Monostable Multivibrator:-

The pulse width 'T' of Monostable Multivibrator is calculated as follows

The general solution for a single time constant low pass RC circuit with V_i & V_f as initial and final values

For low pass RC circuit we have

$$V_o = V_f + (V_i - V_f)\, e^{-t/RC} \longrightarrow (1)$$

for the circuit $V_f = -V_{sat}$ & $V_i = V_D$

The output 'V_c' is (V_D = diode forward voltage)

substitute V_f & V_i values in eq (1)

$$V_c = -V_{sat} + (V_D + V_{sat})\, e^{-t/RC} \longrightarrow (2)$$

2

at $t = T$ $V_c = -\beta V_{sat}$

Substitite "t" & V_c values in eq 2

$$-\beta V_{sat} = -V_{sat} + (V_D + V_{sat}) e^{-T/RC} \rightarrow 3$$

$$V_{sat} - \beta V_{sat} = (V_D + V_{sat}) e^{-T/RC}$$

$$(V_D + V_{sat}) e^{-T/RC} = V_{sat}(1-\beta)$$

$$e^{-T/RC} = \frac{V_{sat}(1-\beta)}{V_D + V_{sat}}$$

Take log on both sides

$$\frac{T}{RC} = \ln \frac{(V_D + V_{sat})}{V_{sat}(1-\beta)}$$

$$T = RC \ln \frac{(V_D + V_{sat})}{V_{sat}(1-\beta)}$$

$$T = RC \ln \frac{\cancel{V_{sat}}\left(1 + \frac{V_D}{V_{sat}}\right)}{\cancel{V_{sat}}(1-\beta)}$$

$$\boxed{T = RC \ln \frac{\left(1+\frac{V_D}{V_{sat}}\right)}{(1-\beta)}}$$

We have

$$\beta = \frac{R_2}{R_1+R_2}$$

If $R_1 = R_2$ and $V_{sat} \gg V_{D1}$, the Expression for T modifies as,

$$T = RC \log_e \left[\frac{\left(1+\frac{0}{V_{sat}}\right)}{\left(1-\frac{R_1}{2R_1}\right)}\right]$$

$$T = RC \log_e \left(\frac{1}{1-1/2}\right)$$

$$T = RC \log_e 2$$

$$= 0.6931 RC$$

pulse duration (or) gate width

$$\boxed{T = 0.6931 RC}$$

→ A M.V is a electronic ckt that generates non-sinusoidal waves such as $\triangle^{lar}$ waves, □ wave & saw-tooth waves etc.

→ A M.V is a switching ckt which depends for operation on +ve f/b. basically two stage amp with o/p of one i/p to the other.

*) Diode D_1 F.B and hence conducts
if it F.B (c) gets charged but vtg clamps to (0.7V).
The potential divider R_1 & R_2 in association with Zener diodes,
it controls the vtg at the +ve terminal of an op-amp and it is in stable state
$= \beta V_0 \; (= \beta V_{sat})$

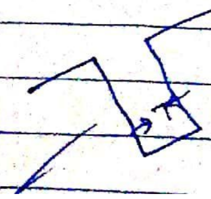
$\beta = R_2 / R_1 + R_2$

*) A -ve triggering pulse of amp V_t is applied to the +ve terminal of an op-amp
Net vtg is at this terminal $(\beta V_{sat} - V_t)$
which is less than 0.7V.

*) $V_{o/p}$ switches to $-V_{sat}$.
D_1 becomes R.B
(C) gets discharges through (R) Exponentially to $-V_{sat}$, with a time constant = RC

vtg at +ve termina $-\beta V_{sat}$.
As soon as (C) vtg → -ve this values become βV_{sat}. The mv switches back to the S.S with $V_{o/p}$ level at $+V_{sat}$.

Again D_1 is F.B → it switches SS to q.S.S
D_1 " R.B " " "



*) Monostable M.V has one stable state and one quasi-stable stable.

*) This M.V is normally in the stable state, if any Externally triggering pulse is applied it switches from stable to the quasi-stable state

It remains in the q.s.s for short while (or) Period but automatically it reverts (i.e) switch back to its original state, without any External triggering pulse

(ckt)

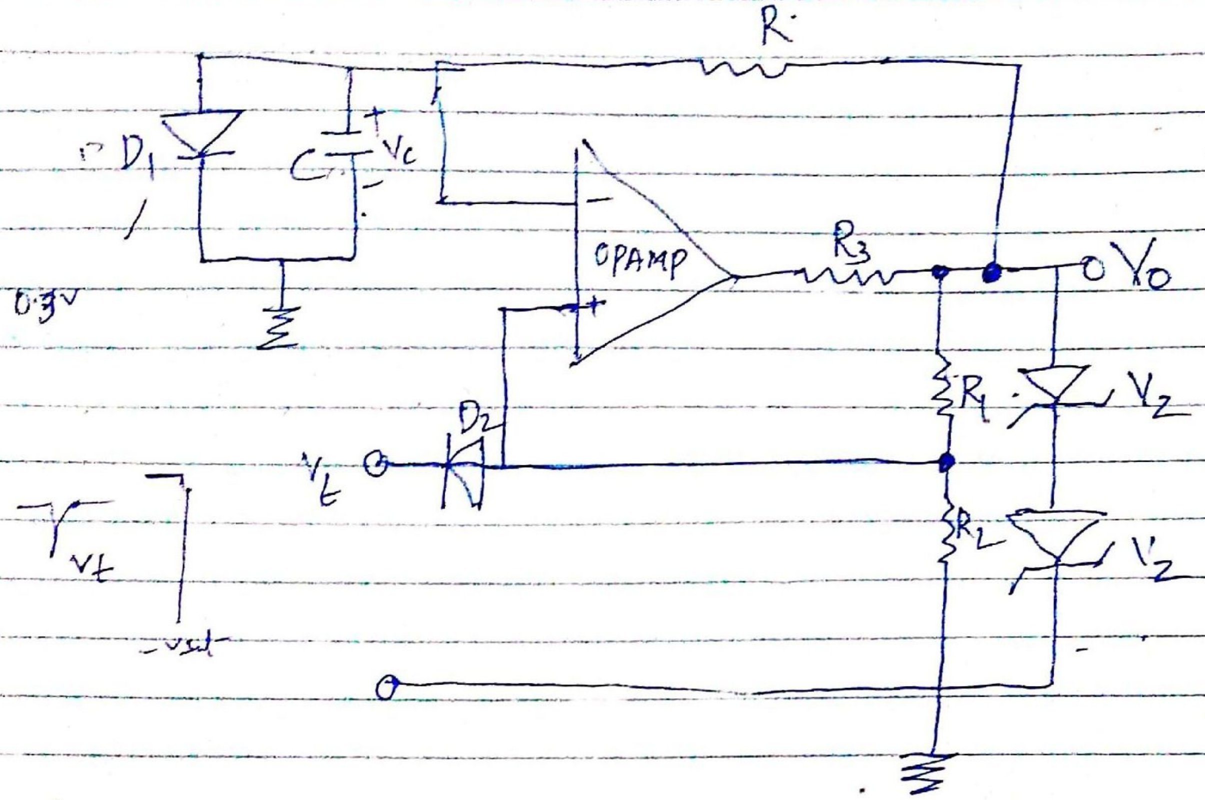
*) The ckt uses two diodes D_1 & D_2
" " Zeners Z_1 & Z_2
capacitor C and several Ⓡ in conjunction

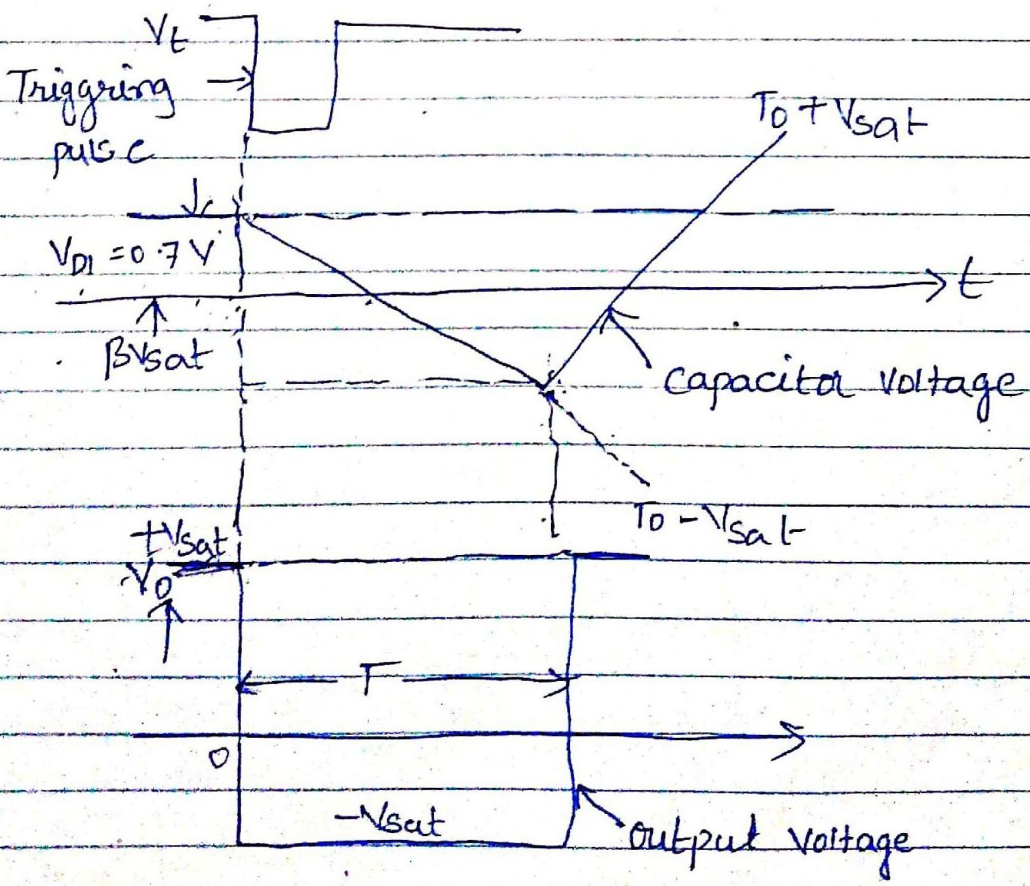
*) $D_1 \rightarrow$ cut in vtg (0.7V) (assume)
D_1 connected across the Ⓒ
it clamps V_c 0.7V, when the o/p vtg is at +ve saturation level.

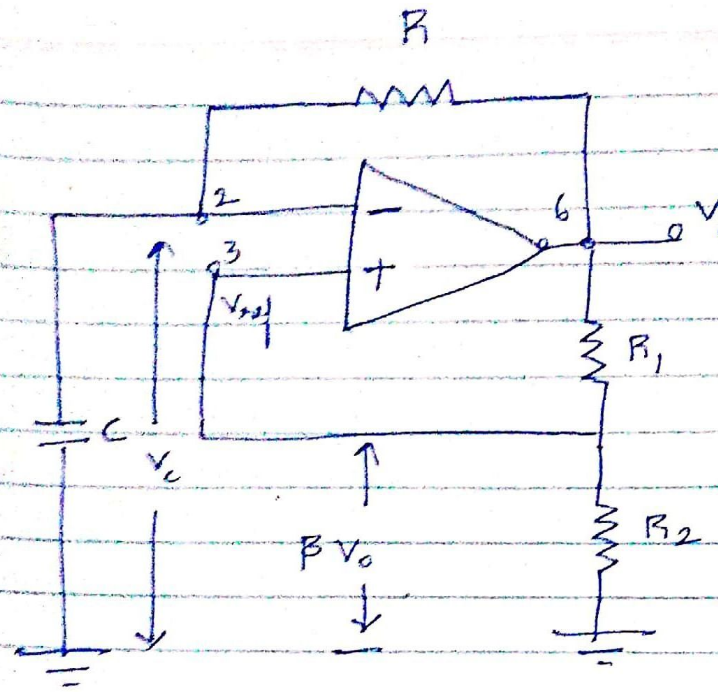
*) The triggering of the M.V by means of -ve pulse V_t applied to the +ve terminal of the op-amp through Diode D_2.

*) To understand the operation of the M.V → assumed to be stable state, so V_o is +ve saturation level
" ($+V_{sat}$)

(Free ...


R
D1
C
Vc
OPAMP
0.3V
R3
Vo
R1
V2
D2
Vt
R2
V'2
-vsat


Vt
Triggering pulse
To + Vsat
Vc
VD1 = 0.7 V
t
βVsat
capacitor voltage
To - Vsat
+Vsat
Vo
T
0
-Vsat
output voltage



Square wave Generator

Free running oscillator
↓
(without any i/p getting the o/p)

Description :

*) Main principle is op-amp should operate in saturation region to get square wave form

*) Here R_1 & R_2 called as β fraction
$\beta = R_2 / R_1 + R_2$

this β fraction is fed back +ve terminal of on op-amp through Resistor.

this βv_o → reference vtg — Either $+\beta v_{sat}$ or $-\beta V_{sat}$

+V ..

*) And Also same o/p (i.e) through R & C
fed back to -ve terminal of an op-amp

o/p $+V_{sat}$ is true
-- " " -ve

operation:

consider instant of time the o/p should be in $+V_{sat}$ when capacitor is charging.
-> (+) V_{ref}

*) whenever i/p at the (-) i/p terminal just exceeds V_{ref}
-> V_{ref} (+) then only switching takes place

resulting square wave o/p

in Astable both states are quasi stable state.

*) And vtg at the +ve terminal is
Held at $+\beta V_{sat}$ by R_1 & R_2 combination.

C charges when -> $+V_{ref}$
~~above~~ $+V_{sat}$ above $+\beta V_{sat}$

when C discharge $+V_{sat}$ ↑ more -vely
and it crosses $-V_{sat}$ in -ve terminal.

from again

(i) when C is charges to $+V_{sat}$ ↑ more and more +vely and it crosses the $+\beta V_{sat}$.

$$+V_{sat} > +\beta V_{sat}.$$

(ii) when C is discharges $+\beta V_{sat}$ ↓ more & more −vely and it crosse $-\beta V_{sat}$

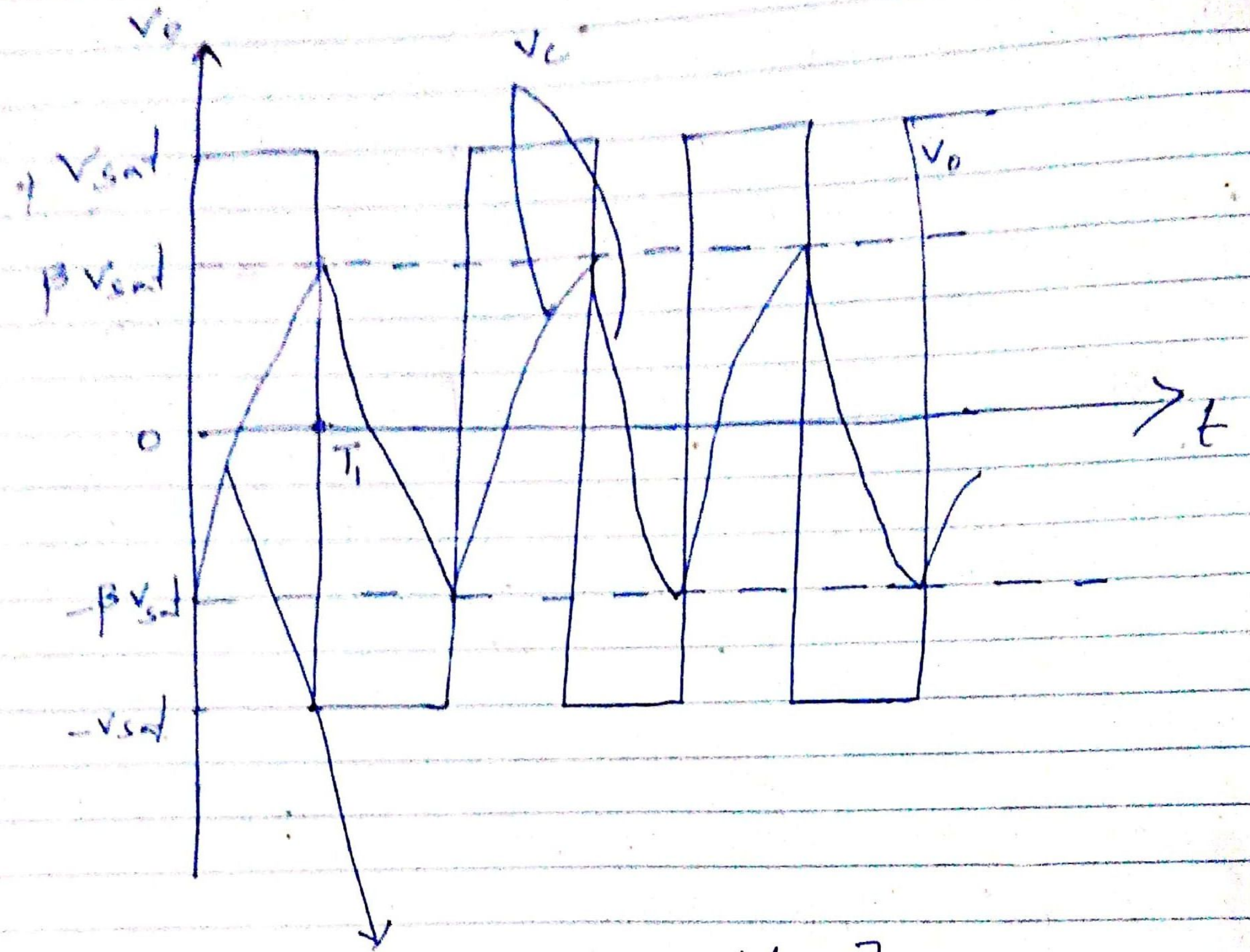
$$-V_{sat} > -\beta V_{sat}.$$

from again C is back to the +ve saturation cycle is go on.

C → charging wen it is +ve satu vtg. region

C → dis " " " " −ve " " "

Rapidly changing the o/p state.



$$V_{sat}\left[1-(1+\beta)e^{-t/RC}\right]$$

Wave forms of Aastable M.V

...stable Multivibrator:-

The voltage across the capacitor as function of time is given by

$$V_C = V_f + (V_i - V_f)e^{-t/RC} \quad (1)$$

when final value $V_f = +V_{sat}$)

and initial value $V_i = -\beta V_{sat}$

Substitute V_i & V_f values in eq (1) we get

$$V_C = V_{sat} + (-\beta V_{sat} - V_{sat})e^{-t/RC}$$

Voltage across capacitor reaches βV_{sat} and switching takes place.

$(\because V_C = \beta V_{sat})$ $V_C = V_{sat} - V_{sat}(1+\beta)e^{-T_1/RC} \quad (2)$

Substitute "V_C" value in eq (2) $(\because T_1 = t)$

$$\beta V_{sat} = V_{sat} - V_{sat}(1+\beta)e^{-T_1/RC}$$

$$V_{sat}(1+\beta)e^{-T_1/RC} = V_{sat} - \beta V_{sat}$$

$$\cancel{V_{sat}}(1+\beta)e^{-T_1/RC} = \cancel{V_{sat}}(1-\beta)$$

$$(1+\beta)e^{-T_1/RC} = (1-\beta)$$

$$e^{-T_1/RC} = \frac{(1-\beta)}{(1+\beta)}$$

Take log on both sides

$$\frac{T_1}{RC} = \ln\left(\frac{1+\beta}{1-\beta}\right)$$

$$\boxed{T_1 = RC\ln\left(\frac{1+\beta}{1-\beta}\right)}$$

This is give only half of the period

Total time period

$$\boxed{T = 2T_1 = 2RC\ln\left(\frac{1+\beta}{1-\beta}\right)}$$

And output wave form is symmetrical

If $R_1 = R_2$, then $\beta = 0.5$ and $T = 2RC$

in 3.

And for $R_1 = 1.16 R_2$, it can be

Seen that $T = RC$

or $f_o = \dfrac{1}{2RC}$

output swings from $+V_{sat}$ to $-V_{sat}$

V_o peak-to-peak $= 2V_{sat}$