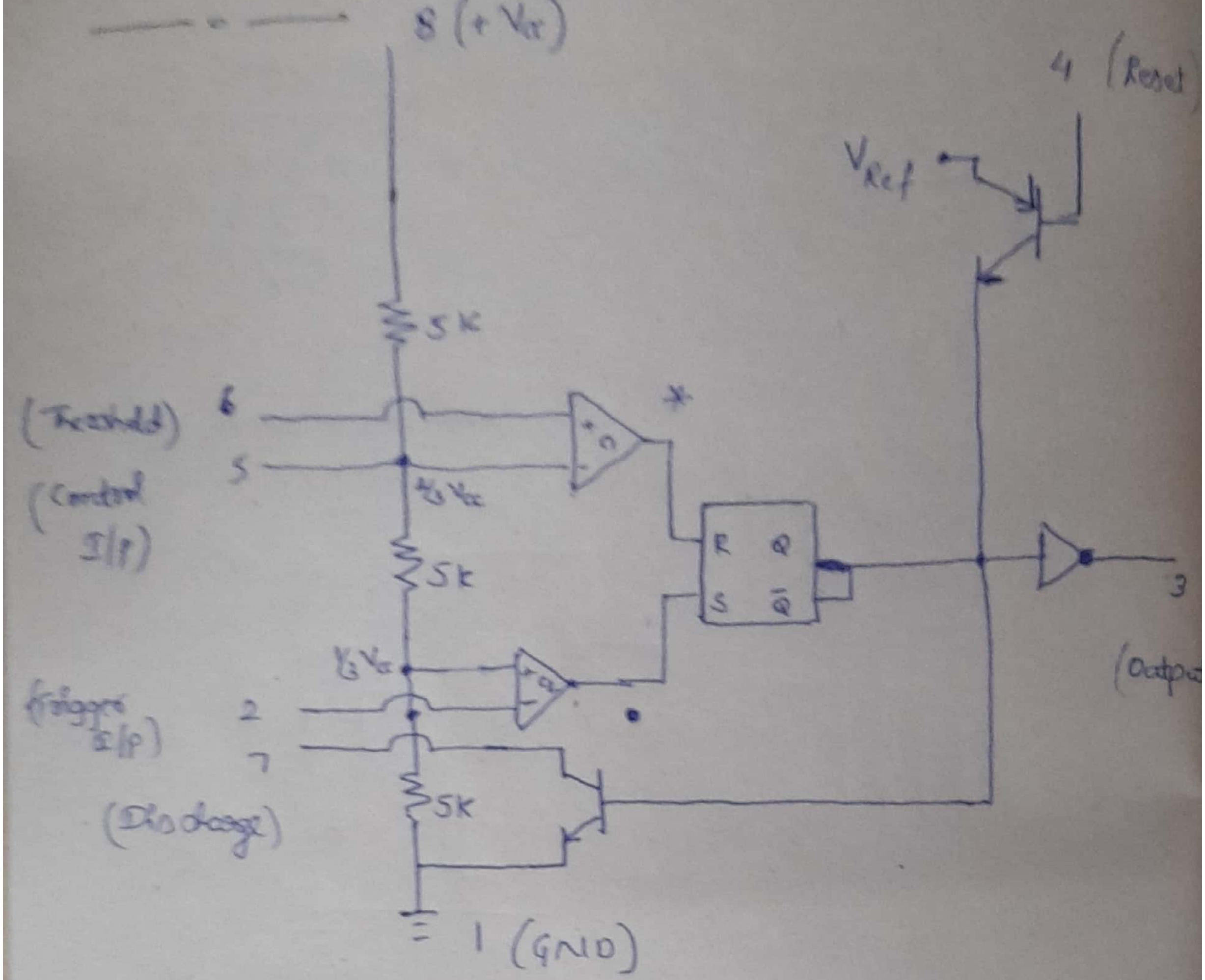
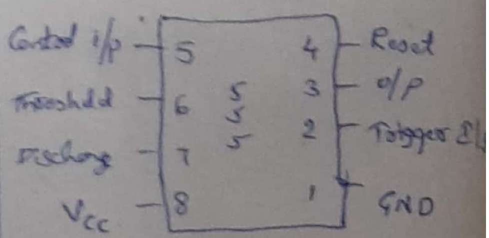
Unit. 5 : Linear IC's

555 Timer



R	S	Q	$\bar{Q}$	
0	0	Q	$\bar{Q}$	No change
0	1	1	0	Set
1	0	0	1	Reset
1	1	0^*	0^*	Invalid



S

- Trigger i/p > $\frac{1}{3}V_{cc} \rightarrow 0$
  Trigger i/p < $\frac{1}{3}V_{cc} \rightarrow 1$

R

* Threshold > $\frac{2}{3}V_{cc} \rightarrow 1$
Threshold < $\frac{2}{3}V_{cc} \rightarrow 0$

Scanned with OKEN Scanner

⇒ when Trigger i/p < 1/3 V_{cc} → Set pin is High (1)
Output is High (1), discharge transistor is Off ($\bar{1}$) ($\bar{0}$)

→ when Threshold i/p > 2/3 V_{cc}

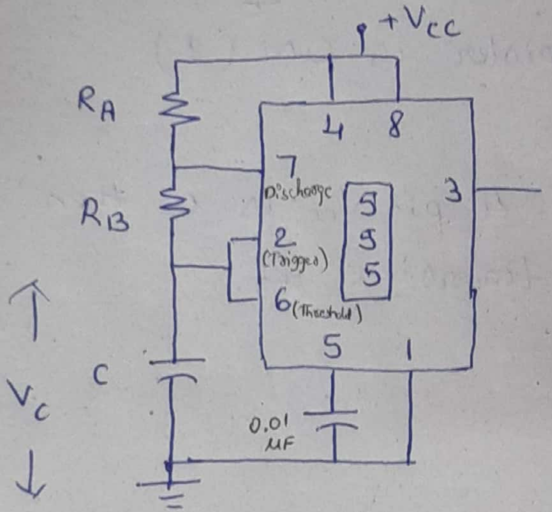
then R = 1
then Q = 0, $\bar{Q}$ = 1
compt
∴ Output = $\underline{0}$
Discharge transistor is ON (1)

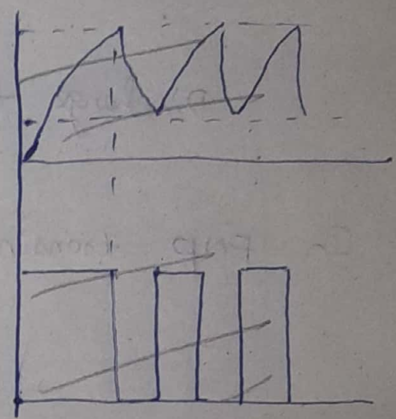
→ In PNP transistor 4 pin V_{cc} is 0 then transistor off

Multivibrator (Using 555 Timer)

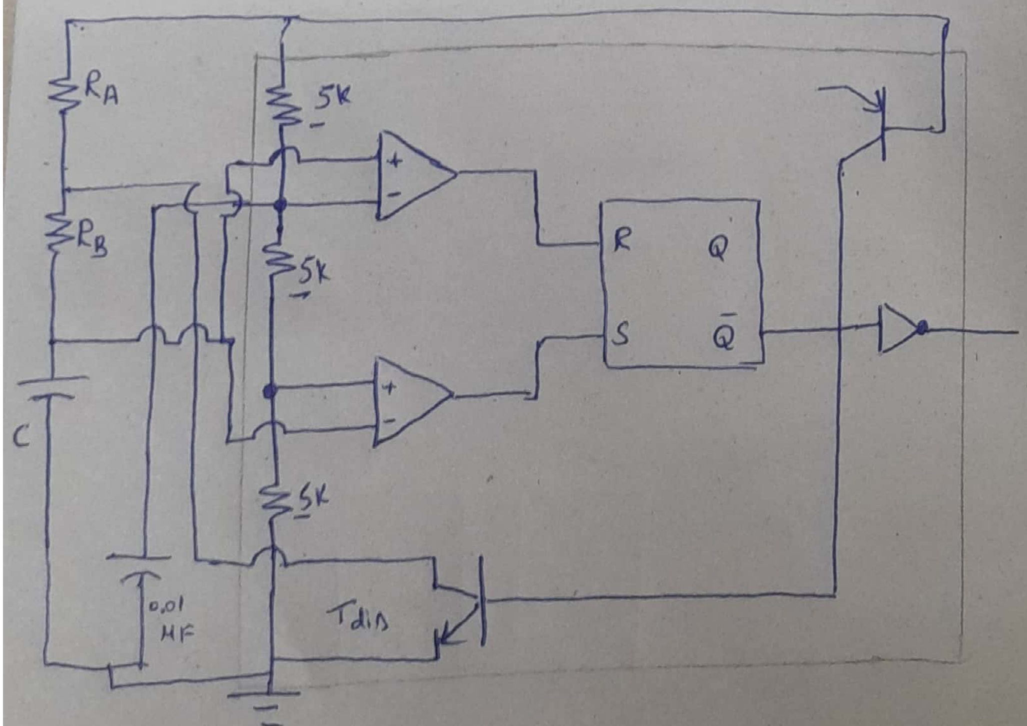
- Astable Multivibrator (zero stable state)
- Monostable Multivibrator (one stable state)
- Bistable Multivibrator (two stable state)

Astable Multivibrator



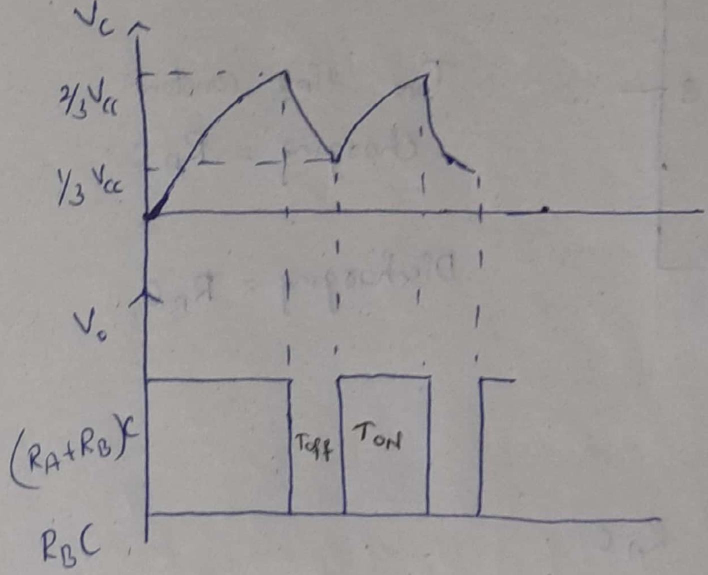


Internal

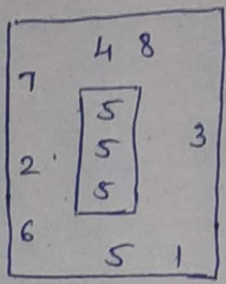


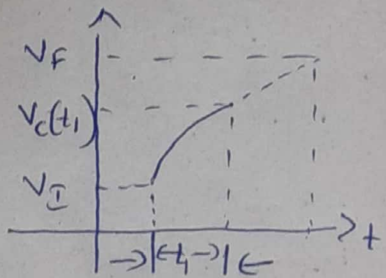
* Charging Time const = $(R_A + R_B)C$

Discharging time const = $R_B C$

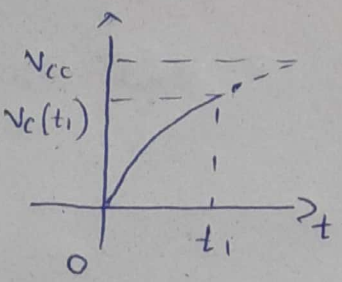


Astable Multivibrator using 555 Timer

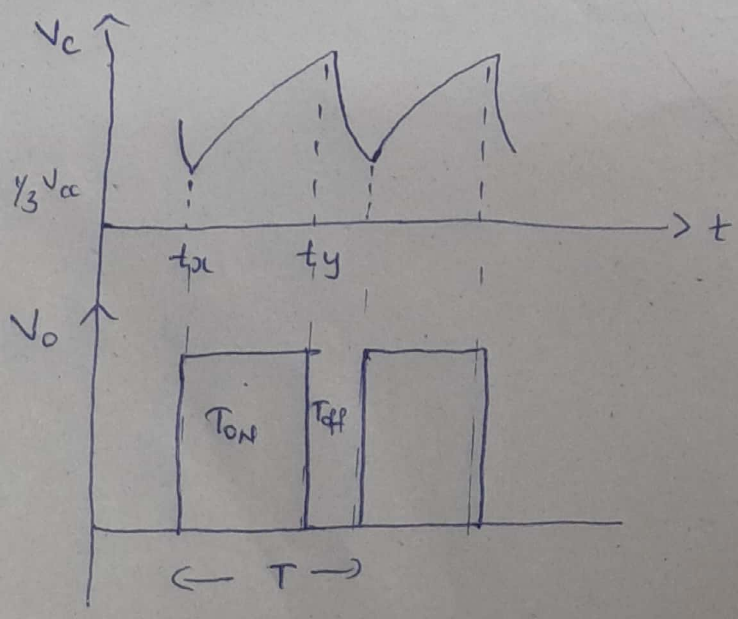




$$V_c(t_1) = V_F - (V_F - V_I)\, e^{-t_1/RC}$$



$$V_c(t_1) = V_{cc}\left(1 - e^{-t/RC}\right)$$



Charging time constant $= (R_A + R_B)C$

Discharging $= R_B C$

To find t_x

$$V_c(t_x) = V_{CC}\left(1 - e^{\frac{-t_x}{(R_A+R_B)C}}\right)$$

$$\frac{1}{3}V_{CC} = V_{CC}\left(1 - e^{\frac{-t_x}{(R_A+R_B)C}}\right)$$

$$\cancel{-}\, e^{\frac{-t_x}{(R_A+R_B)C}} = \frac{1}{3} - 1 = \cancel{-}\frac{2}{3}$$

$$\frac{\cancel{-}\, t_x}{(R_A+R_B)C} = \ln\left(\frac{2}{3}\right) = \cancel{-}\,0.4054$$

$$\boxed{t_x = 0.4054\,(R_A+R_B)C}$$

to find t_y

$$V_c(t_y) = V_{CC}\left(1 - e^{\frac{-t_y}{(R_A+R_B)C}}\right)$$

$$\frac{2}{3}V_{CC} = V_{CC}\left(1 - e^{\frac{-t_y}{(R_A+R_B)C}}\right)$$

$$\cancel{-}\, e^{\frac{-t_y}{(R_A+R_B)C}} = \frac{2}{3} - 1 = \cancel{-}\frac{1}{3}$$

$$\frac{\cancel{-}\, t_y}{(R_A+R_B)C} = \ln\left(1/3\right) = \cancel{-}1.0986$$

$$\boxed{t_y = 1.0986\,(R_A + R_B)\,C}$$

$$T_{ON} = t_y - t_x$$

$$\boxed{T_{ON} = 0.693\,(R_A + R_B)\,C}$$

$||^{ly}$ $\boxed{T_{off} = 0.693\,R_B C}$

$$T = T_{ON} + T_{off} = 0.693\,(R_A + 2R_B)\,C$$

$$\text{Duty Cycle} = \frac{T_{ON}}{T} = \frac{0.693\,(R_A + R_B)\cancel{C}}{0.693\,(R_A + 2R_B)\cancel{C}}$$

$$\text{Duty Cycle} = \frac{R_A + R_B}{R_A + 2R_B}$$

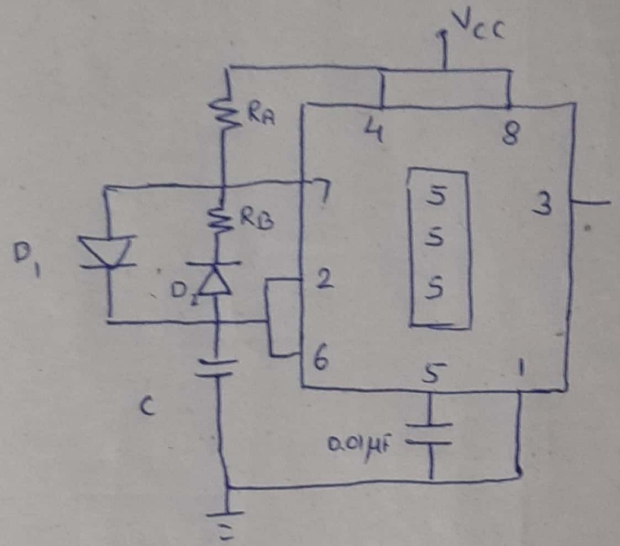
$$f = \frac{1}{T} = \frac{1}{0.693\,(R_A + 2R_B)\,C}$$

Design Astable MV using 555 timer for following specification

(i) $f = 1\ KHz$, 50% Duty Cycle

(ii) $f = 1K\ Hz$, 75% Duty cycle

(iii) $f = 1\ KHz$, Duty cycle = 25%



(i) $T = \frac{1}{f} = 1\ ms$

Duty cycle = $\frac{T_{ON}}{T}$ $\therefore T_{ON} = 0.5 \times 1 \times 10^{-3}$

$= 0.5\ ms$

$T = T_{ON} + T_{of}$

$T_{off} = 0.5\ ms$

$T_{ON} = 0.693\,(R_A + \cancel{R_B})\,C = 0.5ms$ Let $C = 0.1\mu f$

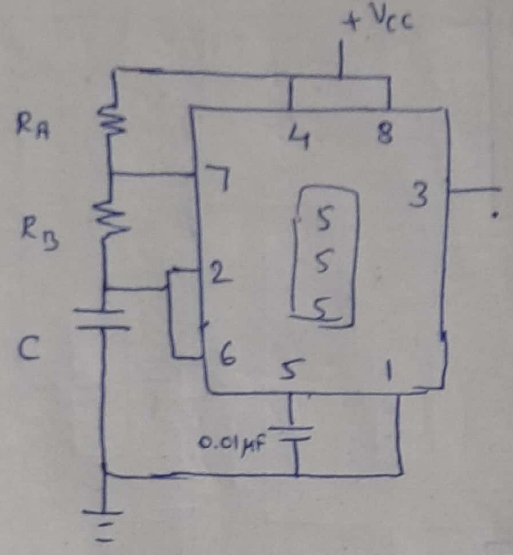
$T_{off} = 0.693\,(R_B)\,C = 0.5\ ms$

$R_A = \frac{0.5 \times 10^{-3}}{.693 \times 0.1 \times 10^{-6}} = 7.2\ k\Omega$

$R_B = 7.2\ K\Omega$

Design a Astable MV using 555 timer without using diode for foll spec

① $f_{o/p} = 1\,KHz$, Duty cycle = 70%



$T = \frac{1}{f} = 1ms$

Duty cycle = $\frac{T_{ON}}{T} = 0.7$

$T_{ON} = 0.7\,ms$

$T = T_{off} + T_{ON} = 1ms$. $C = 0.1\mu F$

$T_{off} = 0.3\,ms$

$T_{ON} = 0.693\,(R_A + R_B)C = 0.7ms$ — ①

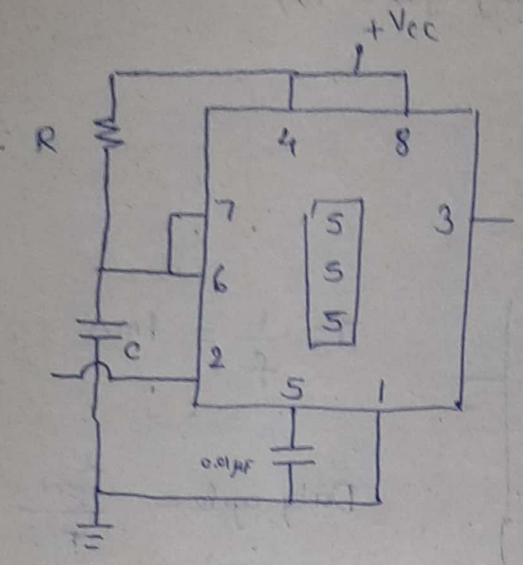
$T_{off} = 0.693\,R_B C = 0.3ms$

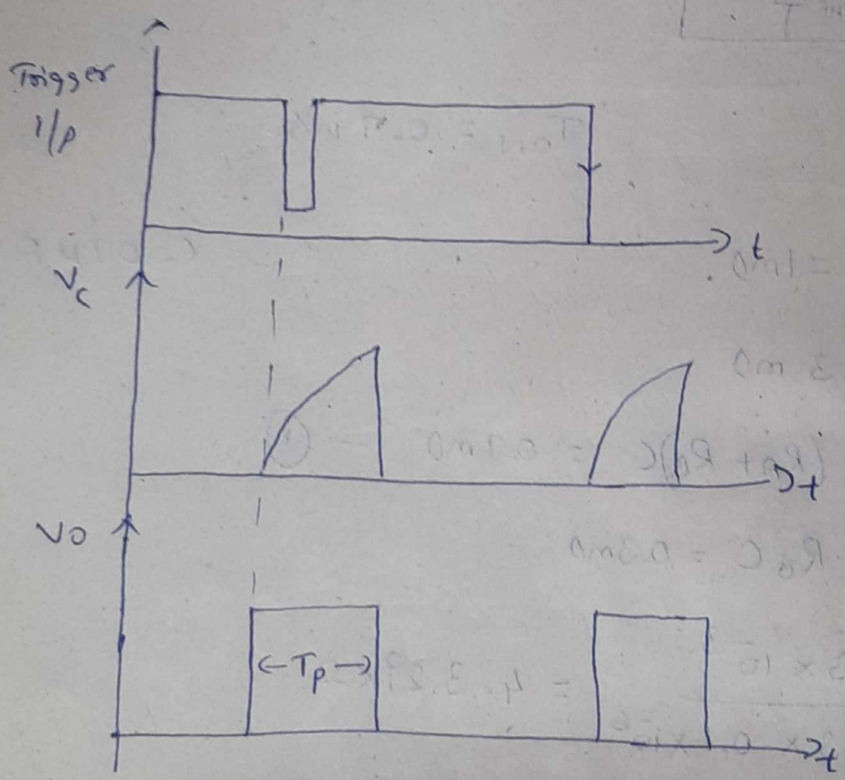
$R_B = \frac{0.3 \times 10^{-3}}{0.693 \times 0.1 \times 10^{-6}} = 4.329K\Omega$

① ⇒ $R_A + 4.33 \times 10^{3} = \frac{0.7 \times 10^{-3}}{0.1 \times 10^{-6} \times 0.693}$

$$\boxed{R_A = 5.77\ K\Omega}$$

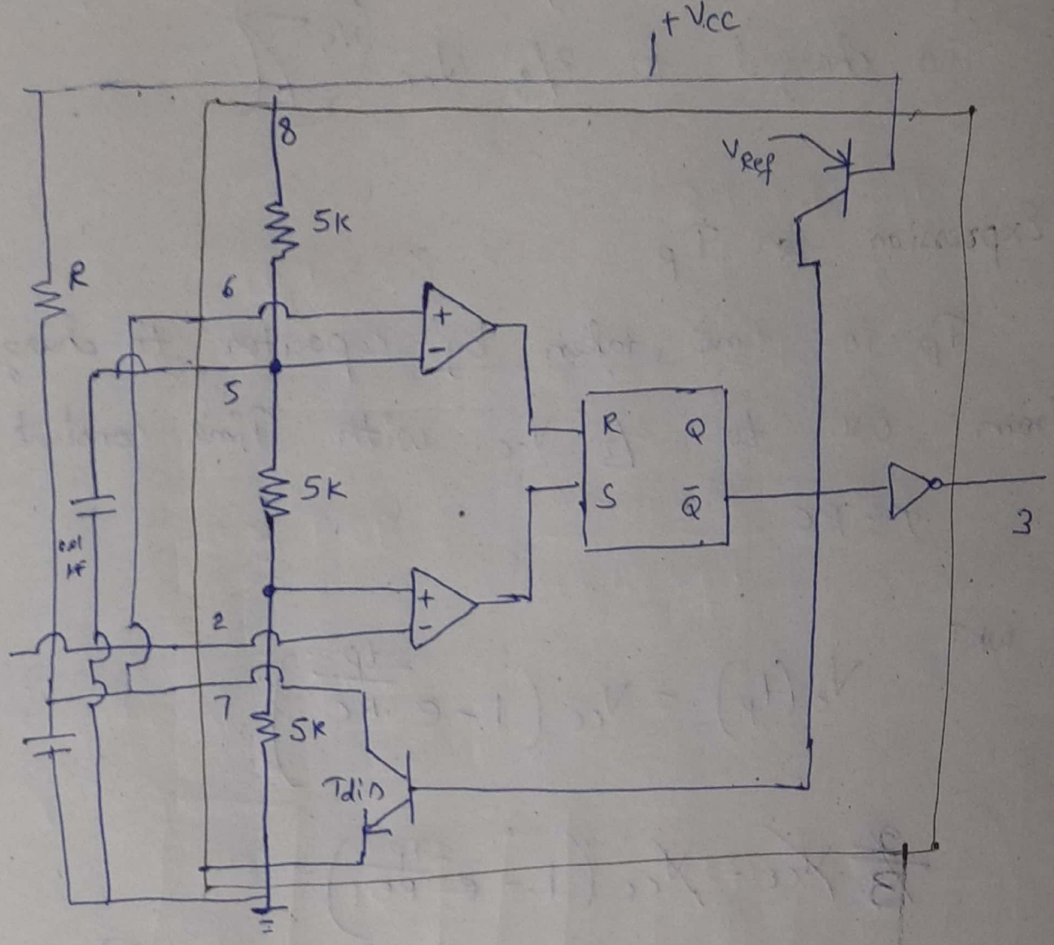
Monostable Multi vibrator



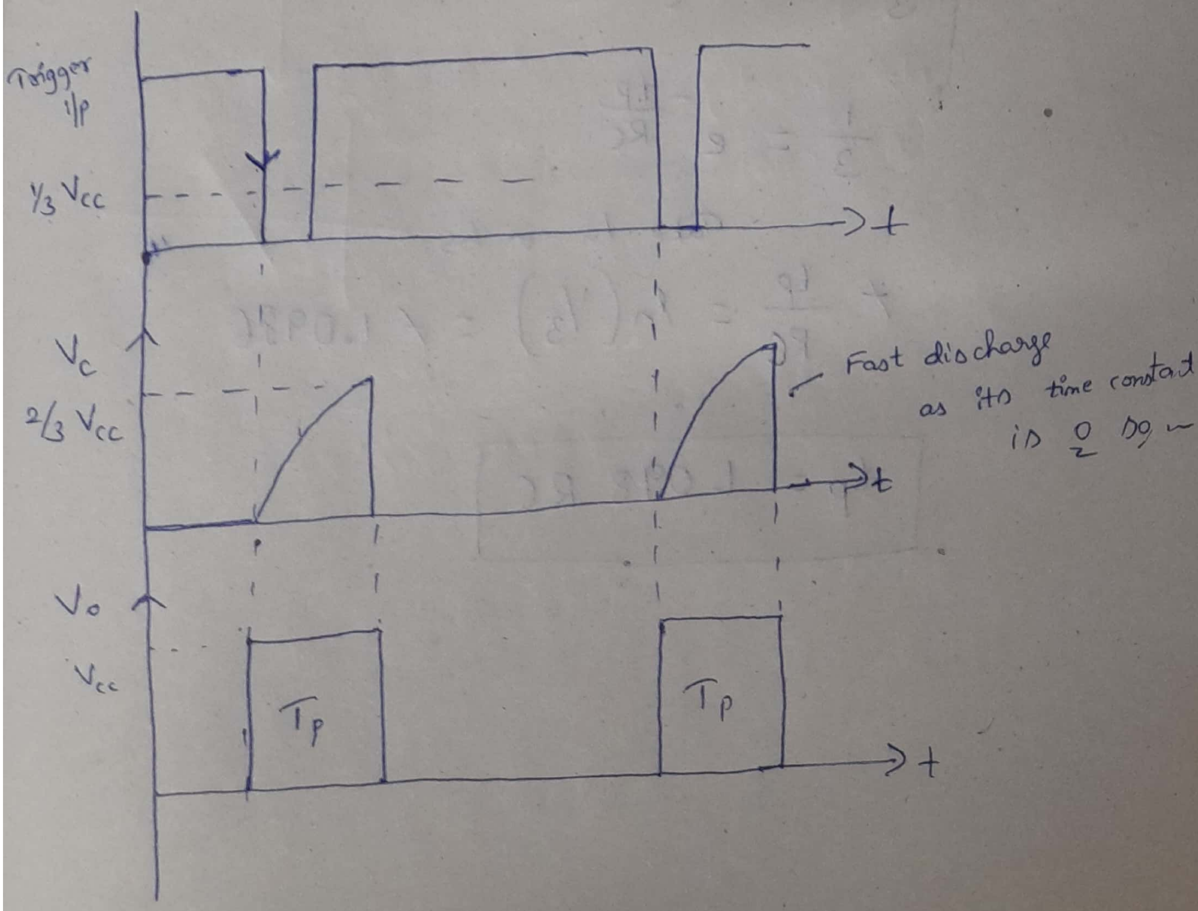


Applⁿ: Pulse streching (If trigger i/p is longer duration)

	No change
R	0
S	0



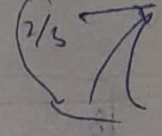
+Vcc
8
5K
R
6
5
5K
2
7
5K
Tdis
VRef
R
S
Q
Q̄
3



Trigger i/p
1/3 Vcc
t
Vc
2/3 Vcc
Fast discharge as its time constant is ≅ 0
t
Vo
Vcc
Tp
Tp
t

Appl^n: Timer

→ T_p is decided by how fast the capaci[tor]
is charged to $2/3\ V_{CC}$



Expression for T_p

T_p is time taken by capacitor to charge
from 0V to $2/3\ V_{CC}$ with Time constant

$T = RC$

WKT

$$V_c(t_p) = V_{CC}\left(1 - e^{-\frac{t_p}{RC}}\right)$$

$$\frac{2}{3}\cancel{V_{CC}} = \cancel{V_{CC}}\left(1 - e^{-\frac{t_p}{RC}}\right)$$

$$\frac{2}{3} - 1 = -e^{-\frac{t_p}{RC}}$$

$$\frac{1}{3} = e^{-\frac{t_p}{RC}}$$

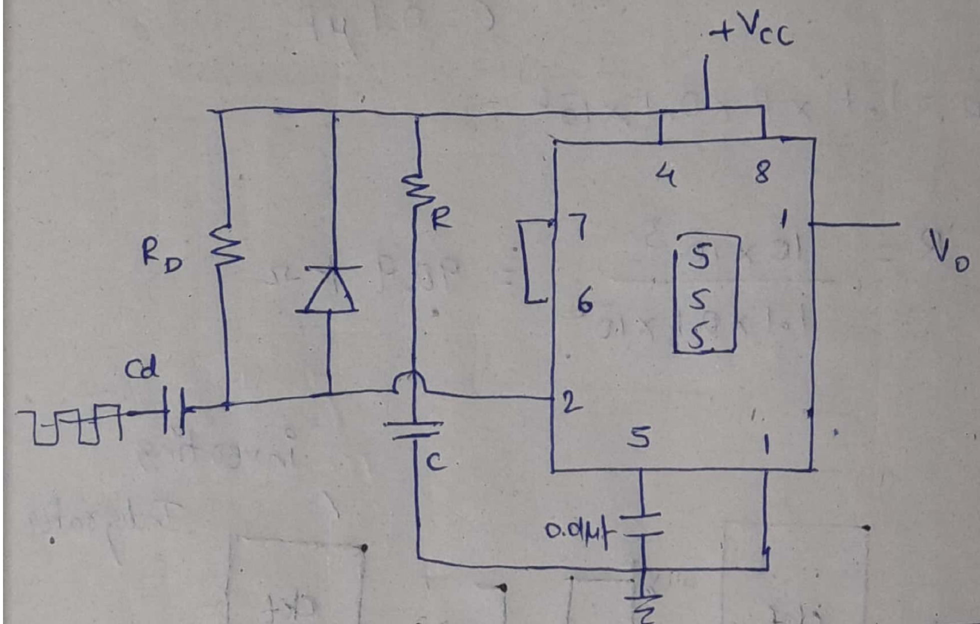
Take ln on bs

$$\cancel{+}\frac{t_p}{RC} = \ln(1/3) = \cancel{+}1.0986$$

$$\boxed{t_p = 1.098\ RC}$$

→ For Trigger to happen ⇒ $T_{off} << t_p$

Monostable MV (without false triggering)



$\boxed{C_D R_D << T}$

⑩ Design a Monostable MV which generate pulse of durⁿ 10 ms

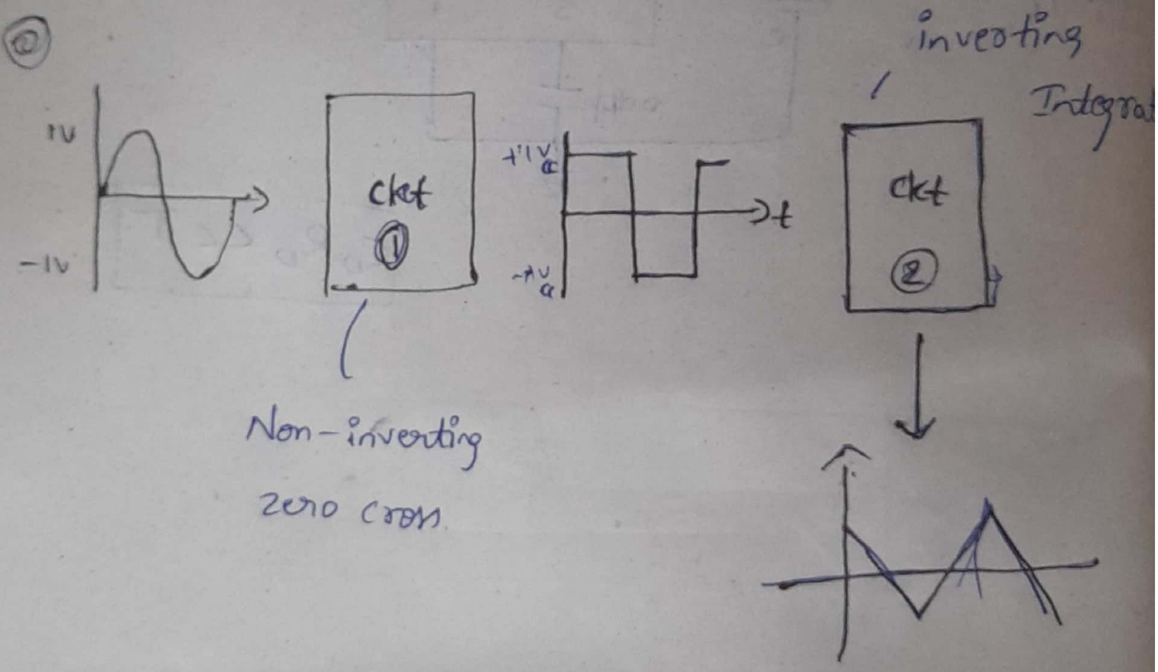
$t_p = 1.1\ RC$

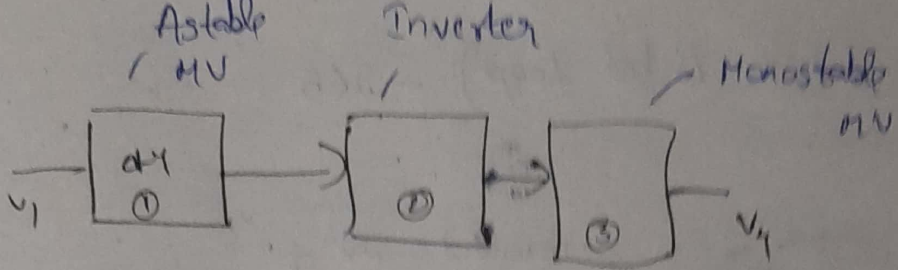
$C = 0.1\ \mu F$

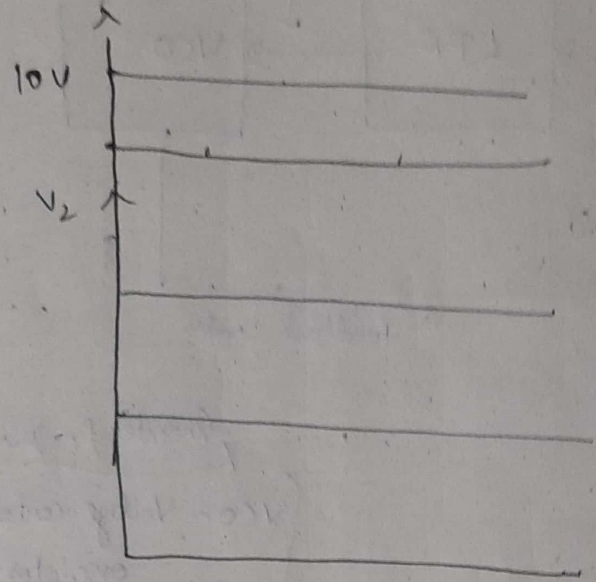
$t_p = 1.1 \times R \times 0.1 \times 10^{-6}$

$R = \dfrac{10 \times 10^{-3}}{1.1 \times 0.1 \times 10^{-6}} = 90.9\ k\Omega$

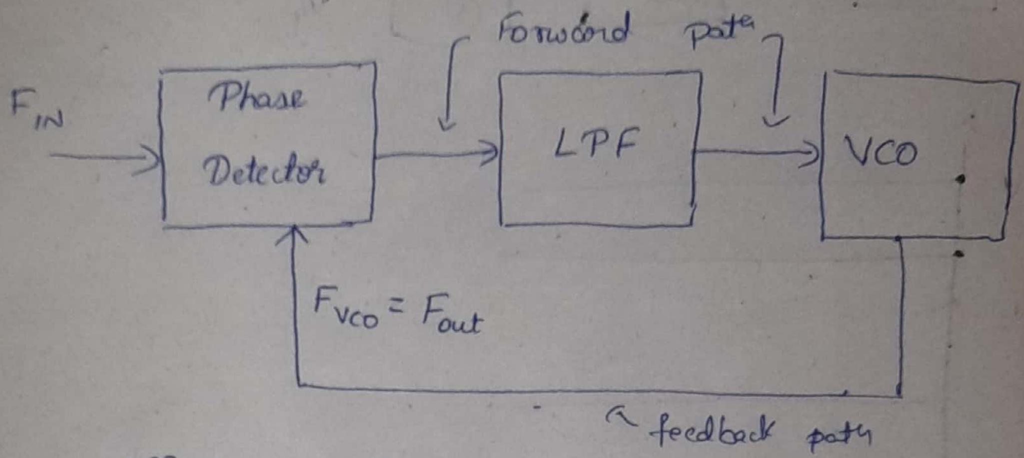
⑩




Astable MV
Inverter
Monostable MV
V1
1
2
3
V4


10V
V2

PLL (Phase Locked Loop) – 565



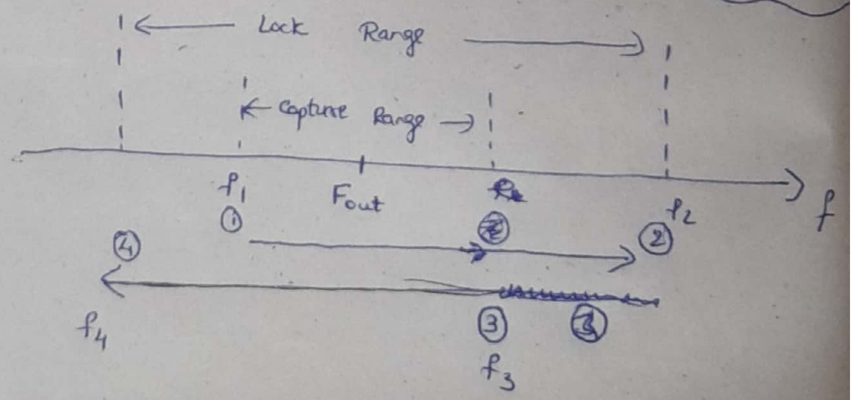
LPF ⇒ low pass filter.

Generate frequency

VCO – Voltage control oscilator
↳ o/p frq depend on i/p volt

<u>States</u>

* Free running
* Capture
* Lock



* Phase and frequency are dependent

* In capture range VCO frq is equal to i/p frq

Application

(i) Demodulation

(ii) Frequency synthesis

(iii) Frequency division

(iv) FSK demodulation (Frequency shift key)

Block diagram

DAC
- Basic concepts
- specification
- Errors
- Binary weighted DAC
- R-2R Ladder DAC

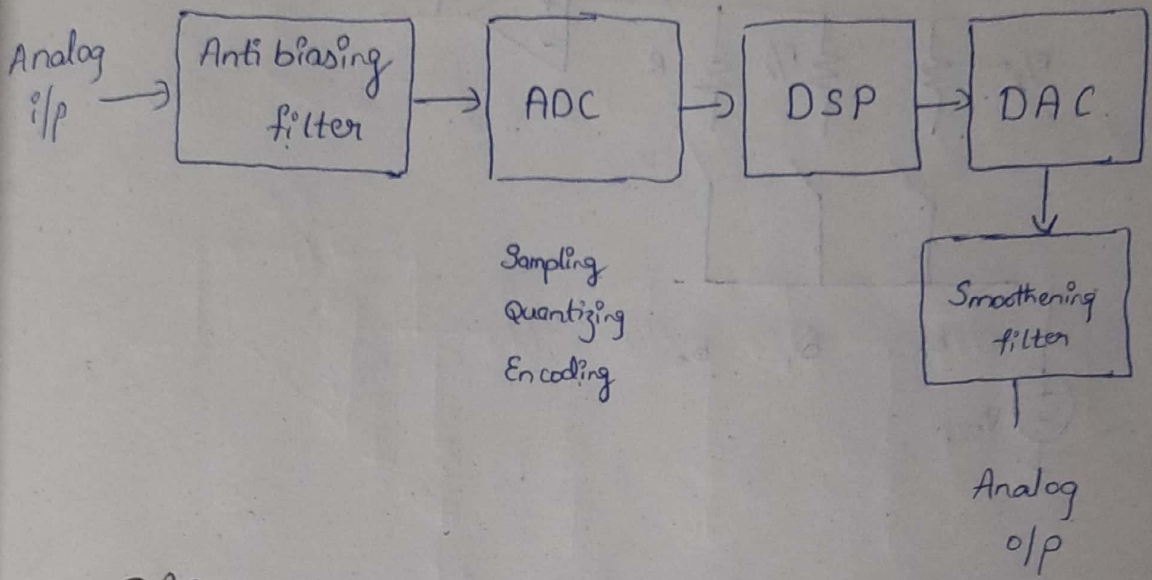
ADC
- Succesive approximtⁿ ADC
- ADC using DAC
- Flash Type

Analog: Continuous time signal & cont amplitude

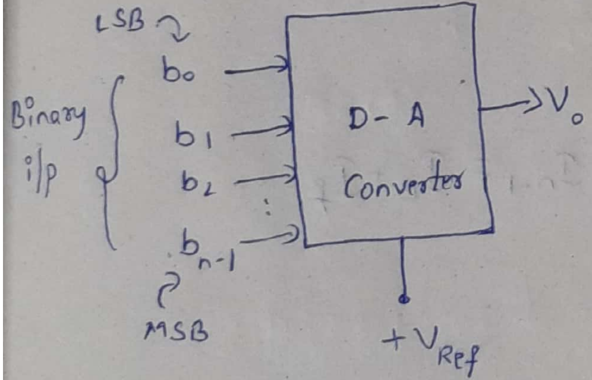
ADC → Discrete time cont amplitud

DSP- Digital signal processing

Block diagram of A-D & D-A Conversion



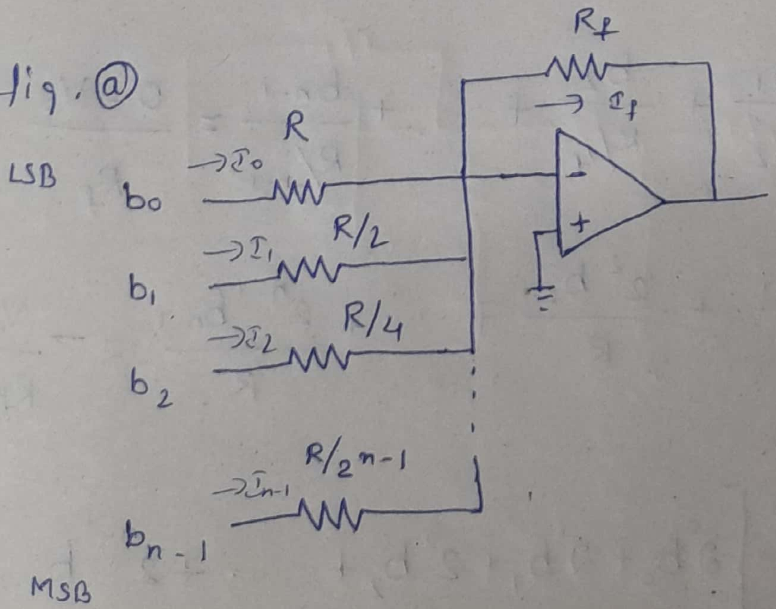
DAC



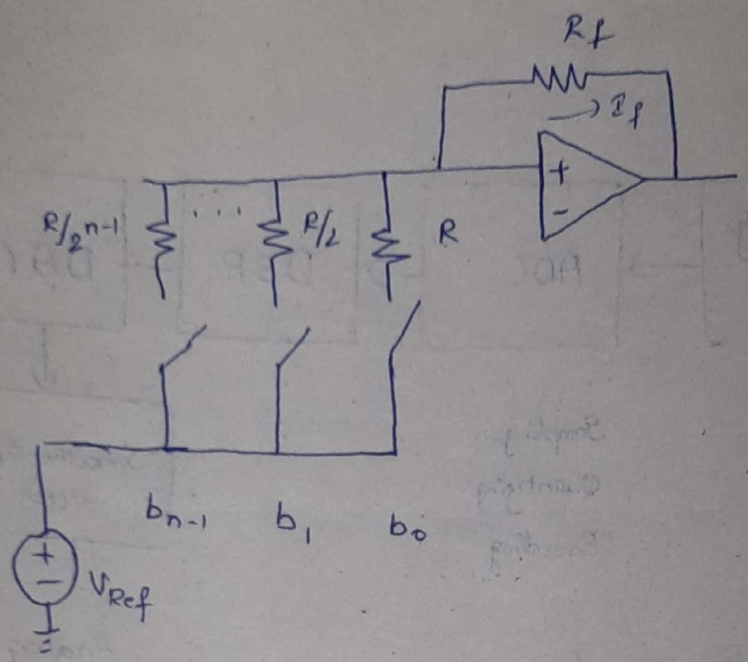
Binary weight

R-2R Ladder DAC

fig. (a)



$\frac{R}{2^n}$



* LSB will have highest resistance

⇒ From fig ⓐ

$$I_0 + I_1 + I_2 + \dots + I_{n-1} = I_B + I_f$$

$$I_B = 0 \qquad R_i = \infty$$

$$I_0 + I_1 + I_2 + \dots + I_{n-1} = I_f$$

$$\frac{b_0}{R} + \frac{b_1}{R/2} + \frac{b_2}{R/4} + \dots + \frac{b_{n-1}}{R/2^{n-1}} = \frac{0 - V_o}{R_f}$$

$$\frac{b_0}{R} + \frac{2b_1}{R} + \frac{2^2 b_2}{R} + \dots + \frac{2^{n-1} b_{n-1}}{R} = -\frac{V_o}{R_f}$$

$$V_o = -\frac{R_f}{R}\left[2^0 b_0 + 2^1 b_1 + 2^2 b_2 + \dots + 2^{n-1} b_{n-1}\right]$$

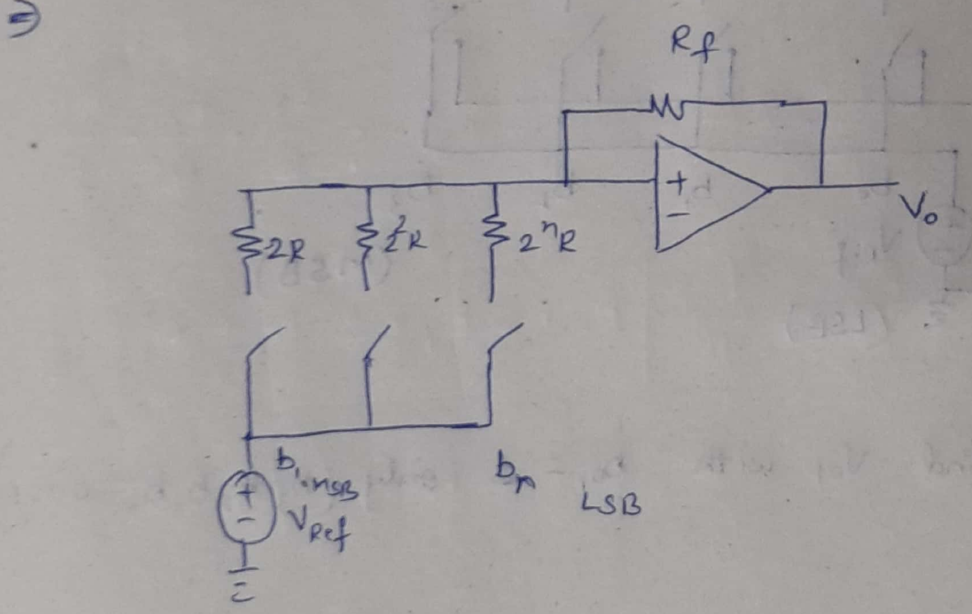
Here $b_i = 0$

$b_i = +V_{Ref}$ for binary data '1'

* So for b_i is high it is Vref

$$\boxed{V_o = -\frac{R_f}{R} \times V_{Ref}\left[b_0 + 2^1 b_1 + 2^2 b_2 + \dots + 2^{n-1} b_{n-1}\right]}$$

for b_i should be '1' or '0'



$$V_o = -\frac{R_f}{R} \times V_{Ref}\left[\frac{b_1}{2^1} + \frac{b_2}{2^2} + \dots + \frac{b_n}{2^n}\right]$$

MSB LSB

Advantage

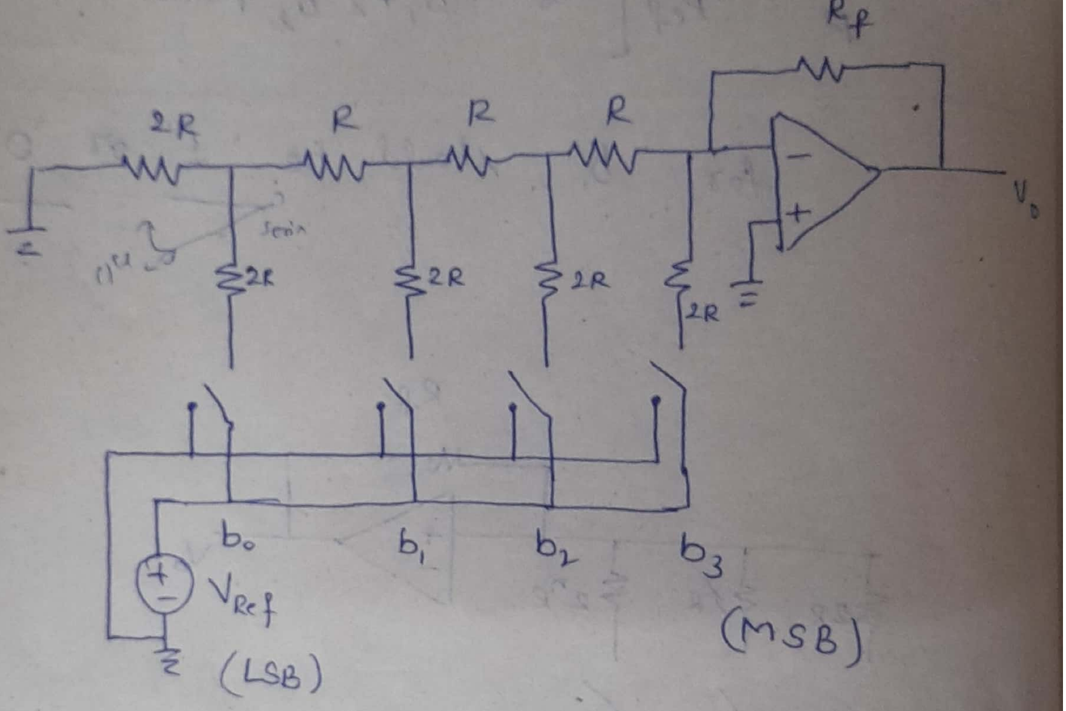
Easy to Design

Disadvantage

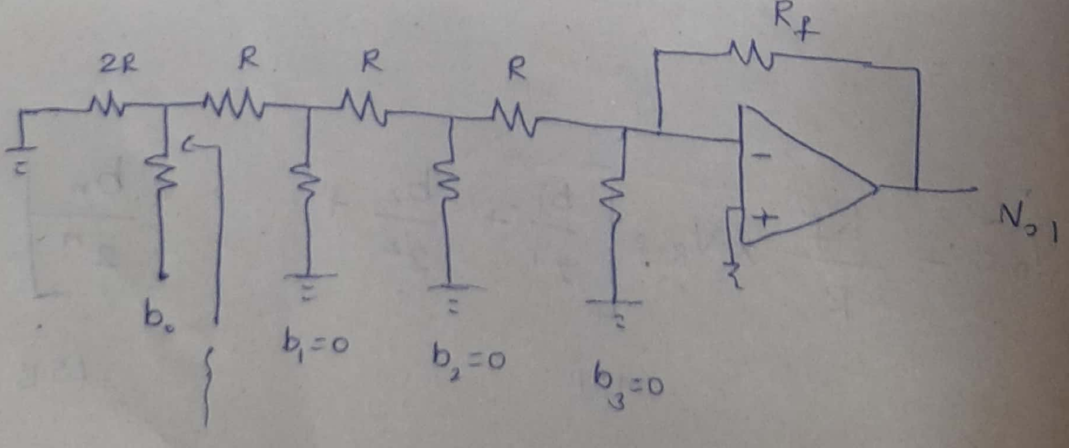
Availability of standard weighted resistance is difficult

lab R-2R ckt

Advantage : Require only 2 type Res

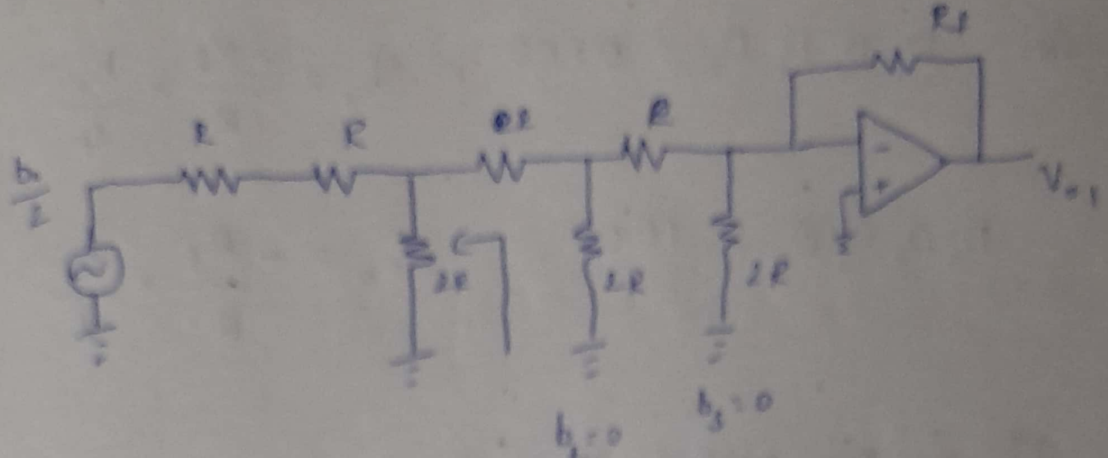


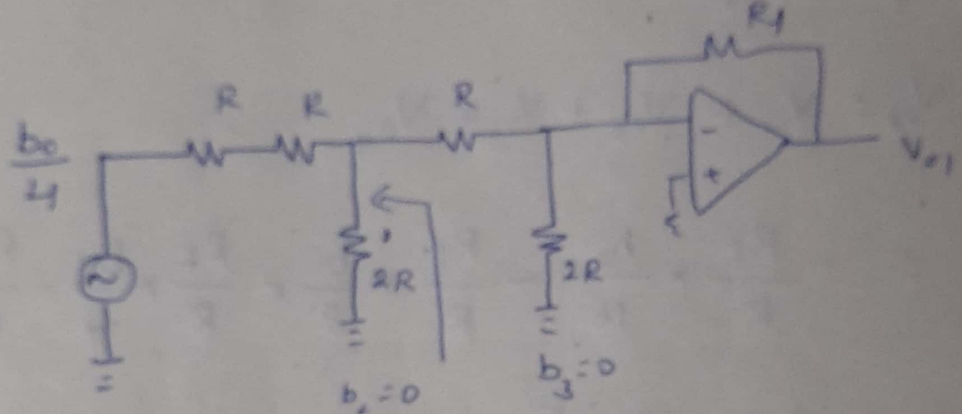
To find V_{01} with $b_{01} = 1$ only $(b_3 b_2 b_1 b_0 = 000$

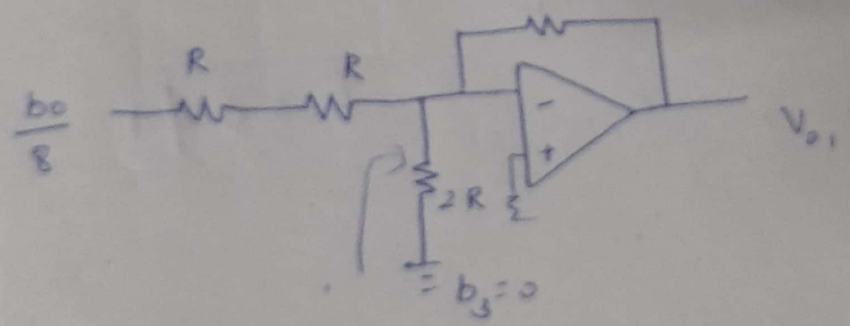


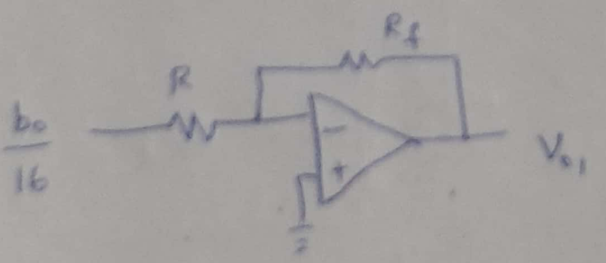
Apply thevenin eqn

Using thevenin's eqⁿ









$$\boxed{V_{o1} = -\frac{R_f}{R} \times \frac{b_0}{16}}$$

for $D_3 D_2 D_1 D_0 = 0010$, $V_{o2} = -\frac{R_f}{R} \times \frac{b_1}{8}$

for $D_3 D_2 D_1 D_0 = 0100$, $V_{o3} = \frac{-R_f}{R} \times \frac{b_2}{4}$

$D_3 D_2 D_1 D_0 = 1000$, $V_{o4} = -\frac{R_f}{R} \times \frac{b_3}{2}$

Using superposition theorem

$$V_o = V_{o1} + V_{o2} + V_{o3} + V_{o4}$$

$$= -\frac{R_f}{R} \times \frac{b_0}{16} - \frac{R_f}{R} \times \frac{b_1}{8} - \frac{R_f}{R} \times \frac{b_2}{4} - \frac{R_f}{R} \frac{b}{}$$

$$V_o = -\frac{R_f}{R} \times \frac{V_{Ref}}{16} \left[b_0 + 2b_1 + 2^2 b_2 + 2^3 b_3 \right]$$

$b_i = 0 / 1$