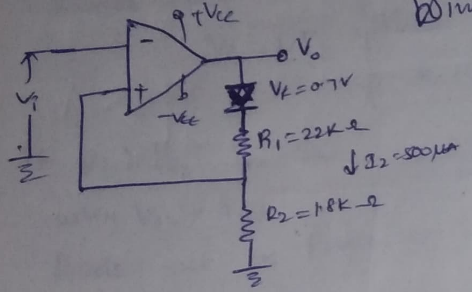
BIFET:

* Choose $R_1 = 1M\Omega$

* from $-V_{R_2} = LTP = \left[\frac{(-V_{sat} + V_F)}{R_1 + R_2} \times R_2\right]$ ← find R_2

① An inverting schmit trigger ckt is to have UTP = 1V & LTP = 0V. Design suitable ckt using Bipolar op-amp with ±15V supply.

Ⓐ



Since UTP = 1V

LTP = 0V

Diode is forward biased $\{V_i < V_{R_2}\}$

$V_F = 0.7V$

$I_2 = 500\mu A$

$R_2 = \frac{UTP}{500\mu A} = \frac{1}{500\mu A}$

$R_2 = 2k\Omega$ $R_2 = 1.8k\Omega$

$V_{sat} = V_{cc} - 1 = 14V$

$UTP = \left(\frac{V_{sat} - V_F}{R_1 + R_2}\right)(R_2)$

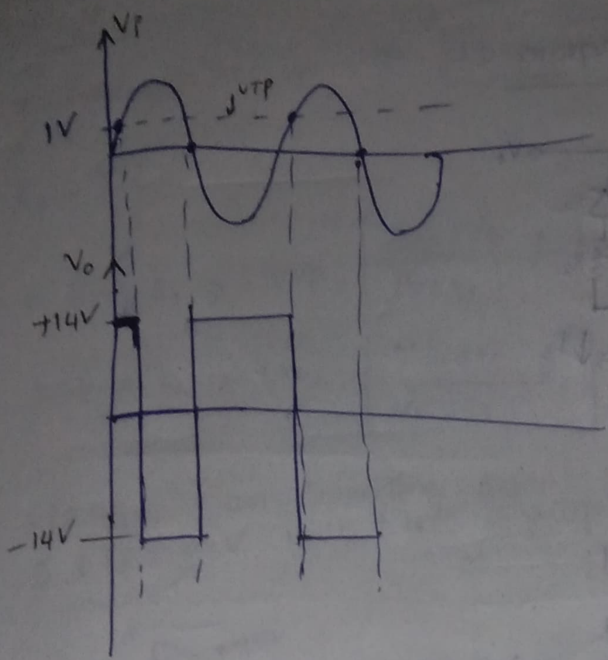
$(1) = \frac{(14 - 0.7)}{R_1 + 1.8k\Omega} 1.8k\Omega$

$23940 = R_1 + 1.8k\Omega$

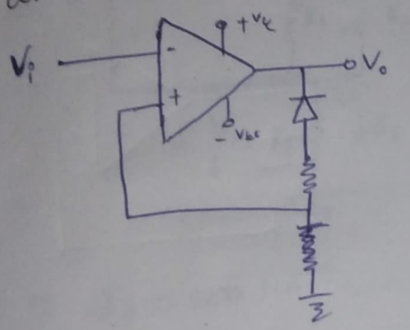
$23.94k\Omega - 1.8k\Omega = R_1$

$R_1 = 22.14k\Omega$

$R_1 = 22k\Omega$



Design suitable ckt with UTP = 0V ; LTP = 2.5V with power supply ±18V. {Bipolar}



LTP = 2.5V

$I_2 = 500\mu A$

$V_{cc} = +18V$

$R_2 = \frac{LTP}{I_2} = \frac{2.5V}{500\mu A}$

$R_2 = 5k\Omega$ | $R_2 = 4.7k\Omega$

R_1 : ?

$LTP = \left(\frac{-V_{sat} + V_F}{R_1 + R_2}\right) \times R_2$

$2.5 = \left(\frac{-17 + 0.7}{R_1 + 4.7k\Omega} \cdot 4.7k\Omega\right)$

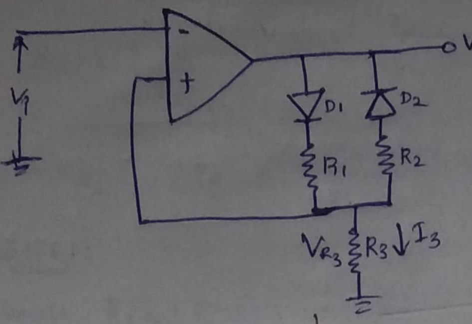
R_1 ~~k~~ = ~~32.6k~~ 30.644kΩ

$R_1 = 25.4k\Omega$

$R_1 = 22k\Omega$

Case (iii)

Ckt Diagram



eqn's

1) $V_i < V_{R_3}$, $V_o = +V_{sat}$

D_1 : forward biased

D_2 : Reverse biased

$$V_{R_3} = UTP = \left[\frac{(+V_{sat} - V_F)}{R_1 + R_3} \cdot R_3\right]$$

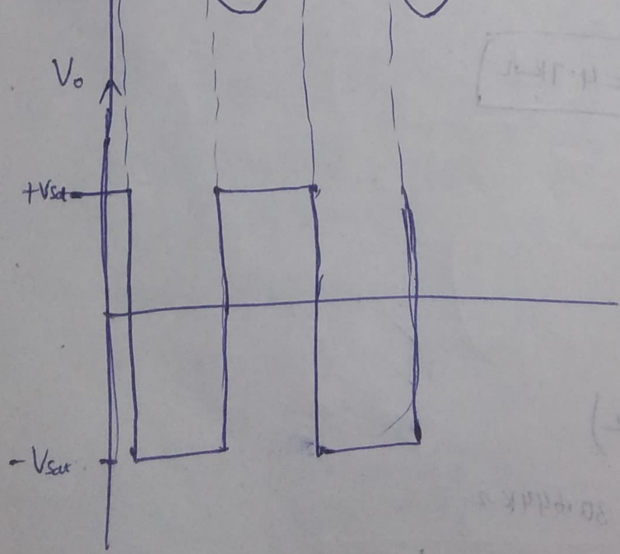
2) $V_i > V_{R_3}$, $V_o = -V_{sat}$

D_1 : Reverse biased

D_2 : forward biased

$$-V_{R_3} = LTP = \left(\frac{-V_{sat} + V_F}{R_2 + R_3} \cdot R_3\right)$$

Wave Forms



DESIGN :

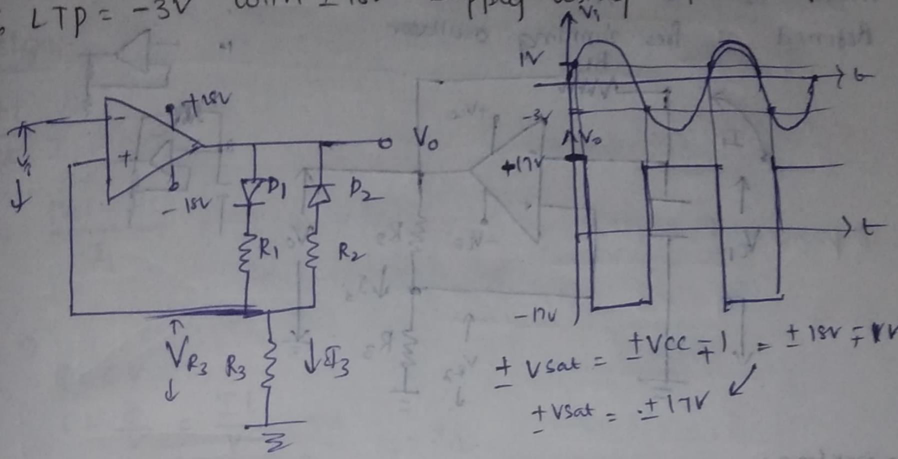
* current through R_3 $\boxed{I_3 = 500\,\mu A}$ ↑ Chose to handle diode forward current

* $R_3 = \dfrac{UTP}{I_3}$

* To find $R_1 \Rightarrow$ $UTP = \left[\dfrac{V_{sat} - V_F}{R_1 + R_3} \cdot R_3\right]$

* To find $R_2 \Rightarrow$ $LTP = \left[\dfrac{-V_{sat} + V_F}{R_2 + R_3} \cdot R_3\right]$

(1) Design an inverting Schmit trigger with UTP = 1.5 V & LTP = −3V with ±18V supply using Bipolar opamp



$\pm V_{sat} = \pm V_{cc} \mp 1 = \pm 18V \mp 1V$

$\pm V_{sat} = \pm 17V$ ✓

1) $I_3 = 500\,\mu A$

2) $R_3 = \dfrac{UTP}{I_3} = \dfrac{1.5V}{500\,\mu A} = 3k\Omega$ $\boxed{R_3 = 2.7k\Omega}$ S.V

3) $R_1 \Rightarrow 1.5V = \left[\dfrac{17 - 0.7}{R_1 + 2.7k\Omega} \cdot 2.7k\Omega\right]$

$R_1 + 2.7k\Omega = 29.34k\Omega$

$\boxed{R_1 = 26.64k\Omega}$ $\boxed{R_1 = 27k\Omega}$ S.V

4) $R_2 \Rightarrow$ $LTP = \left[\dfrac{-V_{sat} + V_F}{R_2 + R_3} \cdot R_3\right]$

$3 = \left[\dfrac{-17 + 0.7}{R_2 + 2.7k\Omega} \cdot 2.7k\Omega\right]$

$R_2 = 11.97k\Omega$

S.V $\boxed{R_2 = 12k\Omega}$

3/08/2020

3) MULTIVIBRATOR's USING OP-AMP:-

Astable MV {Also called Oscillator}

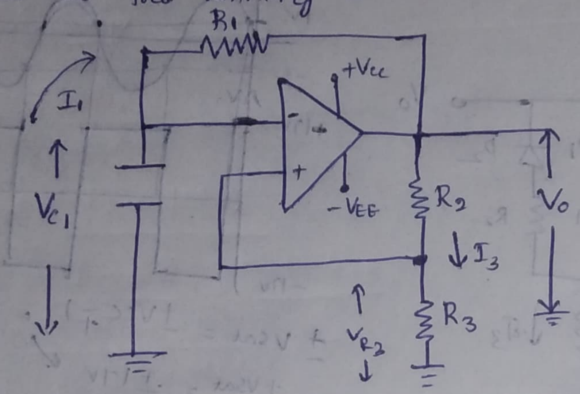
Monostable MV

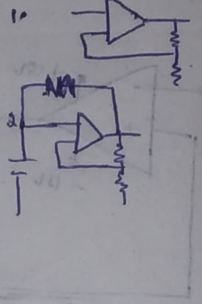
Bistable MV

(3a) ASTABLE MULTIVIBRATOR {using op-amp}

Astable multivibrator doesn't have any stable state the output always switches from one state to another state.

There is no external i/p for Astable Multivibrator, so it is defined as free running oscillator





working:

Voltage at inverting termal is compared with voltage at non-inverting terminal.

if $V_{C_1} < V_{R_3}$ & $V_o = +V_{sat} = V_{cc} - 1$

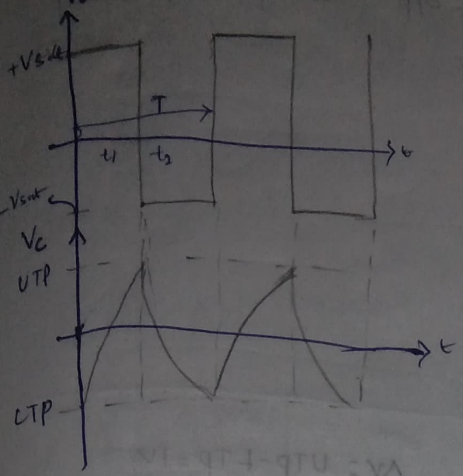
$$V_{R_3} = UTP \quad \frac{+V_{sat}}{R_2 + R_3} \cdot R_3$$

V_{C_1} compared with UTP; if V_{C_1} crosses UTP; the o/p immediately jumps to $-V_{sat}$

if $V_{C_1} > V_{R_3}$ & $V_o = -V_{sat} = -V_{cc} + 1$

$$V_{R_3} = LTP \quad \frac{-V_{sat}}{R_2 + R_3} \cdot R_3$$

Waveform :



{ No stable state
o/p Always switches
from one state to other state }

Design:-

*) 741

1) Let $I_1 = 100 I_{BMax}$.

2) $R_1 = \frac{|V_o| - UTP}{I_1}$ { UTP; LTP are same } ← nothing but triggering voltage

3) $C_1 \Rightarrow$

$Q = CV$

$C = \frac{Q}{V} = \frac{It}{V}$ $t_1 = T/2$

$C_1 = \frac{I_1 t_1}{\Delta V}$ { $\Delta V = UTP - LTP$ }

4) Let $I_3 = 100 I_{BMax}$

5) $R_3 = \frac{V_{R3}}{I_3} = \frac{UTP}{I_3}$

(6) $R_2 = \frac{|V_o| - UTP}{I_3}$

* BIFET | LF353 :- (Imp) { NO, $I = 100 I_{BMax}$ for BIFET }

1) Choose $R_2 = 1M\Omega$

2) $I_3 = \frac{|V_o| - UTP}{R_2}$

(Imp) ★ If there combination of R and C; choose capacitor instead of Resistor

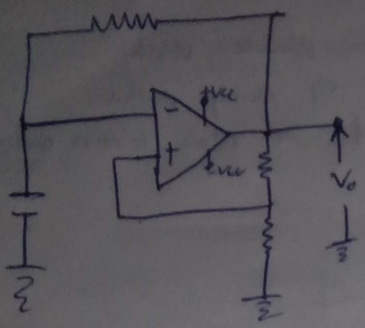
3) $R_3 = \frac{UTP}{I_3}$

4) Choose $C_1 = 0.1 \mu F$ { To avoid parasitic capacitance }

5) $I_1 = \frac{C_1 \Delta V}{t_1}$

6) $R_1 = \frac{|V_o| - UTP}{I_1}$

(1) using a BIFET OP-AMP DESIGN A ASTABLE MULTIVIBRATOR to have ±9v o/p with a frequency of 1 KHz



$\pm 9V = \pm V_{sat}$

$V_{sat} = 9V$

$V_{cc} = V_{sat} + 1$

$V_{cc} = 10V$

Normally $\Delta V = UTP - LTP = 1V$

$UTP = 0.5$

$LTP = -0.5$

1) Choose $R_2 = 1M\Omega$

2) $I_3 = \frac{9 - 0.5}{1M\Omega} = \frac{|V_o| - V_{UTP}}{R_2}$

$I_3 = 8.5\,\mu A$

3) $R_3 = \frac{0.5}{I_3} = 58.82\,K\Omega$ $\boxed{R_3 = 56\,K\Omega}$

4) Choose $C_1 = 0.1\,\mu F$

5) $I_1 = \frac{C_1 \Delta V}{t_1} = \frac{(0.1\,\mu F)(1V)}{0.5\,msec}$

$I_1 = 0.2\,mA$

6) $R_1 = \frac{|V_o| - UTP}{I_1} = \frac{9 - 0.5}{0.2\,mA}$

$R_1 = 42.5\,K\Omega$ $\boxed{R_1 = 39K\Omega}$

(2) Design an op-amp Astable Multivibration to have o/p frequency 400Hz use a 741 op-amp with a supply of ±18V.

A) $f = 400Hz$ $V_{cc} = +18V$

$T = 2.5\,msec$ $t_1 = 1.25\,msec$ $V_{sat} = 17V$

(iv) $I_1 = 100 I_{Bmax} = 50\mu A$

2) $R_1 = \frac{|V_o| - UTP}{I_1} = \frac{17-0.5}{50\mu A}$

$R_1 = 330K\Omega$

3) $C_1 = \frac{I_1 t_1}{\Delta V}$

$= \frac{(50\mu A)(1.25 msec)}{1V}$

$C_1 = 0.06 \mu F$

4) $I_3 = 100 I_{Bmax} = 50\mu A$

5) $R_3 = \frac{UTP}{I_3} = \frac{0.5}{50\mu A}$

$R_3 = 10K\Omega$

6) $R_2 = \frac{|V_o| - UTP}{I_3} =$

$R_2 = 330K\Omega$

BIFET

1) Choose $R_2 = 1M\Omega$

2) $I_3 = \frac{|V_o| - UTP}{R_2} = \frac{17-0.5}{1M\Omega} = 16.5\mu A$

3) $R_3 = \frac{UTP}{I_3} = 30.3K\Omega$ $R_3 = 27K\Omega$

4) Choose $C_1 = 0.1\mu F$

5) $I_1 = \frac{C_1 \Delta V}{t_1} = \frac{(0.1\mu F)(1V)}{1.25 msec} = 0.08 mA$

6) $R_1 = \frac{|V_o| - UTP}{I_1} = 206.25K\Omega$

$R_1 = 180K\Omega$

Design Astable multivibrator using 741 opamp with ±15V supply with $T_{ON} = T_{OFF} = 1$ msec.

1) Choose $I_1 = 100 I_{Bmax}$

$I_1 = 50\mu A$

2) $$R_1 = \frac{|V_o| - UTP}{I_1}$$

$V_o = +V_{cc} - 1$
$= 15 - 1$

$V_{sat} = 14$

If UTP, LTP, ΔV not mentioned
Consider UTP = 0.5V; LTP = −0.5V; ΔV = 1V

$$= \frac{14 - 0.5}{50\mu}$$

$R_1 = 270K\Omega$

3) $$C_1 = \frac{I_1 t_1}{\Delta V}$$

$$= \frac{(50\mu A)(1 msec)}{1V}$$

$C_1 = 50 nF$

$C_1 = 0.05 \mu F$

4) $I_3 = 100 I_{Bmax} = 50\mu A$

5) $$R_3 = \frac{UTP}{I_3} = \frac{0.5}{50\mu A}$$

$R_3 = 10K\Omega$

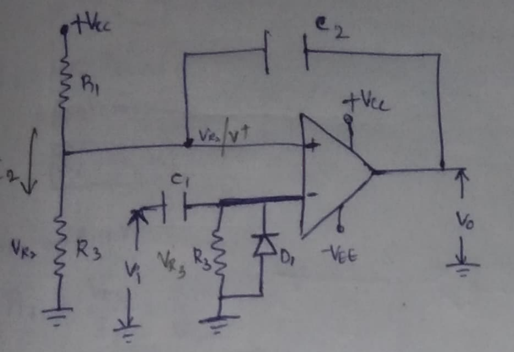
6) $$R_2 = \frac{|V_o| - UTP}{I_3} = \frac{14 - 0.5}{50\mu A}$$

$R_2 = 270K\Omega$

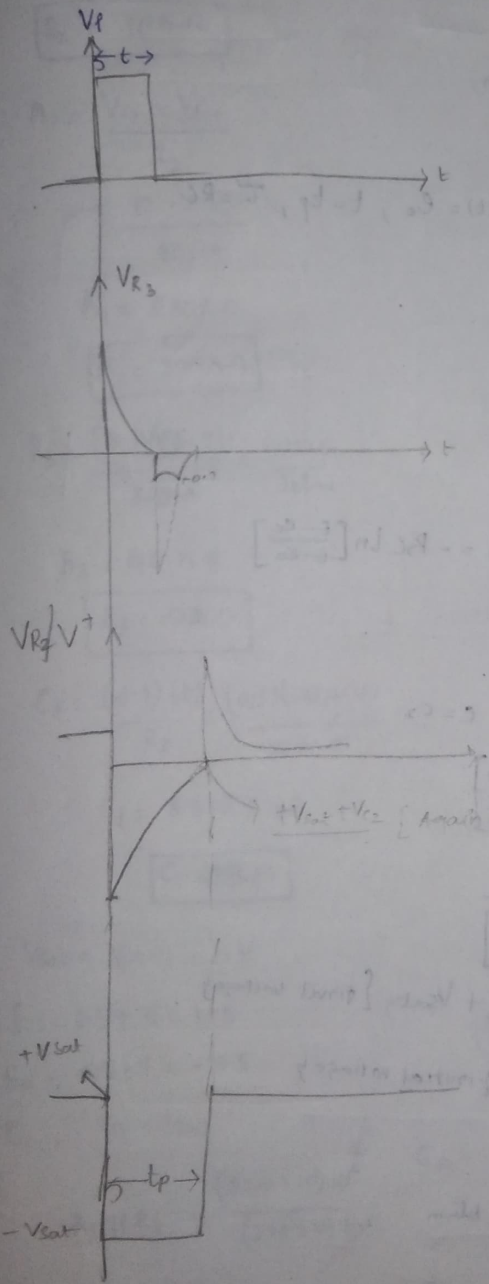
MONOSTABLE MULTIVIBRATOR USING OP-AMP:-

- Monostable multivibrator has one stable state o/p & it stays in stable state until trigger is applied.
- when trigger input is applied it switches to the opposite state for a time dependent on the circuit components.

{ Similar to capacitor coupled crossing detector with some modifications }



1) feedback Capacitor C2
2) Diode (D1)



{ No need of negative spikes so Diode is connected to clip off }

Design:-

T41:-

1) Let $I_2 = 100 I_{BMax}$

2) $V_{R_2} = 0.5V$ {Assume}

3) $R_2 = \dfrac{V_{R_2}}{I_2}$

4) $R_1 = \dfrac{+V_{cc} - V_{R_2}}{I_2}$

5) $R_3 = \dfrac{0.1 V_{BE}}{I_{BMax}}$

6) $C_1 R_3 = 0.1t$

$C_1 = \dfrac{0.1t}{R_3}$

7) To find C_2

Consider Capacitor Charging eqn:

$$V_c(t) = V_F - [V_F - V_I]e^{-t/T}$$

Let $V_F = E$, $V_I = E_o$ and $V_c(t) = e_c$, $t = t_p$, $\tau = RC$

$$e_c = E - [E - E_o]e^{-t_p/RC}$$

$$E - e_c = (E - E_o)e^{-t_p/RC}$$

$$e^{-\frac{t_p}{RC}} = \frac{E - e_c}{E - E_o}$$

$$-\frac{t_p}{RC} = \ln\left[\frac{E - e_c}{E - E_o}\right] \qquad t_p = -RC\ln\left[\frac{E - e_c}{E - E_o}\right]$$

$$t_p = RC\ln\left[\frac{E - E_o}{E - e_c}\right]$$

t_p: pulsewidth $\quad R = R_1 || R_2 \quad C = C_2$

$$t_p = (R_1 || R_2)\, C_2 \ln\left[\frac{E - E_o}{E - e_c}\right]$$

$$C_2 = \frac{t_p}{(R_1 || R_2)\ln\left[\frac{E - E_o}{E - e_c}\right]}$$

$E = V_F = V_{R_2} - [-V_{sat}] = V_{R_2} + V_{sat}$ {final voltage}

$E_o = V_{R_2} - [+V_{sat}] = V_{R_2} - V_{sat}$ {initial voltage}

$e_c = 0 - (-V_{sat}) = V_{sat}$

{voltage across capacitor when switching btwn $-V_{sat}$ to $+V_{sat}$}

Design Monostable Multivibrator to have an o/p pulsewidth of 1msec when triggered by 2V, 100μsec I/p pulse use 741 op-amp with ±12V supply?

$t_p = 1\,msec$

$t = 100\,\mu sec$

$V_i = 2V$

$V_{cc} = +12V$

1) $I_2 = 100\, I_{Bmax}$

$= (100)(500nA)$

$\boxed{I_2 = 50\mu A}$

2) $V_{R_2} = 0.5V$

3) $R_2 = \frac{V_{R2}}{I_2} = \frac{0.5}{50\mu A}$

$\boxed{R_2 = 10K\Omega}$

4) $R_1 = \frac{V_{cc} - V_{R2}}{I_2}$

$= \frac{12 - 0.5}{50\mu A}$

$R_1 = 230K\Omega$

$\boxed{R_1 = 220K\Omega}$

5) $R_3 = \frac{(0.1)(0.7)}{500nA} = \frac{0.1V_{BE}}{I_{Blow}}$

$R_3 = 140\,K\Omega$

$\boxed{R_3 = 120K\Omega}$

6) $C_1 = \frac{(0.1)(t)}{R_3} = \frac{(0.1)(100\mu sec)}{120\times10^3}$

$C_1 = 83.33\,pF$

$\boxed{C_1 = 91\,pF}$

7) $V_{sat} = V_{cc} - 1 = 11V$

$E = 0.5 + 11 = 11.5$

$E_0 = 0.5 - 11 = -10.5$

$e_c = 11V = V_{sat}$

$R_1 \| R_2 = \frac{(220\times10)10^3}{(220+10)10^3}$

$C_2 = \frac{t_p}{(R_1\|R_2)\ln\left[\frac{E - E_0}{E - e_c}\right]}$

$C_2 = \frac{1msec}{(9.5652\times10^3)\ln\left[\frac{11.5+10.5}{11.5-11}\right]} =$

$\boxed{C_2 = 0.027\,\mu F}$

5/03/20

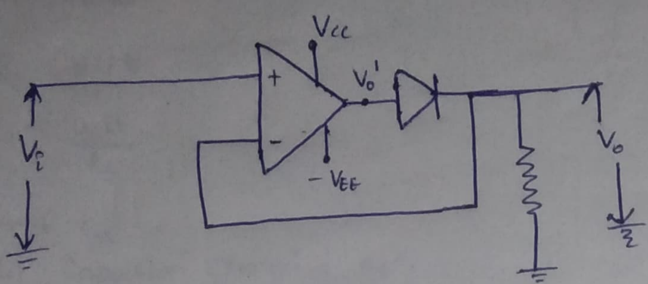
Signal processing Circuits:-

1) precision Rectifier

① precision Rectifier:-

- precision rectifier are those circuits which rectify the signals whose voltage is less than 0.7 volts

a) precision halfwave rectifier: {using voltage follower}



1) if $V_i = +ve$; $V_o' = +ve$

Diode: forward biased

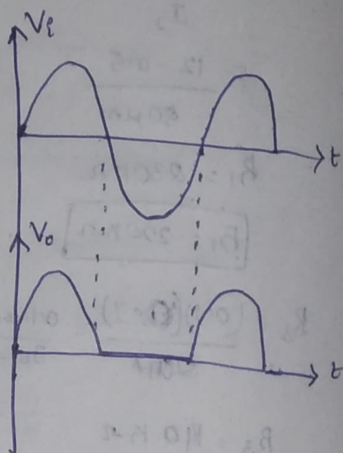
$V_o = V_i$

2) if $V_i = -ve$; $V_o' = -ve$

Diode: Reverse biased

{open ckt}

O/P ⇒ {V_o = 0 volts}



∴ Also known as Saturating precision Halfwave Rectifier.

Adv: *) Amplifies below V_γ.

1) Also provide gain to o/p

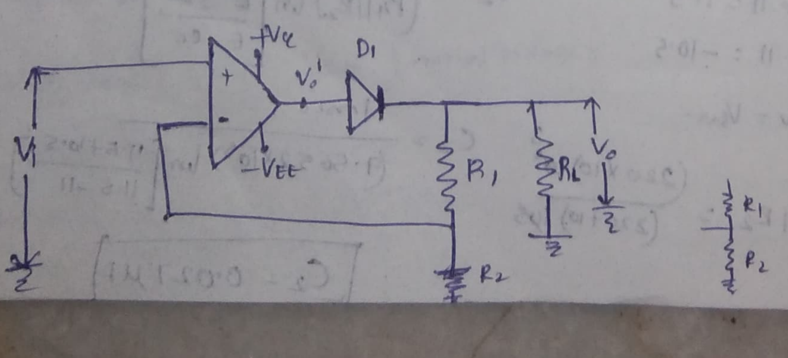
2) No Diode drop

3) Acts ideal diode ckt

{op-amp: low o/p impedance}

b) Saturating precision HWR {using Non-inverting Amplifier}

↳ Adv: provides gain



If $V_i = +Ve$, $V_o^t = +Ve$

Diode: forward biased

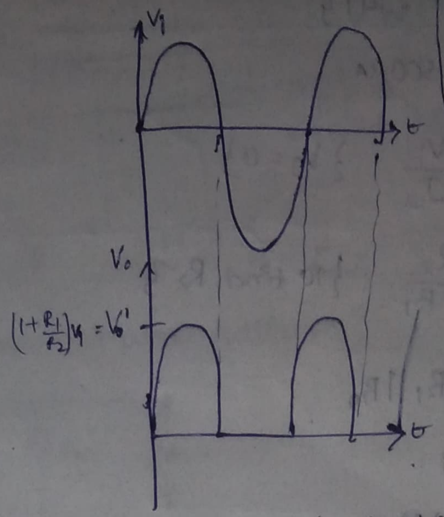
$$\frac{V_o}{V_i} = A_{Vf}$$

$$V_o = \left(1 + \frac{R_1}{R_2}\right) V_i$$

If $V_i = -V_e$, $V_o' = -Ve$

Diode: Reverse biased

$V_o = 0$ volts



Note: Diode can be reversed. ⇓ o/p waveforms inverted

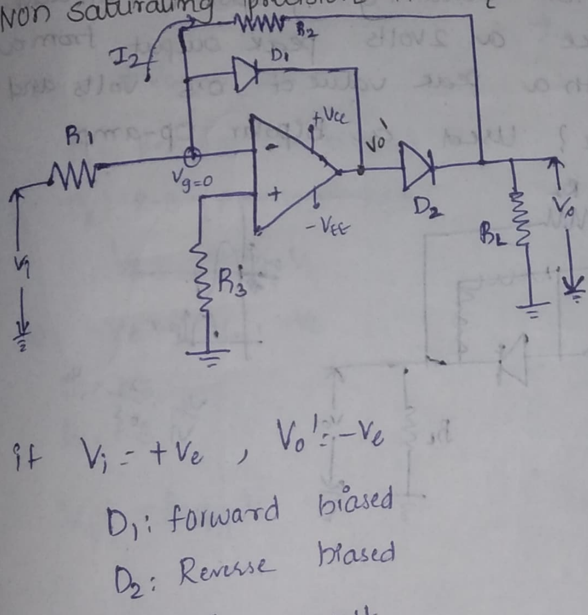
Design:-

a) $I_2 = 500\mu A$

$R_2 = \frac{V_i}{I_2}$; $R_1 = ?$ from $A_{Vf} = 1 + \frac{R_1}{R_2}$

for amplifier o/p was going

c) Non saturating precision HWR {Inverting Amplifier}



$R_3 = R_1 // R_2$ ↑ Biasing Resistor

$V_o' = -(V_i)$

If no diode $V_o' = V_{cc}$ so, Diode used

If $V_i = +V_e$, $V_o' = -V_e$

D_1: forward biased

D_2: Reverse biased

$V_o' = -0.7$ volts

When $V_i = -V_e$, $V_o' = +V_e$

D_1: Reverse biased

D_2: forward biased

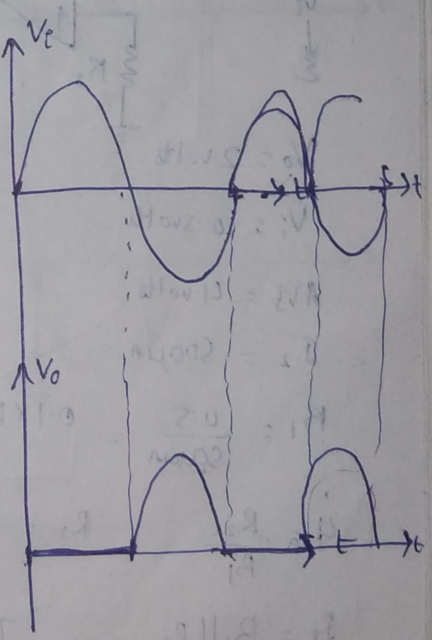
$$V_o = -\frac{R_2}{R_1} V_i$$

At $R_2 = R_1$

$V_o = -V_i$

But $V_i = -V_e$

$V_o = +V_e$



$R_2 > R_1$

Amplification is provided

Design :- {741}

$I_2 = 500\mu A$

$R_1 = \frac{V_1}{I_2}$; $\{V_g = 0\}$

(1)

$A_V = \frac{R_2}{R_1}$ {to find R_2}

$R_3 = R_1 || R_2$

{BIFET}

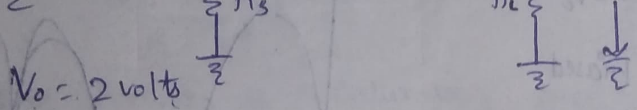
1) $R_2 = 1M\Omega$

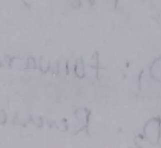
2) R_1 {from $A_{Vf} = R_2/R_1$}

3) $R_3 = R_1 || R_2$

(1) Design a non-saturing precision Halfwave rectifier to produce a 2volts peak output from a sine wave i/p with a peak value of 0.5 volts and frequency of 1MHz? Used a Bipolar op-amp with supply ±15V.

(A)





$\frac{V_o}{V_i} = \frac{2}{0.5} = 4$

$V_o = 2$ volts

$V_i = 0.5$volts

$A_{Vf} = 4$ volts

$I_2 = 500\mu A$

$R_1 = \frac{0.5}{500\mu A} = 0.1 \times 10^{4} = 1k\Omega$ (S.V) $R_1 = 1k\Omega$

$4 = \frac{R_2}{R_1}$ $R_2 = 4k\Omega$ (S.V) $R_2 = 3.9k\Omega$

$R_3 = R_1 || R_2 = 795.91\Omega$

(S.V) $R_3 = 820\Omega$

Note:

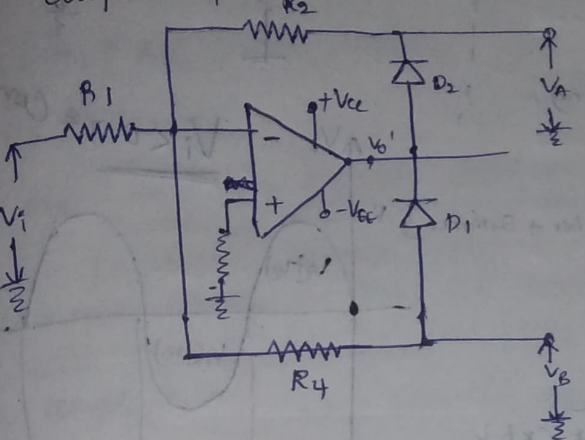
The Breakdown voltage of diodes D_1 and D_2 should be greater than 30 volts {+15 − {−15}} (supply ±15)

∴ Therefore reverse recovery time of diode should be less (TRR)

than "T"

Let $T_{rr} = \frac{1}{10} T$ $T \Rightarrow \frac{1}{f} = \frac{1}{1 MHz} = 10^{-6}$ sec = 1 μsec

d) Two output non-saturating precision halfwave rectifier:-



$V_i = +Ve$; $V_o' = -ve$

D_1 : f.B {forward biased}

D_2 : R.B {Reverse biased}

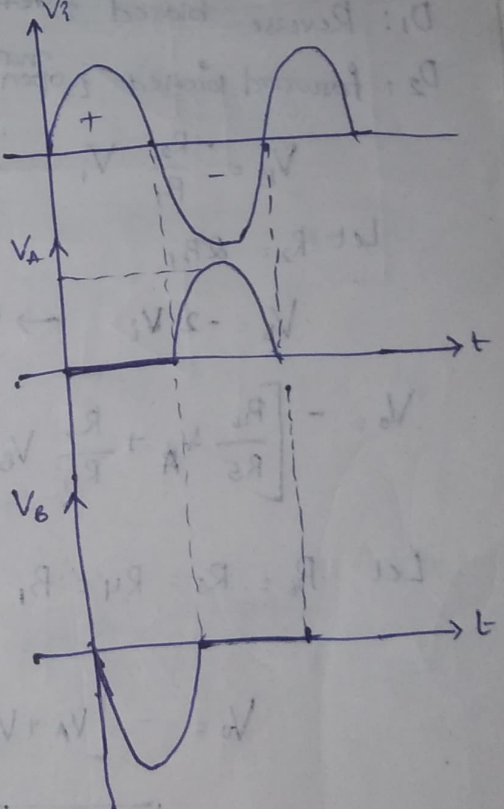
$V_B = -R_4/R_1 \, V_i$

$V_i = -Ve$; $V_o' = +Ve$

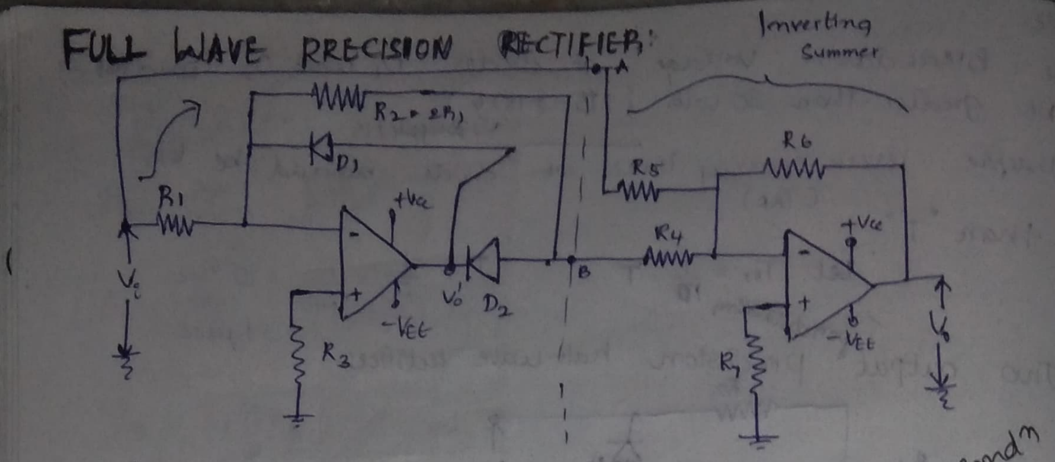
D_1 : R.B

D_2 : f B

$V_o = -R_2/R_1 \, V_i$

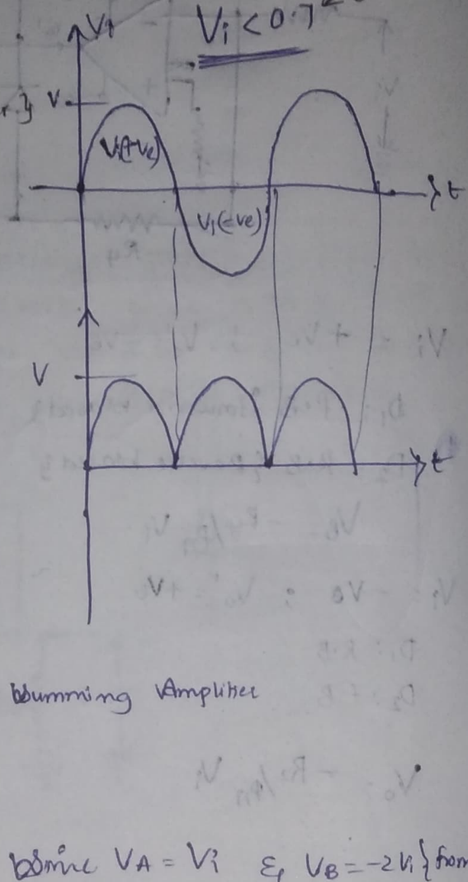


FULL WAVE PRECISION RECTIFIER:



Non - saturating Inverting Amplifier

HWPR
{Non-saturing inverting Amplifier + Summer}



Case(i)

$V_i = +ve$; $V_o' = -ve$

D_1: Reverse biased {open ~~Short~~ ckt}

D_2: forward biased {short ~~open~~ ckt}

$$V_B = \frac{-R_2}{R_1} V_i$$

Let $R_2 = 2R_1$

$$V_B = -2V_i \rightarrow (1)$$

$$V_o = -\left[\frac{R_6}{R_5} V_A + \frac{R_6}{R_4} V_B\right]$$

Summing Amplifier

Let $R_6 = R_5 = R_4 = R_1$

Since $V_A = V_i$ & $V_B = -2V_i$ {from (1)}

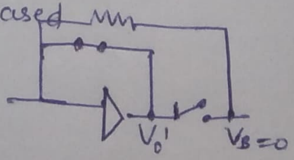
$$V_o = -[V_A + V_B] = -[V_i - 2V_i]$$

$$\boxed{V_o = V_i}$$

Case (ii)

$V_i = -ve$; $V_o' = +ve$

D_1: forward biased (Short ckt) ; D_2: Reverse biased (open ckt)



$V_B = 0$; {Short ckt}

$V_A = V_i = -V_i$ given negative V_i

$$V_o = -\left[\frac{R_6}{R_5} V_A + \frac{R_6}{R_4} V_B\right]$$

$R_6 = R_5 = R_4 = R_1$

$$V_o = -\left[V_A + V_B\right]$$

$$V_o = -\left[-V_i\right] = +V_i$$

- $R_3 = R_1 \parallel R_2$.
- $R_7 = R_4 \parallel R_5 \parallel R_6$

ckt Also called as <u>Absolute value ckt</u>

Q: Design precision fullwave Rectifier ckt to produce a 2volts peak output from a sinewave input with a peak value of 0.5 volts and a frequency of 1MHz use a bipolar opamp with supply ±15V?

- Non-saturation o/p
- $V_{cc} = \pm 15V$

When diode present in ckt $I = 500\mu A$

A)

- $V_o = 2$ Volts
- $V_i = 0.5$ volts

$I_1 = 500\mu A$

$R_1 = \frac{V_i}{I_1} = 1k\Omega$

$R_2 = 2R_1 = 2k\Omega$

$R_4 = R_5 = R_1 = 1k\Omega$ {choose}

$A_{vf} = R_6/R_5$

$4 = R_6/1k\Omega$

$R_6 = 3.9k\Omega$ (S.V)

$R_3 = R_1 \parallel R_2 = \frac{(1k)(2k\Omega)}{(1+2)k\Omega} = \frac{2}{3}k\Omega = 666.67\Omega = 680\Omega$

$R_3 = 680\Omega$

$R_7 = R_4 \parallel R_5 \parallel R_6$

$1 + 1 + 1/3.9$

$\frac{1}{R_7} = \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{3.9}$

$\frac{1}{R_7} = 2.25 \times 10^{-3}$

$\frac{1}{R_7} = \frac{2}{3}k\Omega$

$443.18\Omega = R_7$

S.V

$R_7 = 390\Omega$

Note:

1) Both diodes should maintain breakdown voltage greater than 30V {15-(-15)}
{since ±15V is supply}

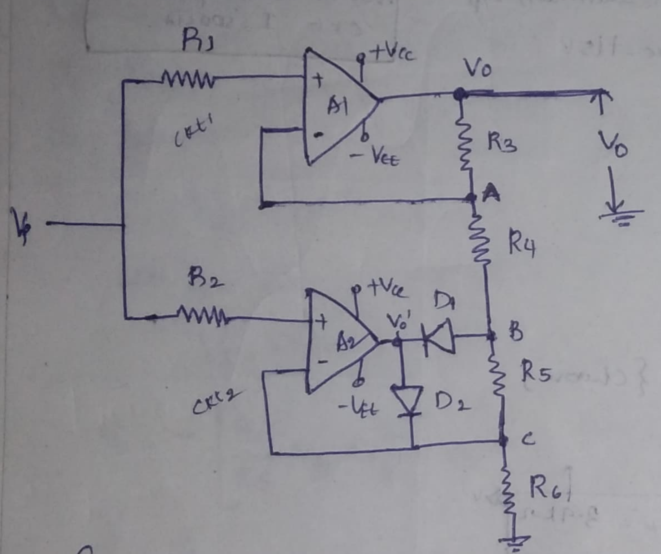
2) T_{rr} = reverse recovery time $= \frac{1}{10} T$

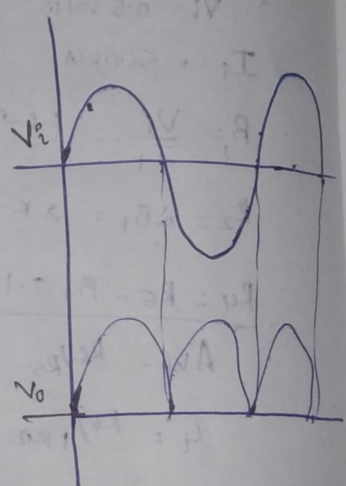
$f = 1MHz \quad T = 10^{-6} sec$

$T_{rr} = 10^{-7} sec = 0.1 \mu sec$

Drawback
Input impedance is very low: as i/p is inverting Amplifier {i/p Z = R_1} due to virtual ground.

High i/p Impedance full wave precision Rectifier:





Case (i):

$V_o' = +ve$

$V_i = +Ve \; ; \; V_A = V_i, \; V_B = 0; \; V_C = V_i$ → voltage follower ckt 2

D_1: Reverse biased

D_2: forward biased

A_2: voltage follower

$V_A = V_i \; ; \; V_C = V_i$

So no current flow through R_3, R_4, R_5, R_6

therefore $V_o = V_i$

Case (ii)

$V_i = -Ve \; ; \; V_o' = -Ve$

D_1: forward biased

D_2: Reverse biased

A_2: non-inverting Amplifier

$$V_B = \left(1 + \frac{R_5}{R_6}\right) V_i$$

Let $R_5 = R_6$

$V_B = 2V_i$ {since $V_i = -V_e$}

$V_B = 2V_i$ —(1)

By superposition theorem {$V_o = V_{o1} + V_{o2}$}

Let i/p for $A_1 = 0$

{inverting Amplifier : A_1}

i) $V_{o1} = +2V_i\,(R_3/R_4)$

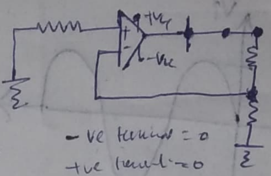
$= -R_3/R_4\, V_B$

$R_3 = 2R_4$ {choose}

$V_{o1} = 4V_i$ —(2)

Let i/p for $A_2 = 0$

i) $V_B = 0$



for A_1 {non-inverting Amplifier}

Inverting terminal is zero

i/p at non-inverting terminal

$V_{o2} = (1 + R_3/R_4)\, V_i$

we choosen $R_3 = 2R_4$

$V_{o2} = (1 + 2)V_i = -3V_i$ —(3)

from superposition theorem

$V_o = 4V_i - 3V_i = V_i$

$\boxed{V_o = V_i}$

(Q.1) Using Bipolar opamp with $V_{cc} = \pm 15V$, Design the high i/p impedance precision full wave rectifier circuit with the input peak voltage is to be 1V and no amplification to occur!

(Draw wave forms & ckt also)

(A) $I_B = 500\mu A$ {Due to presence of diodes}

$R_6 = V_i / I_6 = \frac{1}{500\mu A} = \frac{10^6}{500} = 20k\Omega \Rightarrow$ $\boxed{1.8k\Omega = R_6}$ (S.V)

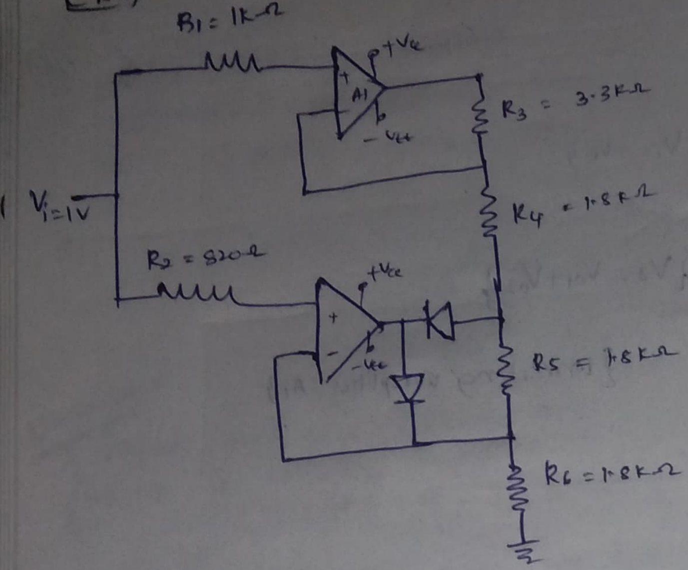
Let $R_4 = R_6 = R_5 = 1.8k\Omega$

$R_3 = 2R_4 = 3.6k\Omega$ $\boxed{R_3 = 3.3k\Omega}$ (S.V)

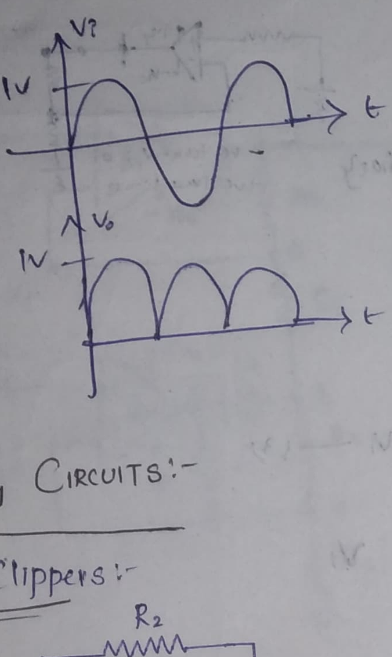
$R_1 = R_3 \| R_4 = \frac{(3.3)(1.8)}{3.3 + 1.8} = 1.16\,k\Omega$ $\boxed{R_1 = 1k\Omega}$

$R_2 = R_5 \| R_6 = \frac{(1.8)(1.8)}{1.8 + 1.8} = 0.9\,k\Omega$ $\boxed{R_2 = 820\Omega}$

CKT

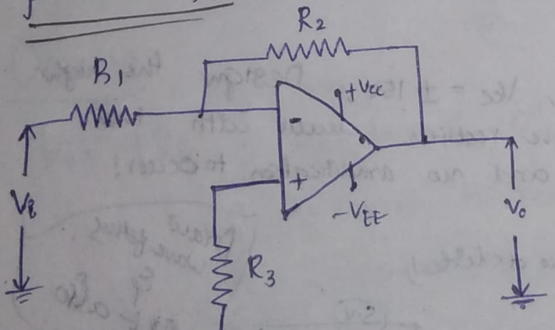


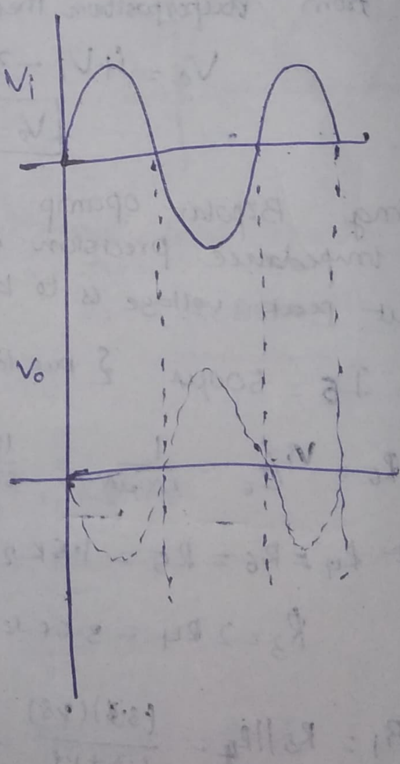
Wave form:



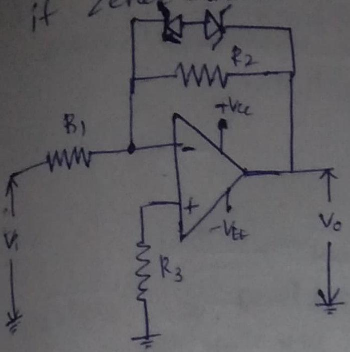
LIMITING CIRCUITS:-

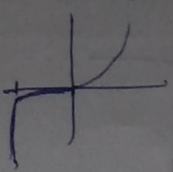
(i) peak Clippers:-





if Zener diodes connected back to back





V_Z : Zener diode voltage

V_F : forward bias voltage

(1) $V_i = +ve$, $V_o' = -ve$

D_1 : Reverse bias
D_2 : forward bias

enter to breakdown $|V_i| > (V_Z + V_F)$

$(V_Z + V_F)$

$V_o = V_Z + V_F$

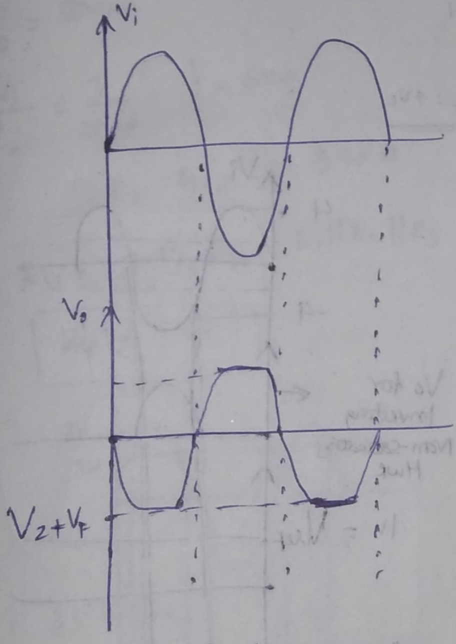
Until $V_Z + V_F$ $V_o = V_i$

(2) $V_i = -Ve$, $V_o' = +ve$

D_1: FB ; D_2 : RB

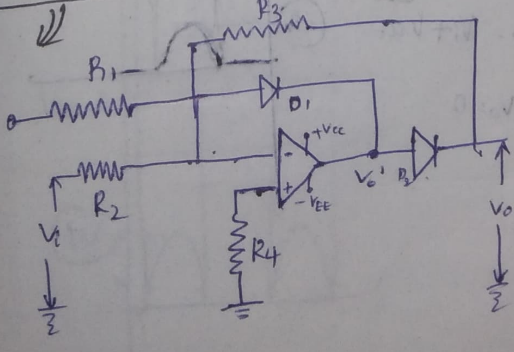
Until $V_Z + V_F$ $V_o = V_i$

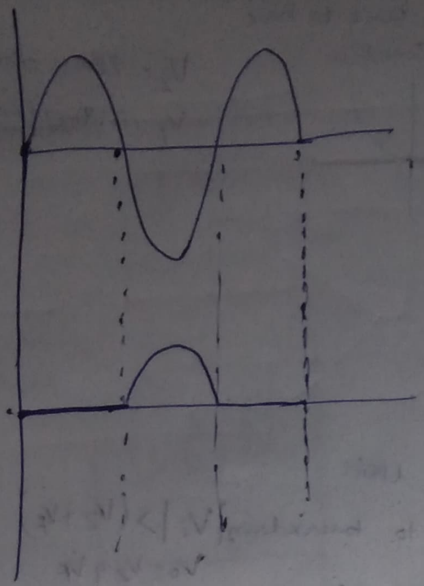
$|V_i| > (V_Z + V_F)$ $V_o = V_Z + V_F$



{practice Numerical}

(8) Dead zone circuit: {Modification of non-saturation HWR - Inverting}





V_i: +ve
D_1 : FB ; D_2 RB
V_o : 0

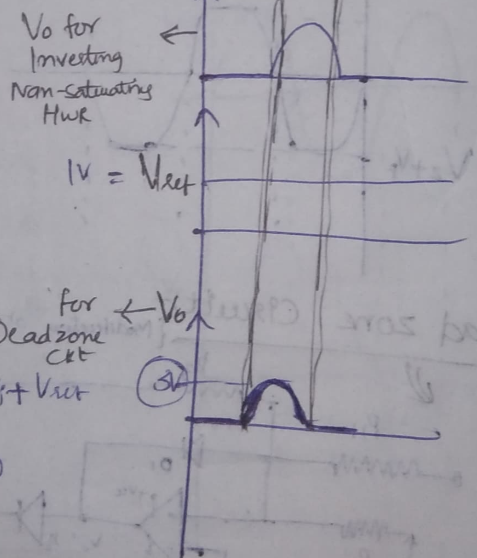
V_i = −ve
D_1 : RB ; D_2 FB
$V_o = -V_i = -(-V_i) = V_i$

] for Inverting non-saturating HWR.

② For Dead zone ckt : V_{ref} : +ve

V_i = +ve ; $V_{ref} = 1V$
V_o' = −ve
D_1 : forward biased
D_2 : Reverse biased
V_o = Zero

if V_i = −ve ; $V_{ref} = 1V$
V_o' = +ve
D_1 : RB
D_2 : fB
V_o if $|V_i| > V_{ref}$ $V_o = V_i + V_{ref}$
V_o if $|V_i| \leq V_{ref}$ $V_o = 0$



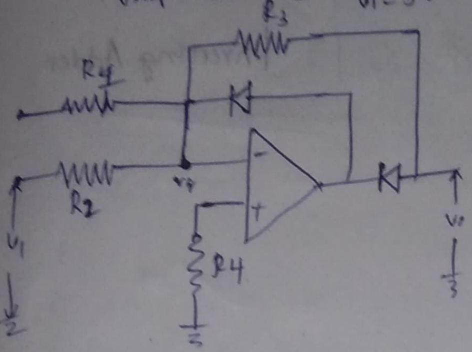
Design:-
Same as non-saturating inverting amplifier

$R_4 = R_2 \| R_3 \| R_1$

Design a Dead zone circuit to pass only upper 1 volt portion of the +ve half cycle of the Sine wave of input with peak value of 3V !

We need to get o/p = 1V

$V_{ref} = 2V$ $V_i = 3V$



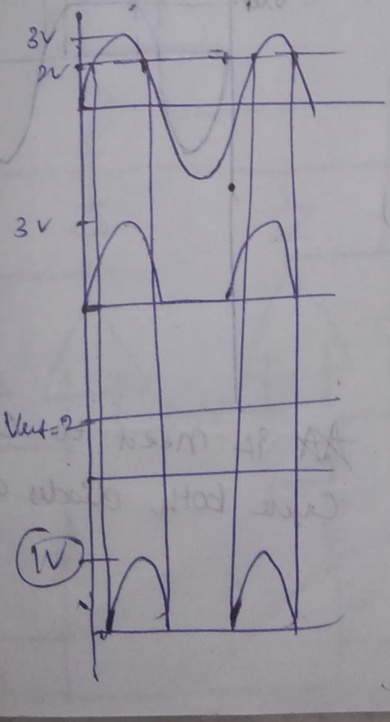
$I_2 = 500 \mu A$

$R_2 = \frac{V_i}{I_2} = \frac{3}{500 \mu A} \} = 6 K\Omega$

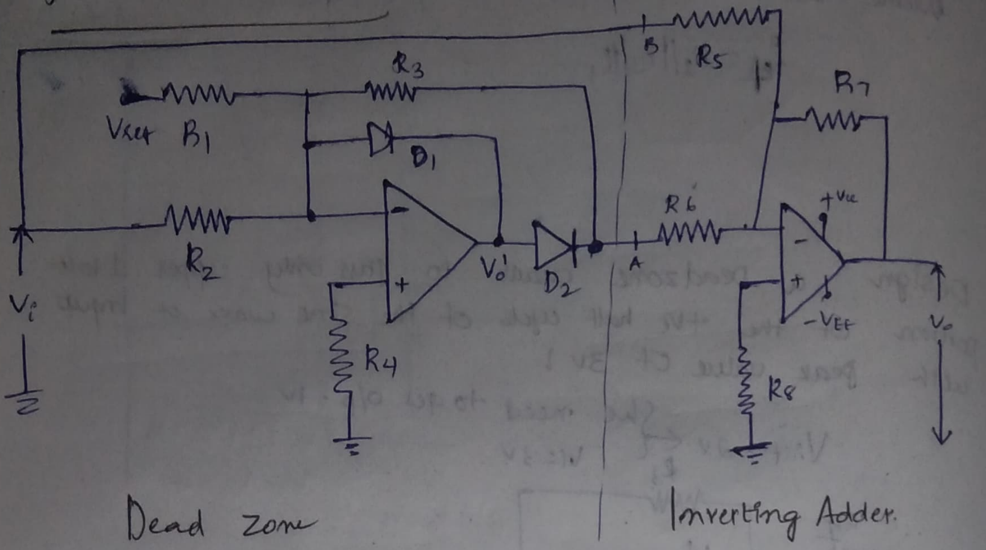
$R_2 = R_1 = R_3 = 5.6 K\Omega$

$R_4 = 5.6/3 \; K\Omega = R_1 \| R_2 \| R_3$

$R_4 = 1.8 K\Omega$



(3) Precision Clipper:-



(1) if $V_i = +Ve$ $V_{ref} = +ve$

$V_o' = -ve$

D_2 : RB

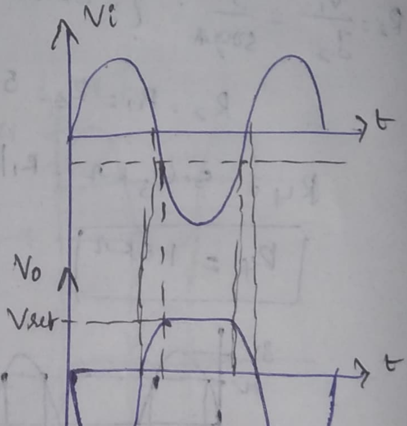
D_1 : FB

$V_A = 0V$; $V_B = V_i$

{ No amplification since $R_5 = R_6 = R_7 = R_8$ }

$V_o = -(V_A + V_B)$

$$\boxed{V_o = -V_i}$$



(2) if $V_i = -Ve$, $V_{ref} = +ve$

$V_o' = +ve$ { if $V_i > V_{ref}$ }

D_1 : RB

D_2 : FB

$V_A = -(V_i + V_{ref}) = -(-V_i + V_{ref})$
$= V_i - V_{ref}$

$V_B = -V_i$

$V_o = -[V_A + V_B]$

$= -[V_i - V_{ref} + V_i]$

$$\boxed{V_o = V_{ref}}$$

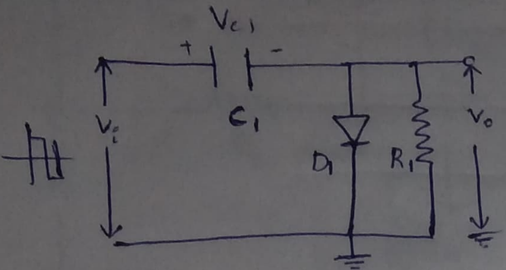
★★ if need to clipp at negative cycle both diodes are reversed.

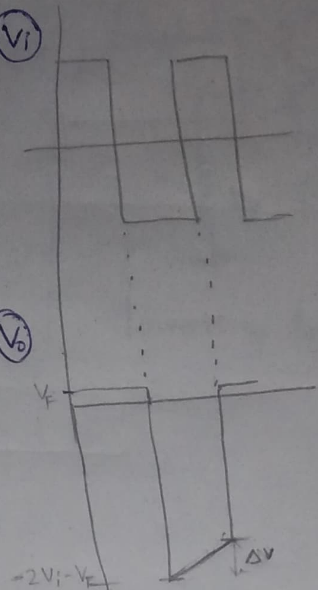
clip-off: Same part in both the -ve cycles:-

12/March

CLAMPERS

(1) DIODE CLAMPING CKT





1) $V_i = +ve$, D_1 : FB {short ckt}

   C_1 charging $V_{C1} = V_i - V_F$

   $V_o = V_F$

2) $V_i = -ve$; D_1 : RB {open ckt}

   C_1 : Discharging through R_1

   $V_o = V_i - V_{c1}$

   $= -V_i - (V_i - V_F)$

   $= -2V_i + V_F$

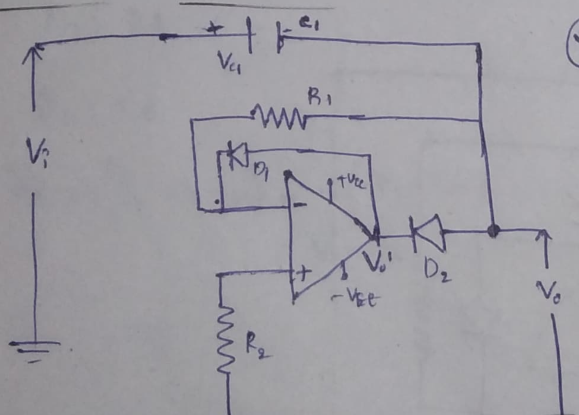
Because of "R_1" capacitor discharging their is a tilt

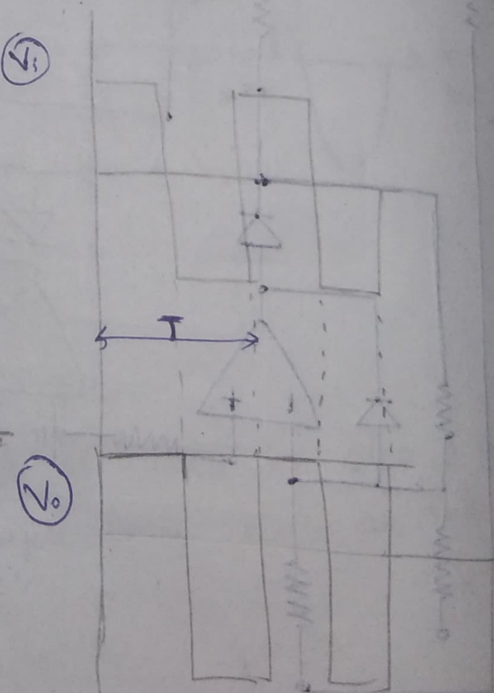
Drawback:

Due to "V_F" $V_o = -2V_i + V_F$ which not equal to $-2V_i$

So, we use op-amp ~~for~~ clamping.

(2) Precision Clamping Circuit:-





1) $V_i = +Ve$; $V_o' = -Ve$

   D_2 : FB ; D_1 : RB

   Due to closed path

Capacitor starts charging towards V_i

$V_{C1} = V_i$

$V_o = V_i - V_{C1} = 0$

The i/p of inverting terminal is same as the i/p of non-inverting terminal.

Since non-inverting terminal is grouned i/p of inverting terminal is zero.

$V_i = -ve$; $V_o' = +ve$:

2) D_1 - FB D_2 - RB

$V_o = V_i - V_{i_1}$ $V_{c1} = V_i$ { During Charging }

$= -V_i - V_i$

$$\boxed{V_o = -2V_i}$$

Design:-

1) $C_1 R_s = T/2$ { R_s : source Resistance }

$$C_1 = \frac{T}{2R_s}$$

$$\boxed{C_1 = \frac{1}{2fR_s}}$$

2) $I \doteq \frac{2V_i}{R_1}$ { $2V_i$: Maxm o/p }

3) $C = \frac{Q}{V} = \frac{It}{V}$

$$C_1 = \frac{I}{\Delta V} T/2$$

$$C_1 = \frac{[2V_i/R_1]}{\Delta V} \frac{T}{2}$$

$$C_1 = \frac{V_i T}{R_1 \Delta V} \qquad C_1 = \frac{V_i}{f R_1 \Delta V}$$

$$\boxed{R_1 = \frac{V_i}{f C_1 \Delta V}}$$

4) $R_2 = R_1$

(1) A ±5V, 10KHz square wave form from a signal source with a resistance of 100-Ω is to have its positive peak clamped precisely at ground level. Tilt on the output should not exceed 1% of the peak amplitude of the wave? Design a suitable op-amp precision clamping circuit with the power supply of ±12V?

$\pm 5V \Rightarrow V_i$ $f = 10\,kHz$ $100\,\Omega = R_s$

$V_o = -(2V_i) = 10V$

$C_1 = \frac{1}{2 f R_s} = \frac{1}{2 \times 10^6}$

$C_1 = 0.5\mu F$

$I = 2V_i / R_1 = 10/R_1$

$\Delta V = 1\%$ of $5V$

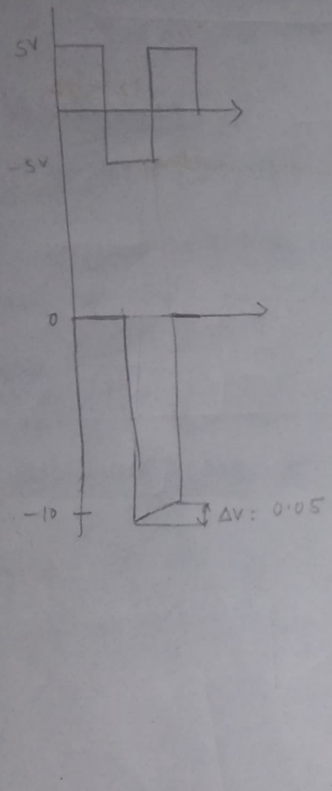
$R_1 = \frac{V_i}{f C_1 \Delta V}$

$\Delta V = 0.05$

$= \frac{5}{(10^4)(0.5 \times 10^{-6})(0.05)}$

$R_1 = 20K\Omega$

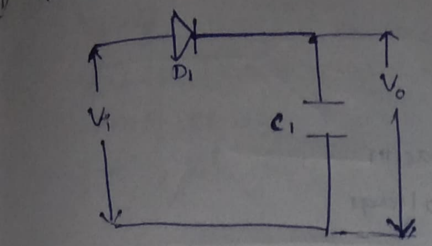
$R_1 = 18K\Omega$

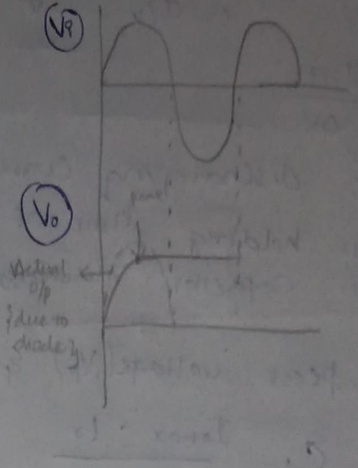


Peak Detectors:-

{first Diode then capacitor}

(1) peak Detector using diode :-





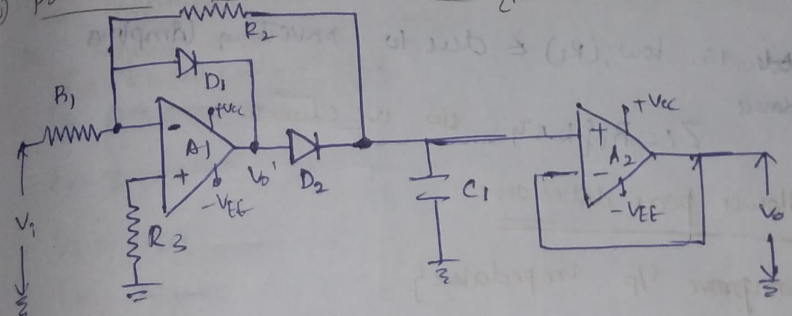
1) V_i: +ve
D_1: FB {closed loop}
C_1: charging

Due to diode
$V_i \neq V_{C1}$ {not exactly equal to V_i}

2) V_i = -Ve
D_1 = Reverse Biased

12/3/20

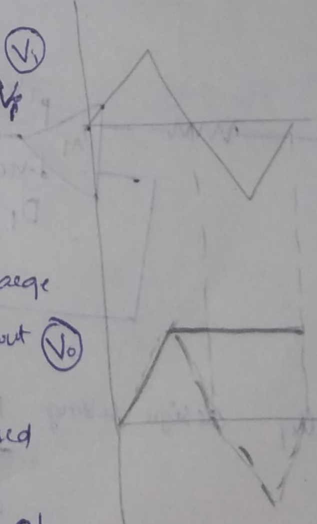
(2) precision rectifier peak detector:- {non-saturated inverting}



1) V_i = +Ve ; V_o' = -ve
D_1: FB ; D_2 : RB
C_1 charges through R_i & R_2 the peak V_p

2) V_i = -Ve, V_o' = +ve
D_1: RB D_2 : FB

Since C_1, has no path to discharge
capacitor holds same value throughout



Design:- A voltage follower is used to isolate the capacitor from discharging effect of any Load resistor design:

We know that

$$Q = CV$$
$$C = Q/V = \frac{I \cdot t}{V}$$

$$C_1 = \frac{I_d t_h}{\Delta V}$$

I_d: discharging current
t_h: holding time of capacitor
ΔV: capacitor discharge voltage

For peak voltage (V_p) & minimum s/g rise time (t_r)

$$C_1 = \frac{I_{omax} \cdot t_r}{V_p}$$

$$I_{omax} = \frac{C_1 V_p}{t_r}$$

Minimum slew rate is given by

$$S_{min} = 3 \cdot \frac{V_p}{t_r}$$

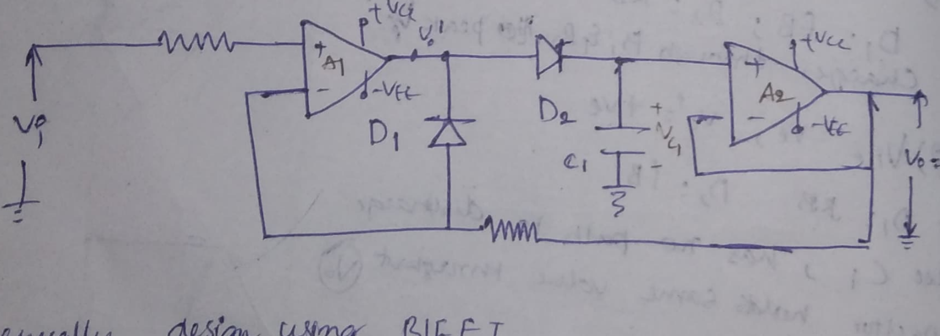
Draw back:

i/p ~~amplitude~~ is low; (R_1) & due to inverting (Amplifier
impedance

$Z_i = R_1 \{k\Omega\}$ ~~so~~ we choose.

3) Voltage follower peak detector:-

{To improve i/p impedance}



Generally design using BIFET

It have minm

Capacitor leakage current

1) If $V_i = +ve$, $V_o' = +ve$

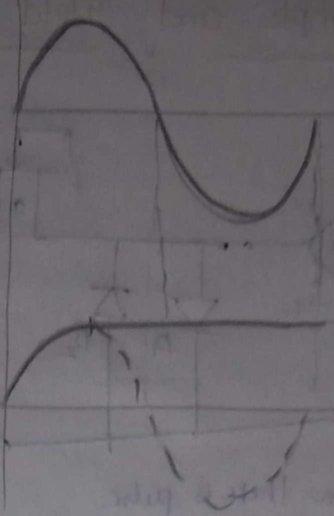
D_1 : RB D_2 : FB

* Charging of C_1 to V_p, Same A_2 (voltage follower, $V_o = V_{c1}$)
* $V_1 > V_i$ holds same value & feedback to A_1

$V_o' = -ve$ { $V_i < V_{c1}$ }

D_1: FB, D_2: RB holds same voltage

2) $V_i = -ve$, $V_o' = -ve$, D_2: RB, D_1: FB



(b)

design:

* Same as precision peak detector

(Q) Design voltage follower peak detector with pulse type signal voltage which has a peak value approximately 2.5V with rise time of 5 μsec and the o/p voltage is to be held at 2.5V for a time of 100 μsec the maximum o/p error is to be approximated 1% calculate the required component values and specify o/p current, Slew rate! {Id = Reverse current = 1μA} Choose $R_1 = R_2 = 1M\Omega$

{ckt designed using BIFET}

(A) $V_i = 2.5V$

$t_r = 5\,\mu sec$

$V_o' = 2.5V$

$t_h = 100\,\mu sec$

$\Delta V = 1\%$ of V_p = 1% of 2.5 =

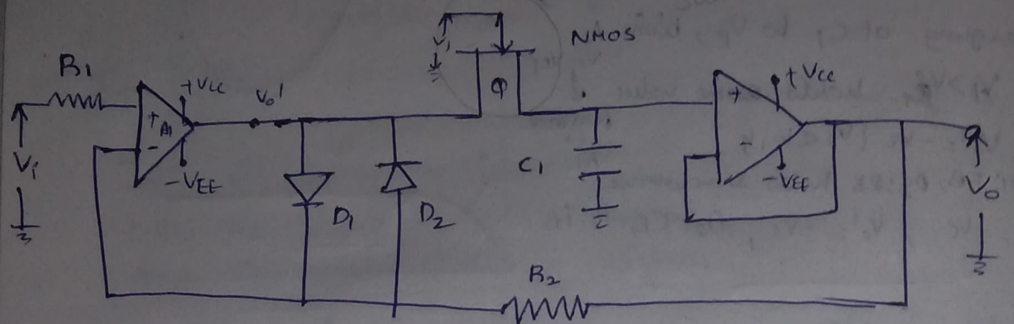
$$C_1 = \frac{I_d\, t_h}{\Delta V} = \frac{(1\mu A)(100\mu sec)}{0.025} = 4000\ pF$$

$$I_{omax} = \frac{C_1 V_p}{t_r} = \frac{(4000pF)(2.5)}{(5\mu)} = 2\ mA.$$

$$S_{min} = 3\frac{V_p}{t_r}$$

$$= \frac{(3)(2.5)}{5\mu sec} = 1.5V/\mu sec$$

Sample and Hold circuit:-



When there is pulse
Q: ON

When No pulse
Q: OFF

1) V_i = +ve ; V_0' = +ve
D_1 = FB, D_2 = RB
Q: ON ; C_1: Charge to V_i
Q: OFF : C_1: Nocharging

2) V_i = -ve, V_0' = -ve
D_1: RB D_2 : FB
Q: ON, C_1: Discharging to D_2.