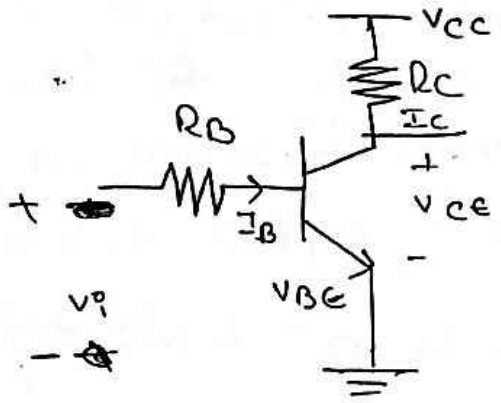
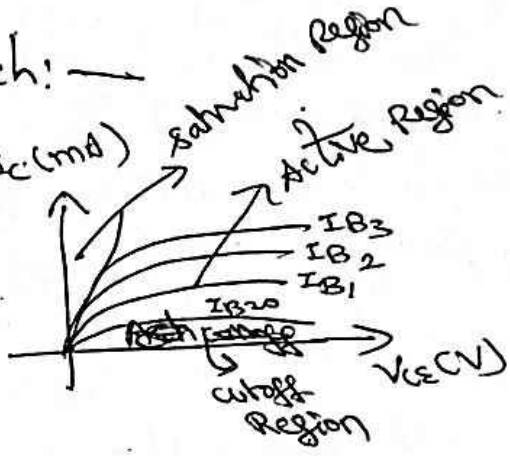
Unit - IV & III

Multivibrators

Transistor Acts as a switch:—





BJT Transistor is used as switching elements. It has three regions of operation.

* when both emitter base and collector base junctions are reverse biased the transistor operates in cutoff region and it acts as open switch.
* when emitter base junction is forward biased and collector base junction is reverse biased then the transistor operates in active region and it acts as an Amp.
* when both emitter base and collector base junctions are forward biased then transistor operates in saturation region and it acts as closed switch

V-I characteristics:

From the above ckt applying the KVL

$$-V_{cc} + I_C R_C + V_{CE} = 0$$

$$I_C = \frac{V_{cc} - V_{CE}}{R_C}$$

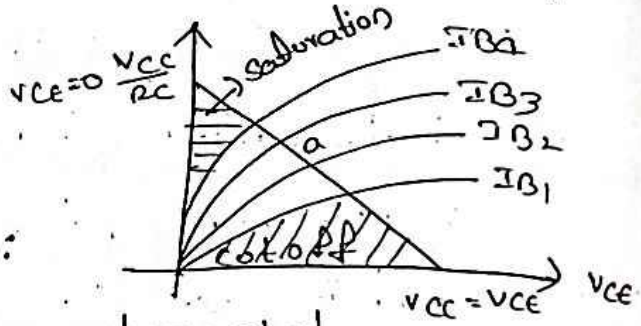
If $V_{CE} = 0$ then $I_{C_{sat}} = \frac{V_{CC} - 0}{R_C} = \frac{V_{CC}}{R_C}$

i.e when the transistor is in saturation region voltages are very small but operating current is very large.

If $I_C = 0 \Rightarrow 0 = \frac{V_{CC} - V_{CE}}{R_C}$

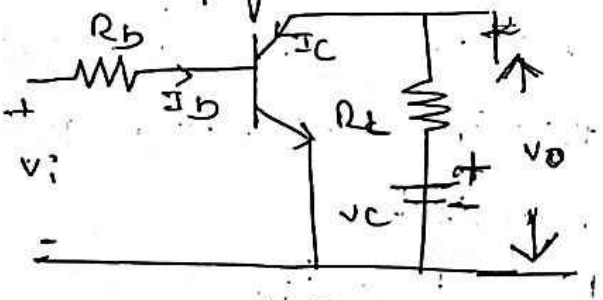
$\Rightarrow V_{CC} = V_{CE}$

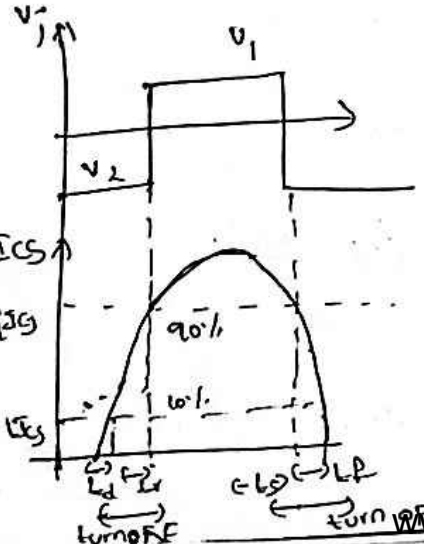
i.e when the transistor is in cut off region the current are zero but the junction voltage is large.



Transistor switching times:

The speed with which a transistor can be switched ON and switched OFF is a critical factor in high speed switching operations when transistor acts as a switch it is either in cut off region (or) saturation region.





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consider the pulse wave makes transistion b/o voltage levels v_1 and v_2 at v_1 the transistor used in saturation region. At v_2 the transistor used in cut off region. In the above ckt the collector current doesn't immediately respond to i/p signal instead there is a delay and the time that elapse during this delay.

Delay time:—

The time required for the current to rise 10% of its saturation value after the application of i/p signal is called delay time t_d.

Rise time (t_r):

The time required for the current to rise from 10% to 90% of the saturation value is called the rise time.

Turn on time:—

The total turn on time is the sum of the delay time and rise time. It is denoted as t_{on}

$$t_{on} = t_d + t_r$$

storage time (t_s):

The time interval which elapses b/w the transistion of i/p wave form and the time when saturation current has dropped to 90% of saturation value is called storage time.

Fall time:— (t_f):

The time required for saturation current to fall from 90% to 10% of its saturation level

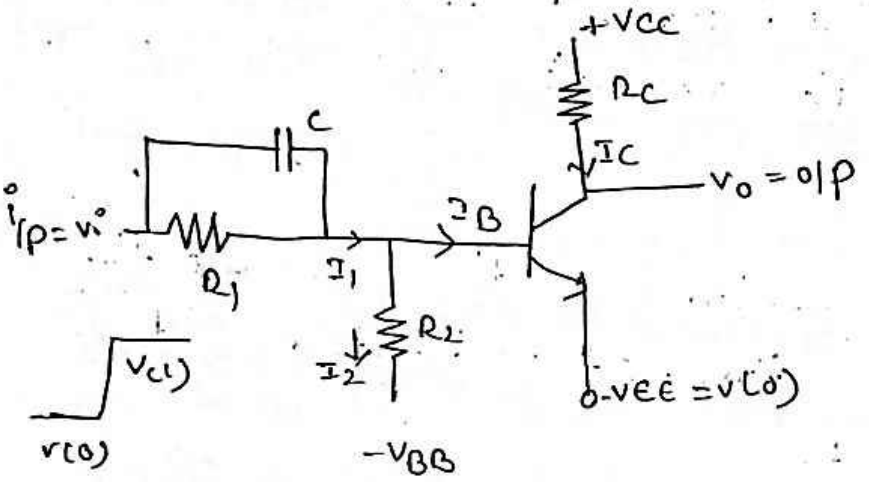
is called fall time.

turn OFF time:

The total turn OFF time is the sum of the storage time and Fall time $t_{OFF} = t_s + t_f$

The property of BJT by which it can be turned ON and turned OFF alternatively and rapidly makes the transistor ideally fit to be used as a "Fast acting electronic switch". Thus the transistor find extensive application in digital ckts

Design of transistor switch:



Any transistor amp that has the property of inversion can be used as invertor. The transistor acts as a switch, is given b/w cut OFF and saturation. To prove the transient response of invertor the capacitor 'c' is used across the resistor R_1 this helps the removing minority charge carriers in the base when the

signal changes b/w $V_{(0)}$ and $V_{(1)}$

when $V_{(i)} = V_{(1)}$ the transistor is in saturation

i.e on condition from the above ckt

$$I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

WKT $I_C = h_{fe} I_B$

$$I_B = \frac{I_C}{h_{fe}} = \frac{V_{CC} - V_{CE}}{R_C h_{fe}} \quad \text{---(1)}$$

current through the resistor R_1 is

$$I_1 = \frac{V_{(1)} - V_{BE}(sat)}{R_1}$$

current through the R_2 is

$$I_2 = \frac{V_{BE}(sat) - (-V_{BB})}{R_2}$$

From the ckt $I_B = I_1 - I_2$

$$I_B = \frac{V_{(1)} - V_{BE}(sat)}{R_1} + \left[\frac{V_{BE}(sat) - V_{BB}}{R_2}\right] \quad \text{---(2)}$$

eq(1) = (2)

$$\frac{V_{CC} - V_{CE}}{R_C h_{fe}} = \frac{V_{(1)} - V_{BE}(sat)}{R_1} - \left[\frac{V_{BE}(sat) - V_{BB}}{R_2}\right]$$

when we are designing transistor as a switch we much select R_1 & R_2 value for satisfying above eq?.

If $V_1 = V_{(0)}$ the transistor is in cutoff region i.e OFF state then $V_B = V_{(0)} \cdot \frac{R_2}{R_2 + R_1} - V_{BB} \frac{R_1}{R_1 + R_2}$

THE END

CRAZY NOTES JNTUK

Multivibrator:— 3rd unit

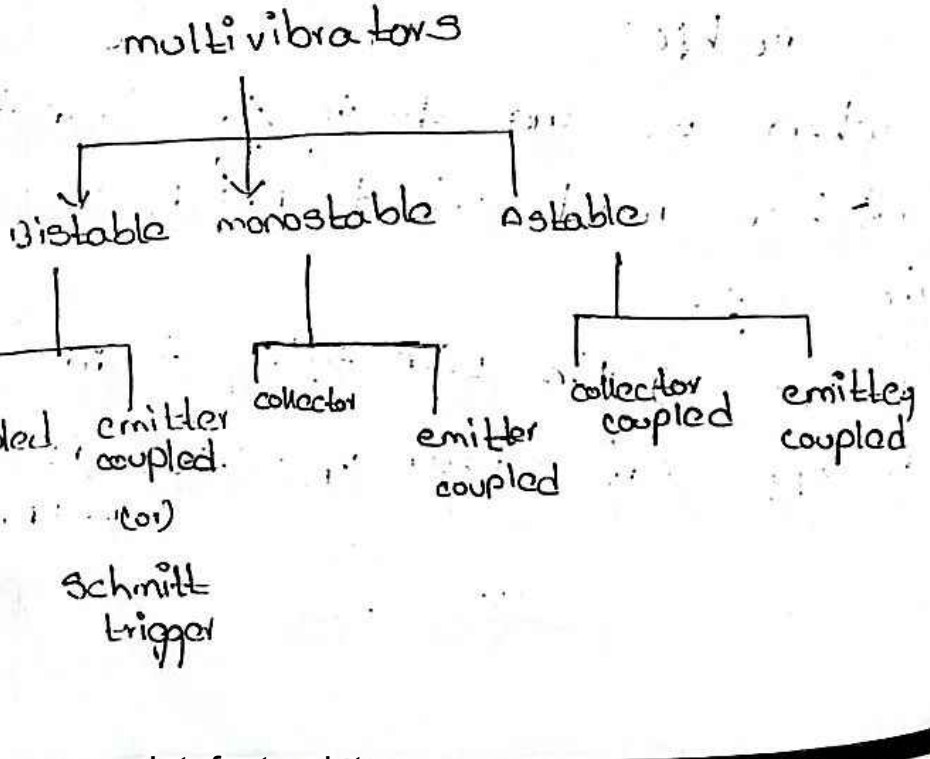
A multivibratay is a basically 2 stage RC coupled amplifieg with +ve feed back from the o/p of one amplifieg to the i/p of otheg amplifieg Multi means many, vibratag means oscillatag. A ckt which can oscillate at no of frequency is called multivibratag.

Multivibrators aye used in storing binary numbegs, counting pulses, synchronizing aythematic operations and also generates the non sinusoidal waves.

classifications of multivibrators:

Multivibrators aye classified into 3 types. Based upon theig o/p stage.

(i) Bistable multivibrators
(ii) Monostable multivibrators
(iii) Astable multivibrators.



other names of bistable multivibrators are
→ flip flop
→ binary ckts
→ Eccles jordhan ckt
→ Trigger ckt
→ scale of two toggle ckt

other names of monostable multivibrator
→ single shot ckt
→ one shot
→ pulse generator
→ univibrator, delay ckt
→ gating ckt, single swing

other names of astable multivibrator
→ free running oscillator
→ square wave generator
→ relaxation oscillator
→ symmetric
→ synchronized oscillator

There are only two possible states of multivibrator

1st state

Transistor Q_1 ON, Q_2 OFF

2nd state

Transistor Q_1 OFF, Q_2 ON

Bistable multivibrator having two stable states
mono stable having only one stable state

3rd unit

Multivibrator:—

A multivibrator is a basically 2 stage RC coupled amplifier with +ve feed back from the o/p of one amplifier to the i/p of other amplifier. Multi means many, vibrator means oscillator.

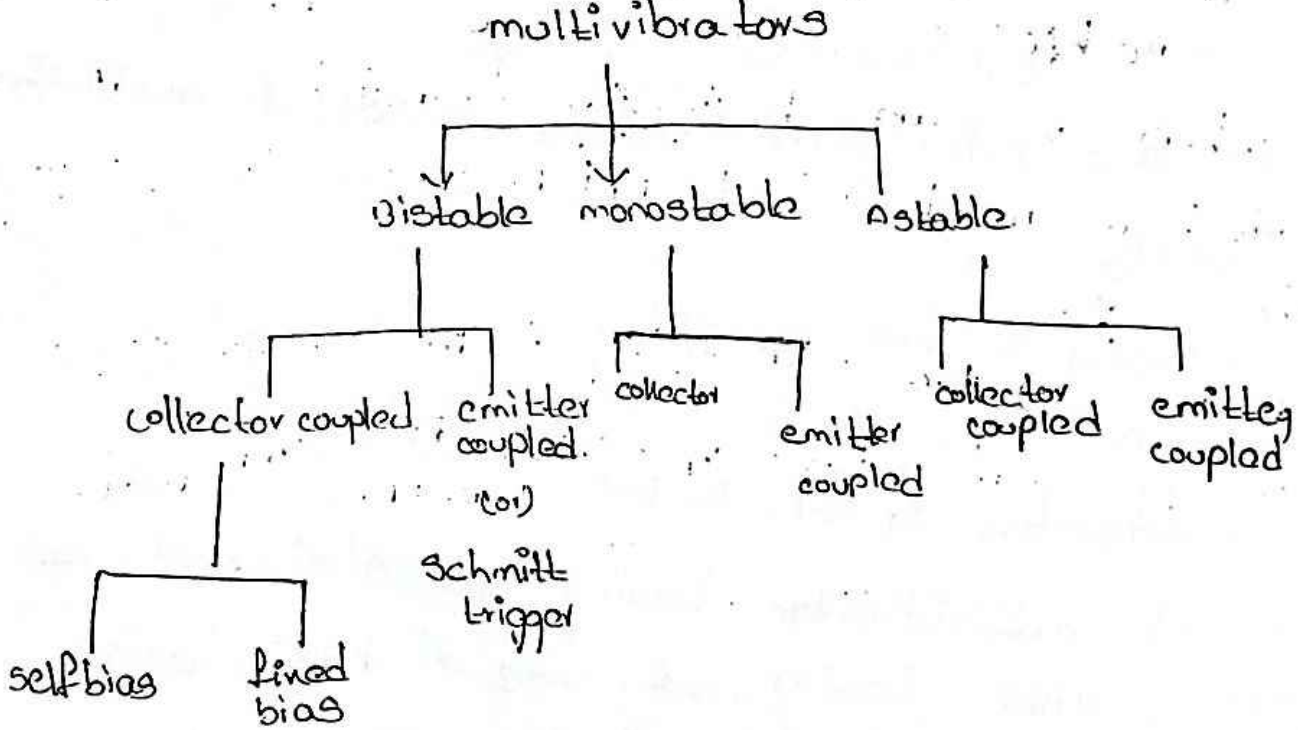
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Transistor Q_1 OFF, Q_2 ON

Bistable multivibrator having two stable states
mono stable having only one stable state

and other stable being quisi stable state.

Astable multivibrator not having stable states

It having both the states being quasi stable states

stable state:—

The state inwhich the device can stay permanently. only when at a proper external triggering signal is applied it will change its state

quasi stable state:

It is a temperogly stable state after a pre determined time the device will automatically come out of the quasi stable state.

In Bistable ckt both the coupling elements are resistors (both the dc coupling).

In monostable ckts the coupling elements are capacitor (ac) and other is (dc) resistor.

In Astable ckts the coupling elements are capacitors (both are ac coupling)

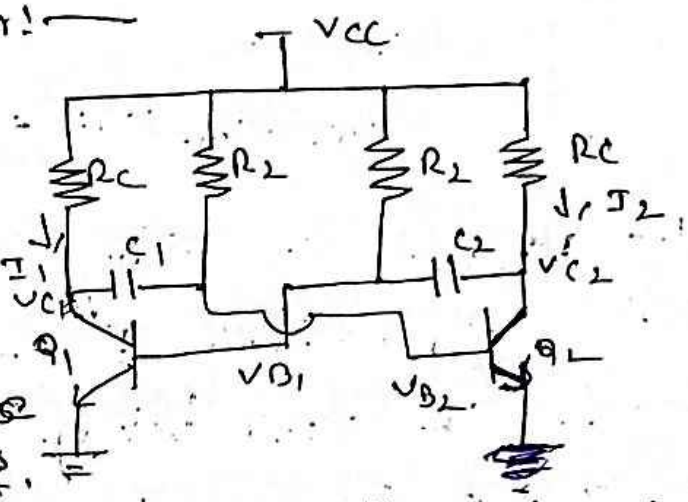
Applications:—

* Bistable multivibrator is basic memory element used to perform many digital operations such as counting (or) storing of binary data

* Monostable finds extensive applications in pulse ckts it is used as delay ckt (or) gating ckt.

* Astable multivibrator is used as master oscillator to generate square wave.

Astable multivibrator:—



Astable multivibrator is a free running oscillator. It has 2 quasi stable states. It keeps on switching b/n these two states by itself. No external triggering signal is required. The two amplifier stages of an astable multivibrators are generatively cross coupled by capacitors.

Principle of operation:

The collectors of both transistors Q_1 and Q_2 connected to the base of the other transistors through the coupling capacitor C_1 & C_2. since both are ac coupling, neither transistor can remain permanently at cut off region. so, the ckt has two quasi stable states.

Let us assume $t < 0$, Q_1 was ON and Q was OFF.

$V_{C_1} = V_{CE(sat)}$

$V_{B_1} = V_{BE(sat)}$

$V_{C_2} = V_{CC}$; $V_{B_2} = V_{BE(sat)} - I_1 R_C$ (negative value)

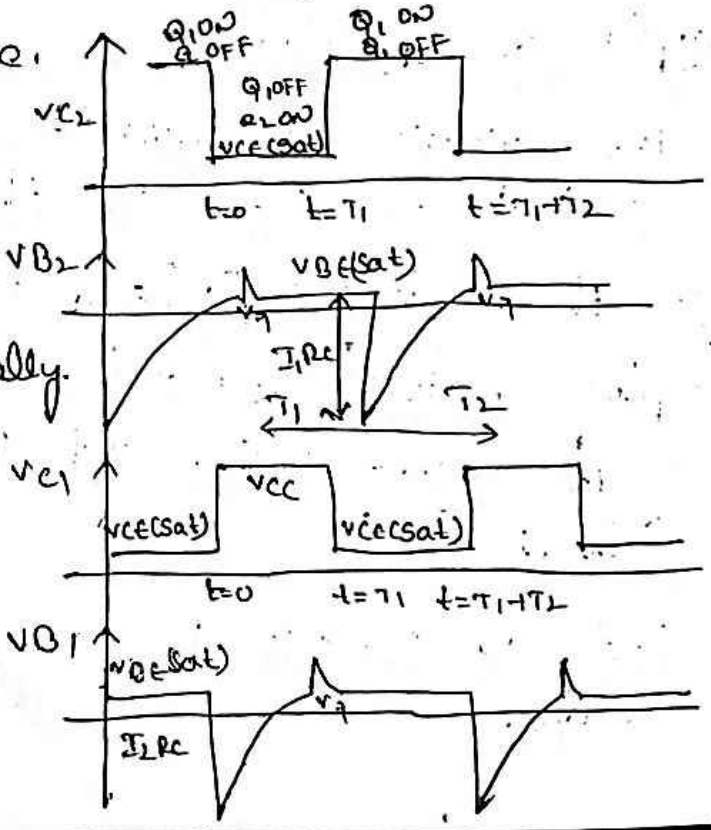
Q_2 is ON, Q_1 OFF

$V_{C_2} = V_{CE(sat)}$; $V_{B_2} = V_{BE(sat)}$

$V_{C_1} = V_{CC}$

$V_{B_1} = V_{BE(sat)} - I_2 R_C$

The capacitor C_2 charges through R_1 and V_{B_2} raises exponentially towards Vcc. At $t=0$ V_{B_2} reaches the cutin voltage 'V_γ' and Q_2 conducts as Q_2 conducts its collector voltage V_{C_2} drops by $I_2 R_C$. It is transmitted to the base of Q_1 through the coupling capacitor C_1 and hence V_{B_1} also falls by $I_2 R_C$. Q_1 goes to OFF state as shown in above.



since Q_2 is ON C_1 charges from Vcc through R_1 and hence V_{B_1} raises exponentially. at $t=t_1$ when V_{B_1} raises to V_γ Q_1 is ON and Q_2 due to regenerative action Q_1 goes into

saturation and Q_2 goes into cutoff region for $t > T_1$, The coupling capacitor charges from Vcc through R_2 and at $t = T_1 + T_2$ when V_{B_2} raises to cutin voltage V_γ then Q_2 is on due to regenerative feed back and Q_1 goes to OFF state.

Therefore the cycle of events repeats and the ckt keeps some oscillating b/n its two quasi stable states. Hence the o/p is a squa wave it is called a square generator (or) free running oscillator (or) Relaxation oscillator

The expression for the frequency of oscillation of Astable multivibrator

At $t=0$ V_{B_1} is $V_{BE}(sat) = I_2 R_C$

from the ckt

$$I_1 R_{C_1} = V_{CC} - V_{CE}(sat)$$

at $t=0 \Rightarrow V_{B_1} = V_{BE}(sat) - [V_{CC} - V_{CE}(sat)]$

$0 < t < T_1$, V_{B_1} increases exponentially toward Vcc

$$V_{B_1} = V_{final} - (V_{final} - V_{initial})\, e^{-t/\tau} \qquad \tau = R_1 C_1$$

$$V_{final} = V_{CC}$$

$$V_{initial} = V_{BE}(sat) - (V_{CC} - V_{CE}(sat))$$

$$V_{B_1} = V_{CC} - (V_{CC} - (V_{BE}(sat) - (V_{CC} - V_{CE}sat))\, e^{-t/R_1C_1}$$

$$V_{B_1} = V_{CC} - (2V_{CE} - (V_{BE}(sat) + V_{CE}(sat))\, e^{-t/R_1C_1}$$

at $t=T_1$ $V_{B_1} = V_1$

$$V_1 = V_{CC} - (2V_{CC} - (V_{BE(sat)} + V_{CE(sat)}))e^{-T_1/R_1C_1}$$

$$V_{CC} - V_1 = [2V_{CC} - (V_{BE(sat)} + V_{CE(sat)})]e^{-T/RC}$$

at room temp $V_1 = \frac{V_{BE(sat)} + V_{CE(sat)}}{2}$

$$V_{CC} - V_1 = 2\left[V_{CC} - \frac{V_{BE(sat)} + V_{CE(sat)}}{2}\right]e^{-T_1/RC}$$

$$V_{CC} - V_1 = 2[V_{CC} - V_1]\, e^{-T/R_1C_1}$$

$$1 = 2.e^{-T_1/R_1C_1}$$

$$e^{T_1/R_1C_1} = 2 \Rightarrow T_1/R_1C_1 = \ln(2)$$

$$T_1 = \ln(2).R_1C_1 = 0.693R_1C_1$$

Similarly $T_2 = 0.693 R_2C_2$

$$T = T_1 + T_2$$

$$= 0.693 R_1C_1 + 0.693R_2C_2$$

$$T = 0.693[R_1C_1 + R_2C_2]$$

we can show that the time T_2 for which Q_2 is OFF and Q_1 is ON is given by $T_2 = 0.693 R_2C_2$

The time period of the wave form $T = T_1 + T_2$

$$T = 0.693\,[R_1C_1 + R_2C_2]$$

The frequency of oscillation is

$$f = 1/T$$

$$f = \frac{1}{0.693\,[R_1C_1 + R_2C_2]}$$

If $R_1 = R_2 = R$, $C_1 = C_2 = C$ then

$$f = \frac{1}{0.693\,[RC + RC]} = \frac{1}{1.386RC}$$

The pulse width of astable multivibrator is

$$T = 0.693 [R_1 C_1 + R_2 C_2]$$

$$T = 1.386\ RC$$

Monostable multivibrators:—

The monostable multivibrator having one permanent stable state and one quasi stable state. A trigger -ve triggering ing signal is required to change to the stable state to quasi stable state.

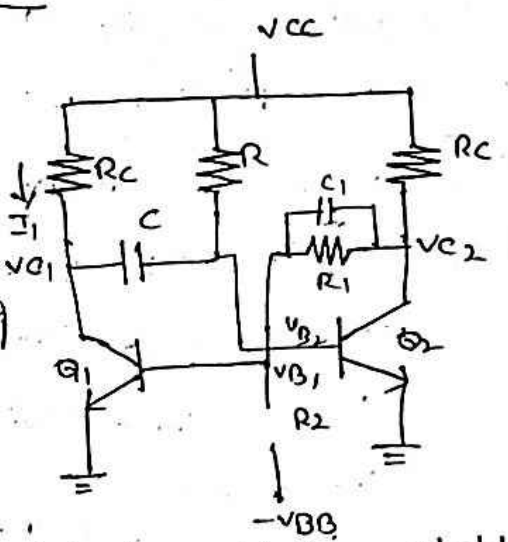


fig:- collector coupled monostable multivibrator

The ckt remains in its quasi stable state for a time equal to RC time constant of the ckt. It returns from the quasi stable state to stable state by itself without any external triggering signal after a time 'T' is called single shot ckt (or) univibrator. It generates rectangular wave forms which can be used to gate ckt. so it is called gating ckt. It generates fast transition at a predetermined time 'T' after the i/p signal so, it is also called delay ckt.

The two amplifier stages of monostable regenera-tively cross coupled by one coupling element is capacitor and other coupling element is resistor.

principle of operation:

The waves of Q_1 connected to $-V_{BB}$ through a resistor 'R_2' to ensure that Q_1 is in cutoff region The base of Q_2 is connected to V_{cc} through resistor 'R' to ensure that Q_2 is on.

For $T<0$, the monostable ckt is in stable state i.e Q_1 is 'OFF' and Q_2 is ON.

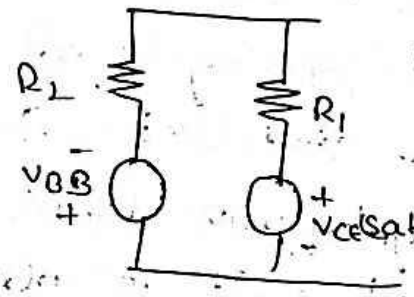
$V_{C_2} = V_{CE}(sat)$

$V_{B_2} = V_{BE}(sat)$

$V_{C_1} = V_{CC}$

$$V_{B_1} = -V_{BB}\frac{R_1}{R_1+R_2} + \frac{R_2}{R_2+R_1}V_{CE}(sat)$$

The voltage at the base of Q_1 using the superposition theorem is given above.



$$V_{B_1} = \frac{R_1}{R_1+R_2}(-V_{BB}) + \frac{R_2}{R_2+R_1}V_{CE}(sat)$$

Quasi stable state:—

A negative triggering signal applied at $T=0$ then Q_2 goes to OFF state and Q_1 goes to ON state. A current I_1 flows through RC of Q_1. So collector voltage of Q_1 drops suddenly by $I_1 R_C$. Since, the voltage across the coupling capacitor 'C' can't change. The

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voltage at the base of Q_2 also drops by $I_1 R_C$

Q_1 ON ; Q_2 OFF:

$V_{C_1} = V_{CE}$ (sat)

$V_{B_1} = V_{BE}$ (sat)

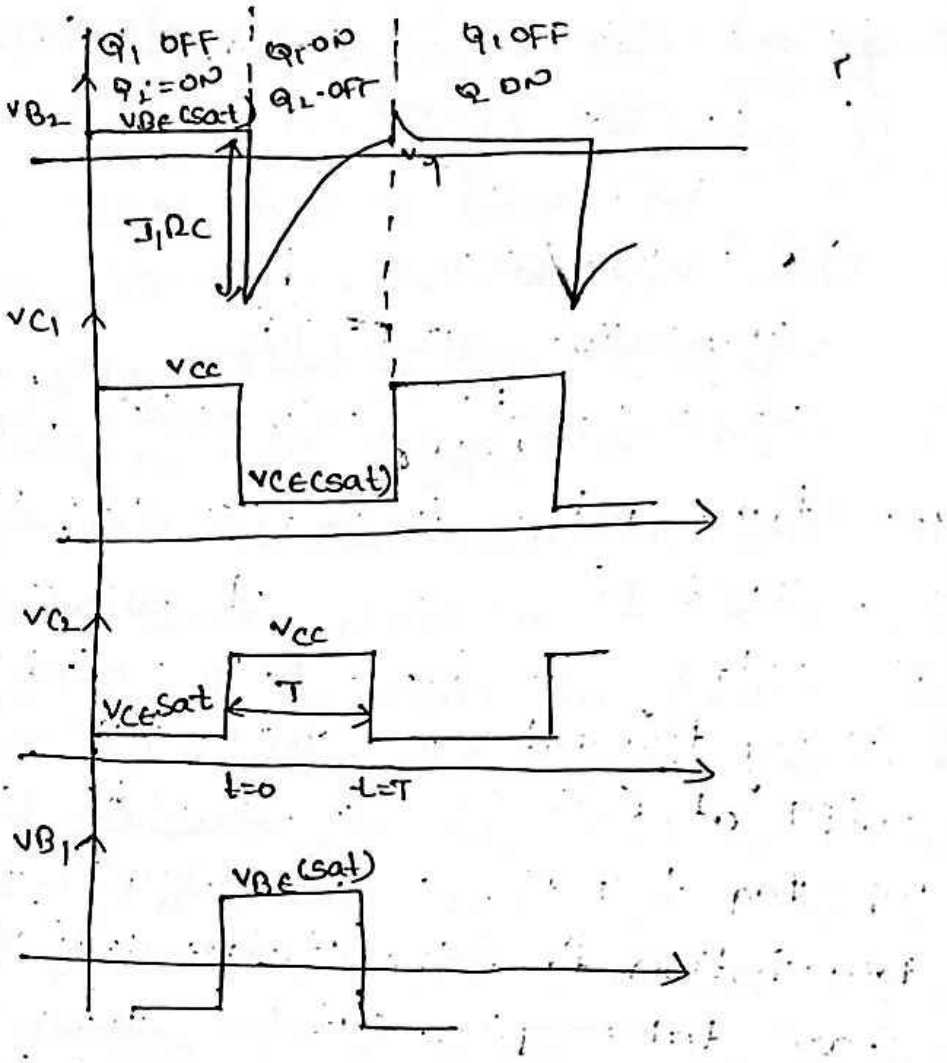
$V_{B_2} = V_{BE}$ (sat) $- I_1 R_C$

$V_{C_2} = V_{CC} \frac{R_1}{R_1 + R_C} + V_{BE}$ (sat) $\frac{R_C}{R_C + R_1}$

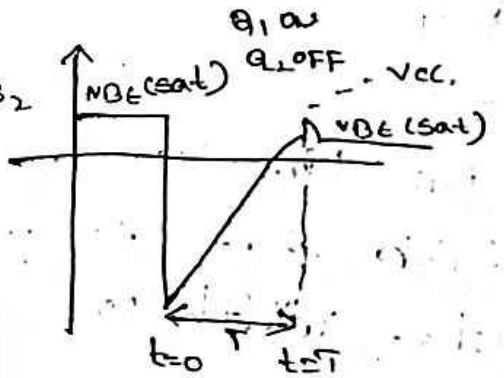
The time interval $0 < t < T$ the voltages V_{C_1}, V_{B_1}, V_{C_2} constant at their values at $t=0$ but the voltage at base of Q_1 exponentially raising towards V_{CC} with time constant $\tau = RC$ until at $t=T$ the V_{B_2} reaches the cutin voltage V_γ for $t > T$ the Q_2 is ON, Q_1 is OFF i.e the transistion from the stable state to quasi stable state takes place at $T=0$ and the transistion from quasi stable state to stable state at $T=T$

Note:→

The time 'T' for which the ckt is in quasi stable state is referred as the delay time (or) pulse width (or) gate width (or) pulse duration



Expression for pulse width 'T' for monostable multivibrator:—



- At $t=0$, $V_{B_2} = V_{BE}(sat) - I_1R_C$

  From ckt

  $I_1R_C = V_{CC} - V_{CE}(sat)$

  $V_{B_2} = V_{BE}(sat) - (V_{CC} - V_{CE}(sat))$

  (Vinitial at $t=0$)

$0 < t < T$, exponentially increases towards V_{CC} so

$$V_{B_2} = V_{final} - (V_{final} - V_{initial})\, e^{-t/RC}$$

$$V_{final} = V_{CC}$$

$$V_{B_2} = V_{CC} - (V_{CC} - (V_{BE}(sat) - (V_{CC} - V_{CE}sat)))\, e^{-t/RC}$$

$= V_{cc} - [2V_{cc} - (V_{BE(sat)} + V_{CE(sat)})] e^{-t/RC}$

at $t = T$

$V_{B_2} = V_\gamma$

$V_\gamma = V_{cc} - [2V_{cc} - [V_{BE\,sat} + V_{CE(sat)}] e^{-t/RC}$

$V_{cc} - V_\gamma = [2V_{cc} - [V_{BE(sat)} + V_{CE(sat)}] e^{-T/RC}$

at room temperature $V_\gamma = \frac{V_{BE(sat)} + V_{CE(sat)}}{2}$

$V_{cc} - V_\gamma = 2\left[V_{cc} - \left(\frac{V_{BE(sat)} + V_{CE(sat)}}{2}\right)\right] e^{-T/RC}$

$V_{cc} - V_\gamma = 2[V_{cc} - V_\gamma] e^{-T/RC}$

$1 = 2 e^{-T/RC}$

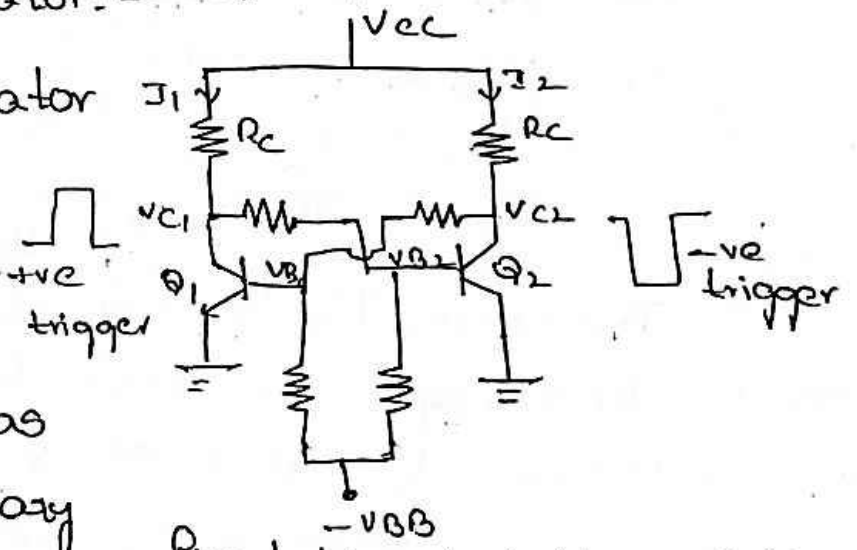
$e^{T/RC} = 2$

$T/RC = \log_e(2) = 0.693$

$T = 0.693RC$

Bistable multivibrator:

A bistable multivibrator is the basic memory element it is used to perform many digital operations such as counting & storing of binary data. The Bistable multivibrator is also called as binary ckt, (or) trigger ckt. (or) eccles Jordan ckt, flip flops, scale of 2 toggle ckt.



fixed bias bistable multivibrator

In bistable multivibrator both coupling elements are resistors ((d.c) coupling). Bistable multivibrator having two stable states and doesnt contain quasi stable state, Here transistion performed from one state to other state by applying triggering signals. In bistable ckt the external supply $-V_{BB}$ is applied to the base of transistor Q_1 and Q_2 is called fixed bias bistable multivibrator.

Principle of operation:

Suppose one of the stable state Q_1 is ON and Q_2 is OFF then

$$V_{C_1} = V_{CE}(sat)$$

$$V_{B_1} = V_{BE}(sat)$$

$$V_{C_2} = V_{CC}$$

$$V_{B_2} = -V_{BB}\frac{R_1}{R_1+R_2} + \frac{R_2}{R_2+R_1} V_{CE}(sat)$$

The multivibrator can change from the first stable to other stable state by applying either a -ve trigger to the base of Q_1 (or) +ve trigger pulse to the base of Q_2 -ve triggering signal is applied at the base Q_1 or at the collector of Q_2. The transistor Q_1 goes to cutoff region

As Q_1 ON collector voltage of Q_1 is transmitted to the base of Q_2

through resistor R_1 then transistor Q_2 goes to saturation region i.e Q_2 ON.

2nd stable state

Q_1 OFF Q_2 ON

$V_{C_2} = V_{CE}(sat)$

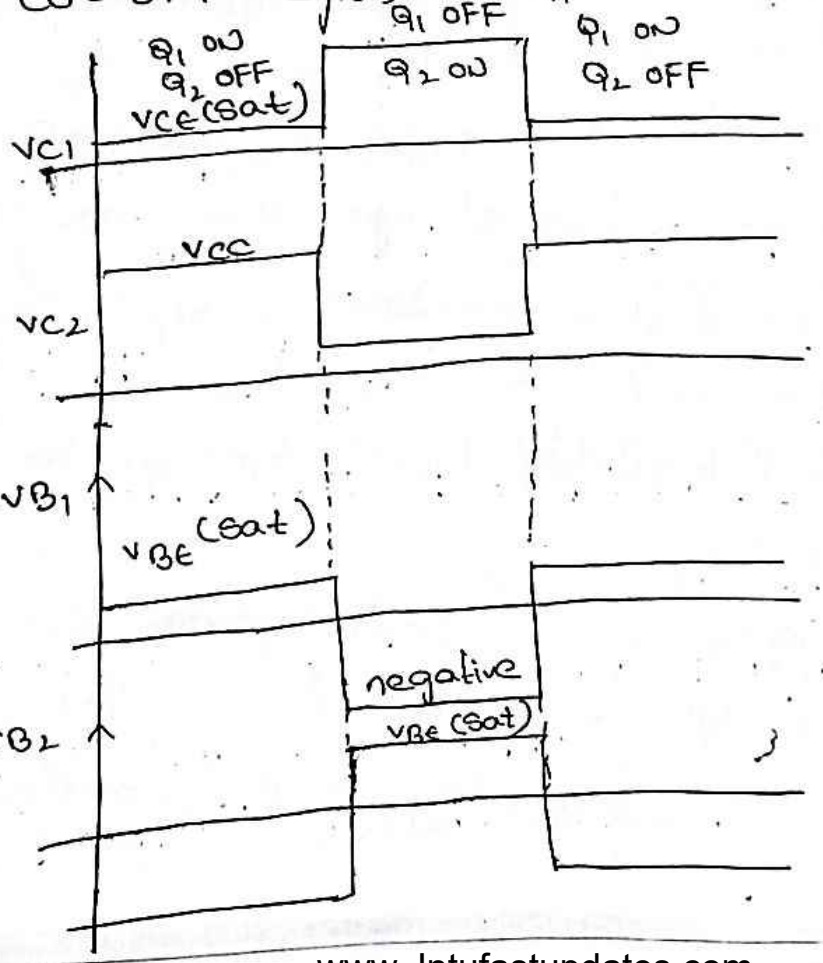
$V_{B_2} = V_{BE}(sat)$

$V_{C_1} = V_{CC}$

$V_{B_1} = V_{BB}\frac{R_1}{R_1+R_2} + V_{CE}(sat)\frac{R_2}{R_2+R_1}$

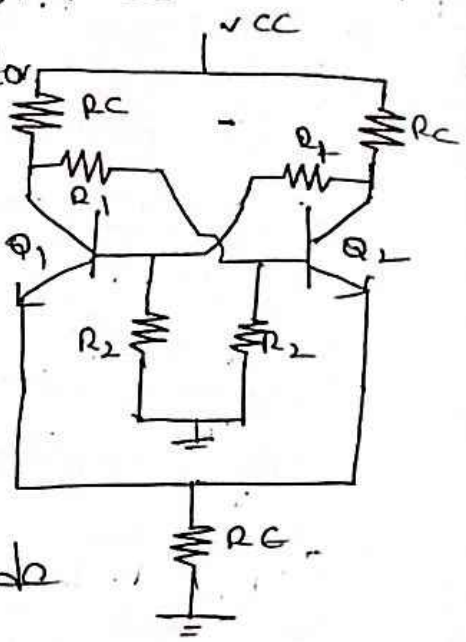
The ckt is in second stable state untill a +ve trigger is applied to the base of Q_1 (or) -ve trigger to the base of Q_2

A -ve triggering signal is applied at the base of Q_2 or at the collector of Q_1 the transistors Q_1 goes to saturation region Q_2 goes to cut off region i.e Q_1 is ON, Q_2 OFF



Self bias bistable multivibrator:—

A fixed bias bistable multivibrator requires two power supplies i.e +ve & -ve (V_{CC}, V_{BB}) the need for the -ve power supply may be eliminated by using common emitter resistor R_E. The bistable using common emitter resistor R_E to provide self bias is called the self bias bistable multivibrator. The analysis of self bias bistable multivibrator is same as fixed bias bistable multivibrator.



1st stable state

Q_1 ON, Q_2 OFF

$V_{C_1} = V_{CE}(sat) + V_\epsilon$

$V_{B_1} = V_{BE}(sat) + V_\epsilon$

$V_{C_2} = V_{CC}$

V_{B_2} = negative

2nd stable state

Q_1 OFF, Q_2 ON

$V_{C_2} = V_{CE}(sat) + V_\epsilon$

$V_{B_2} = V_{BE}(sat) + V_\epsilon$

$V_{C_1} = V_{CC}$

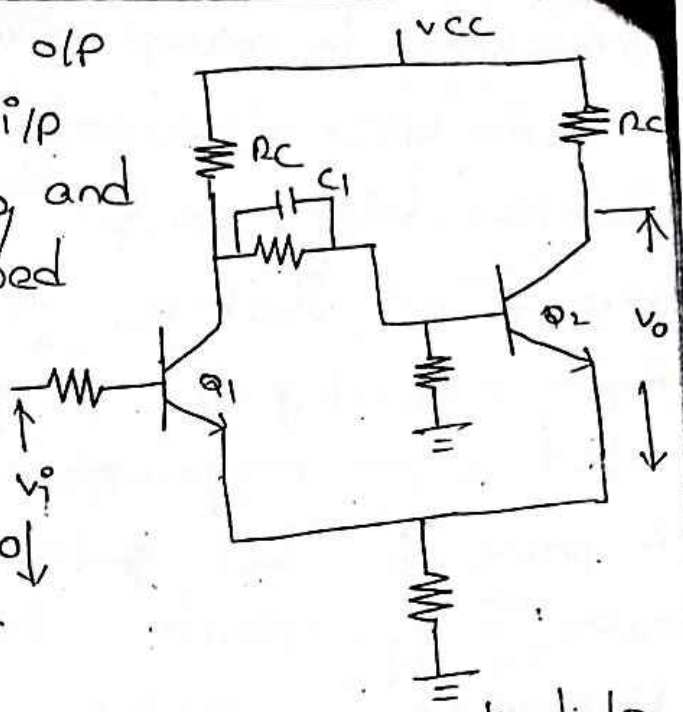
V_{B_1} = negative.

∴ The multivibrator can change from one stable state to other stable state by applying triggering signals only.

Emitter coupled bistable multivibrator (or) schmitt trigger:—

Schmitt trigger is a emitter coupled bistable multivibrator it is different from the collector coupled bistable multivibrator in

that the coupling from the o/p of the 2nd stage to the i/p of first stage is missing and the feed back is obtained through the common emitter resistor R_E and the base of first transistor is connected to a i/p voltage source v_i.



Principle of operation:

The i/p voltage $v_i = v_m \sin\omega t$ is applied to the base Q_1 if $v_i = 0$ Q_1 is OFF however the base of Q_2 drive from the supply voltage Vcc and hence Q_2 is ON.

∴ Q_1 OFF, Q_2 ON ⟶ normal state of schmitt trigger. if an i/p voltage amplitude applied to the base of Q_1 than Q_1 ON when Q_1 turns ON its collector voltage falls. so the base of Q_2 also decreases than Q_2 goes to cutoff region i.e OFF state its collector voltage increases to Vcc when v_i is increasing o/p voltage also increasing so the o/p & i/p in schmitt trigger always inphase.

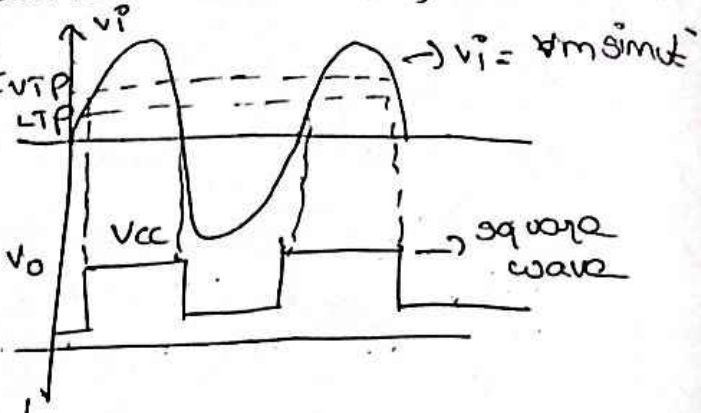
If i/p voltage v_i decreases no current flows through the base of Q_1 then Q_1 OFF & Q_2 ON the BKT has now returned to its normal state the schmitt trigger also called as

sinusiodal to square wave converting

UTP = Upper trigger point

LTP = Lower trigger point

a point at which Q_1 starts conducting is called upper trigger point.



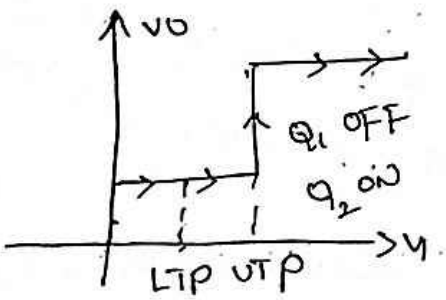
A point at which Q_2 starts conducting is called lower trigger point.

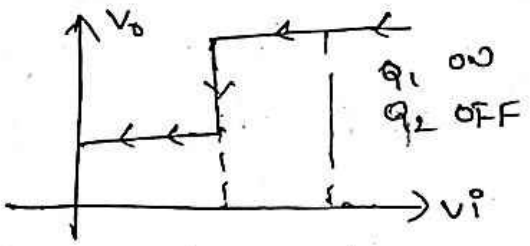
Hysterisis:—

The difference b/n the UTP & LTP is termed as hysterisis of the ckt or hysterisis voltage

$$V_H = V_{UTP} - V_{LTP}$$

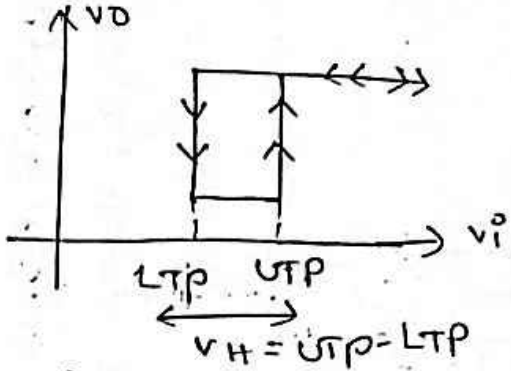
when UTP equal to the LTP then zero hysterisis occurs.in order to study the hysterisis loping the transfer characteristics of the schmitt trigger it is necessary to obtained values of o/p voltage for varying i/p voltage.





The curves shown in above clubed together and the total transfer characteristics can be plotted the closed loop shows

the hysterisis loop.

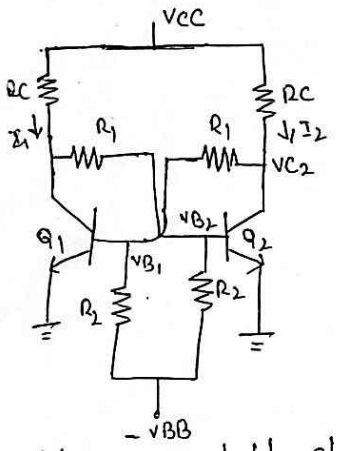


Applications of schmitt trigger:

* It can be used as voltage comparator.
* It is used for generation of rectangular wave form i.e unsymmetrical square wave from sinusoidal waveform.
* It is used for wave shaping ckts.
* The hystersis in schmitt trigger is valuable for conditioning nuising signal in digital ckts.
* It can be used as flipflops with alternative positive and -ve pulses applied to one of the i/p.

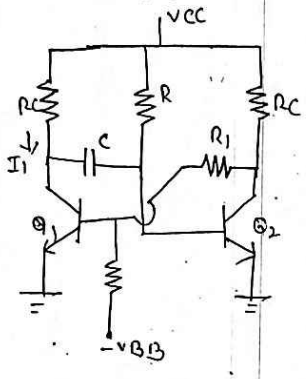
Difference b/n multivibrators

Bistable



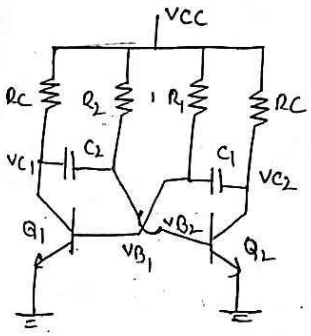
* It having two stable state
* It is a flipflop ckt
* It having both the coupling elements are resistors (dc)
* It requires triggering signal for every transmission.

Monostable



* It having one stable state and other state is quasi stable state
* It is a pulse generator
* It having one coupling element is capacitor (ac coupling) and another coupling element is capacitor (dc)
* It requires only one triggering signal to change the state

Astable



* It having no stable states but it have two quasi stable state.
* It is a square wave generator
* It having two coupling elements as capacitors (
* It doesn't require triggering signal it is free running

* It is also called as binary ckt (or) triggering ckt (or) flip flop (or) Ecclis Jordan ckt.

* In bistable +ve pulse and negative pulse having equal width.

Applications:

* It is one bit memory element used in shift registers, counters
* It can be used as frequency divider
* It is used to generate square waves of symmetrical shape by sending triggering signal by adjusting the freq of signal the width of s.w can modified

temperorly and return back to orignal stable state.

* It is also called as one shot ckt (or) delay ckt (or) gating ckt (or) tunning vibrator (or) single swing ckt
* pulse width is $t = 0.69RC$

Applications:

* It is used as time delay unit
* It is used to adjustable pulse width generator
* It is used to generate uniform pulse width from a paivable width into pulse train and generate clean and sharp pulse from the distorted pulse

oscillator.

* It is also called as free running oscillator (or) relaxation oscillatoy (or) synchronized oscillator
* pulse width is $T = 0.69(R_1C_1 + R_2C_2)$ if $R_1 = R_2 = R$, $R_1 = C_2 = C$ then $T = 1.38RC$

Applications:

* It operated as oscillator over wide range of audio & radio frequencies
* It is used in construction of digital voltmeter & smps
* It is used as square wave generator, voltage to frequency convertor and in pulse synchronization and for binary logic signals

Last - 3rd unit

unit- VI

UNIT-VI

only four Topics

synchronization and frequency division

printed more relevant back side

Synchronization:

Two (or) more waveform generators are said to be synchronized if all of them arrive at same reference point in the cycle at exactly the same instant of time for a digital system.

frequency division:-

Synchronization is said to be with frequency division if generators operate at different frequencies which are integral multiples of each other but arrive at some reference point at the same time.

eg:- counting ckts.

pulse synchronization of relaxation devices:

Relaxation ckts:-

ckts in which the timing interval is established through the gradual charging of capacitor the timing interval terminated by the sudden discharge (relaxation) of the capacitors.

eg:- multivibrators, sweep generators, blocking oscillators.

All these ckts having in common timing interval and relaxation interval and each

exist in an astable (or) monostable form.

UJT sweep generator with synchronization signal:—

UJT is a current controlled negative resistance device which can be used as switch such as silicon controlled switch. Thyristor in such case +ve pulse applied at the gate (or) base will lower the break down voltage.

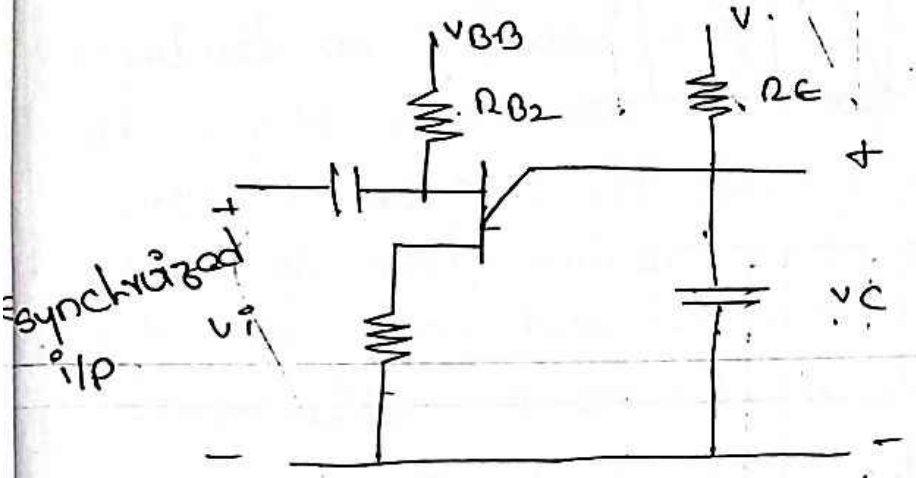
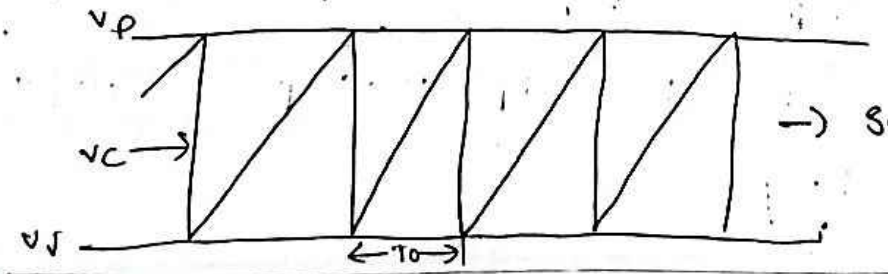


fig: A sweep generator with synchronization signal

In the absent of external sync pulse the capacitor stops charging when the capacitor voltage Ve reaches the peak voltage of breakdown voltage Vp there after the capacitor voltage discharges suddenly to Vv (valley voltage) the UJT goes to OFF state and the capacitor begins to recharges this process repeats.



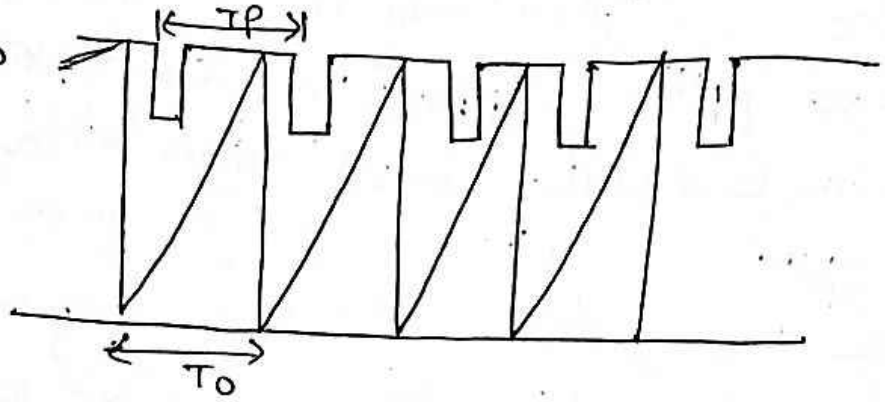
V_p = peak voltage

V_c = capacitor voltage, V_v = valley voltage

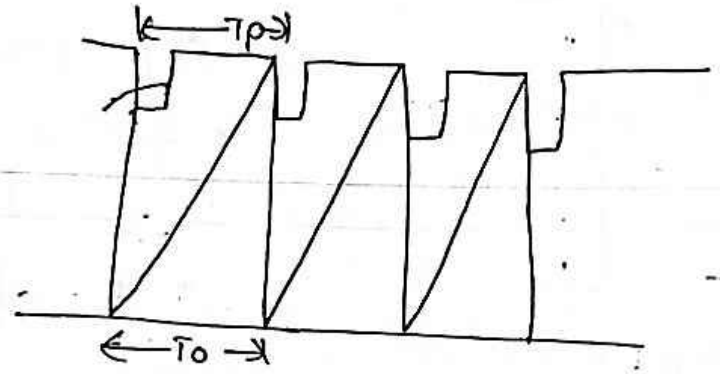
T_o = Time period of sweep generator.

when synchronizing pulses are applied the effect of sinc pulse to lower the peak voltage V_v for the duration of the pulse

$T_p < T_o$



$T_p > T_o$



from the above 2 cases when $T_p > T_o$ no synchronization

Frequency division in the sweep ckt:

The conditions required for synchronization

1. T_p must less than T_o ($T_p < T_o$)
2. The amplitude of the pulse must be large

Let us consider when T_o is much large than T_p i.e $T_o > 2T_p$ and pulse amplitude is large

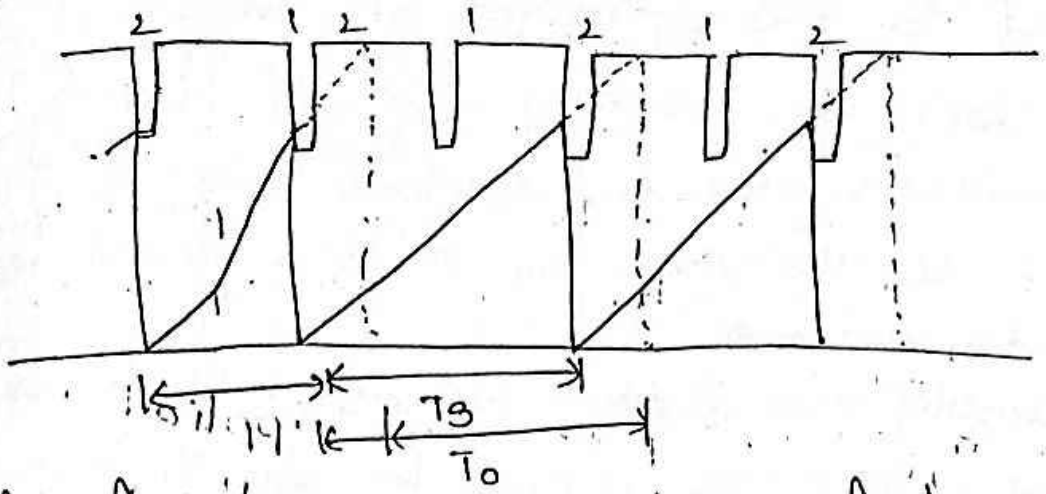
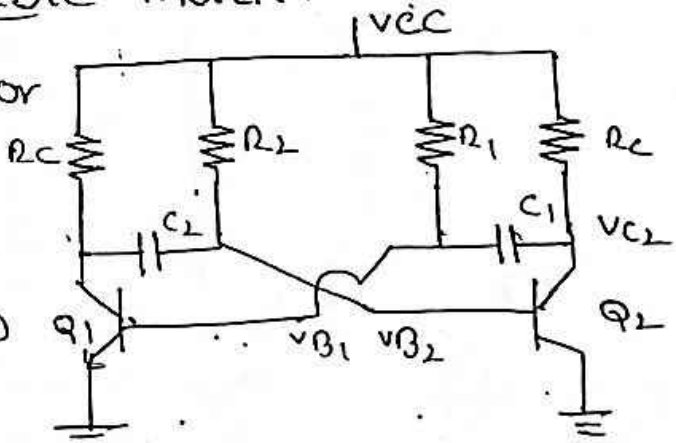


fig: frequency division by a factor 2 in sweep generator.

from the above fig the odd number pulses (marked as '1') are not effective in terminating the cycle where as the even number pulses (marked as '2') effectively terminate the cycle i.e the sweep voltage is found to make one cycle for every two cycles of the synchronizing pulses after synchronizing the period of the sweep generator decreases i.e $T_s < T_o$ The generator function as a divider with division factor of '2'.

Synchronization of astable multivibrator:

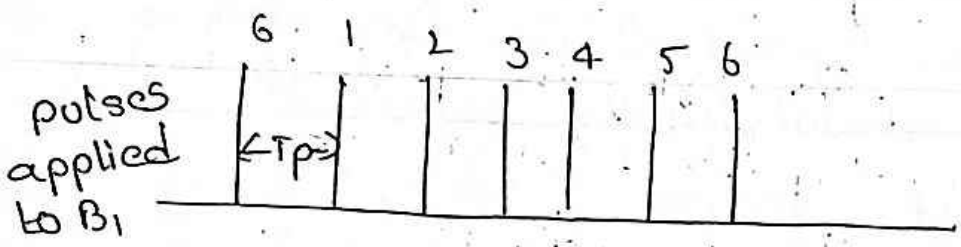


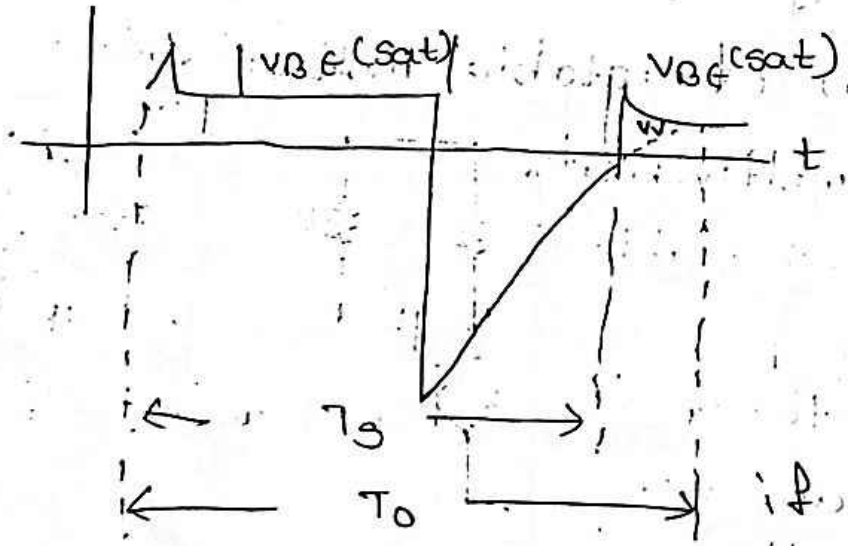
An astable multivibrator having two quasi stable states it keeps switching b/n these two states. The transistors of astable multivibrator regeneratively cross coupled by capacitors.

An astable multivibrator can be

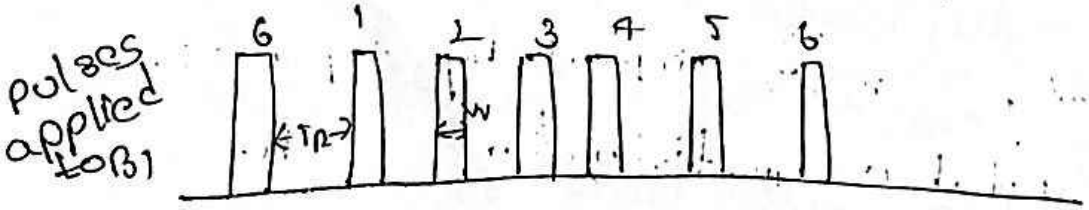
synchronized by the application of triggering pulses +ve (or) -ve to any one of the transistors (or) to both transistors pulse may be applied to the base or emitter or collector of either transistors.

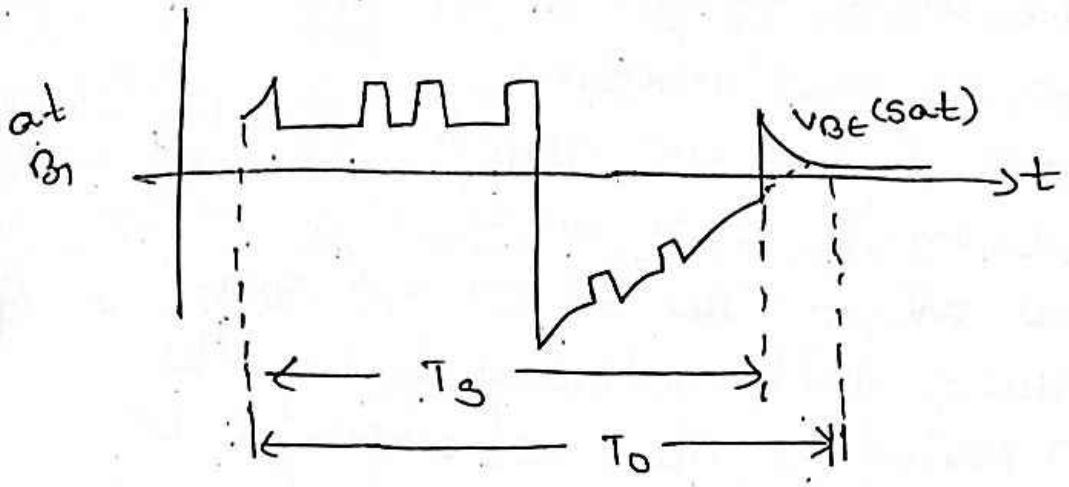
For example +ve pulses are applied to the base B_1 or C_2 or -ve pulses to the E_1. These triggering signals may produce synchronization when +ve pulses are applied at base B_1 from the above ckt the division ratio is '6' the cycle would have terminated the complete multiperiod has been synchronized.





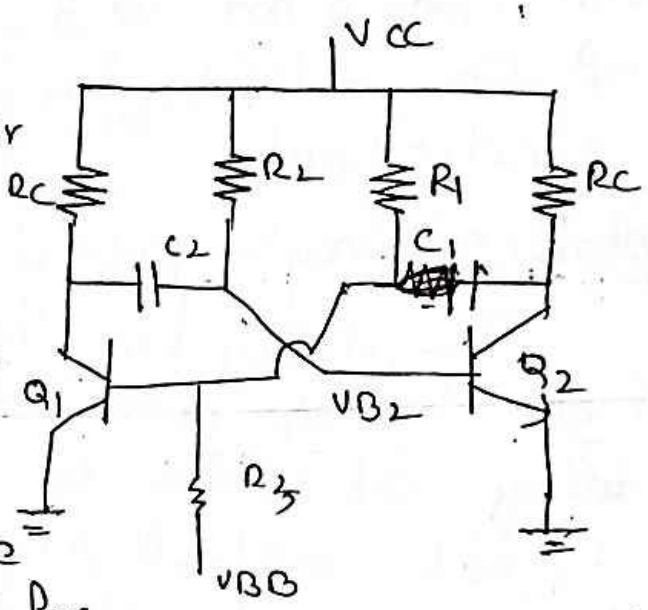
if pulse width is t_W then

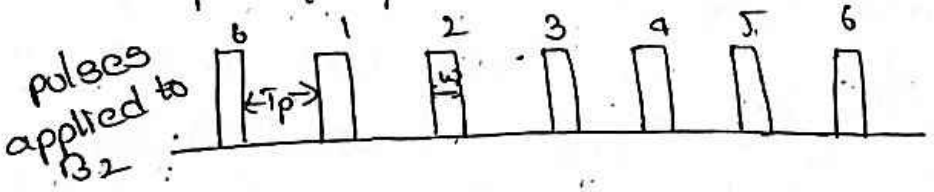


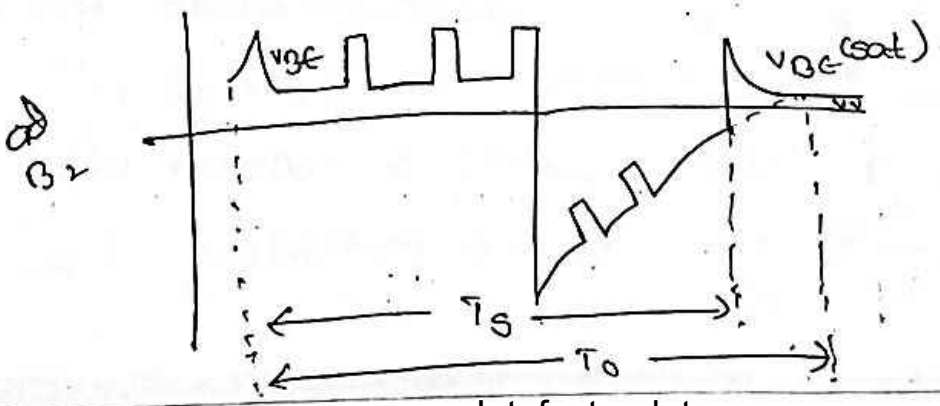


synchronization of monostable multivibrator & frequency division:

Monostable multivibrator having one stable state and one quasi states. The transistors are cross coupled by one capacitor and one resistor. The monostable multivibrator is used for frequency division. The i/p synchronizing pulse may be applied to V_{B1} or C_1 depending on the polarity.







from the above diagram each 6th causes the transistion of multivibrator.

If +ve pulses are applied directly at B_1 through a small capacitance from alow impedance source. The pulses are quasi stable state differentiated during the conduction period Q_1. The -ve overshot is amplified and inverted by Q_1 and appears as +ve over shoot at B_2. Thus the two positions of the multivibrator wave form would be synchronized.

phase delay:—

The delay b/n the i/p pulse to a divider and the o/p pulse is refered as phase delay. It is due to several factors and it is not constant it may vary with time due to variations in device characteristics supply voltages (V_{cc})

phase Jitter:—

A signal may have influence on the exact moment at which the basic wave form reaches cutoff region these several factors which effect phase delay gives rise to what is termed as "phase jitter"

In large scale counters consist of many stages it is compounded.

It have no particular consequence but it constitute an important difficulty in connection with nanosecond pulses.

A method for achieving frequency division without phase jitter:

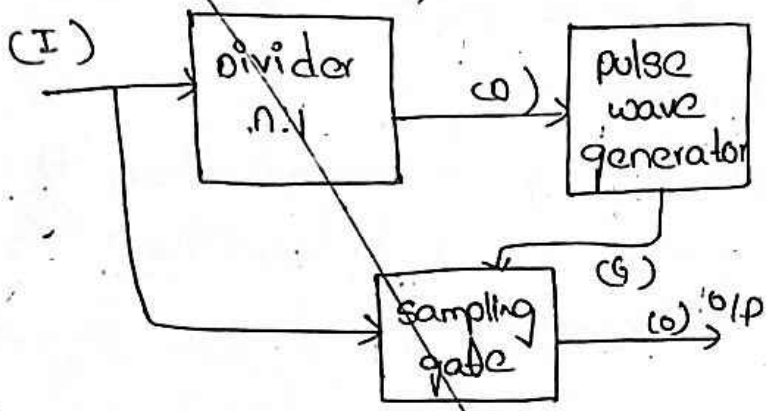
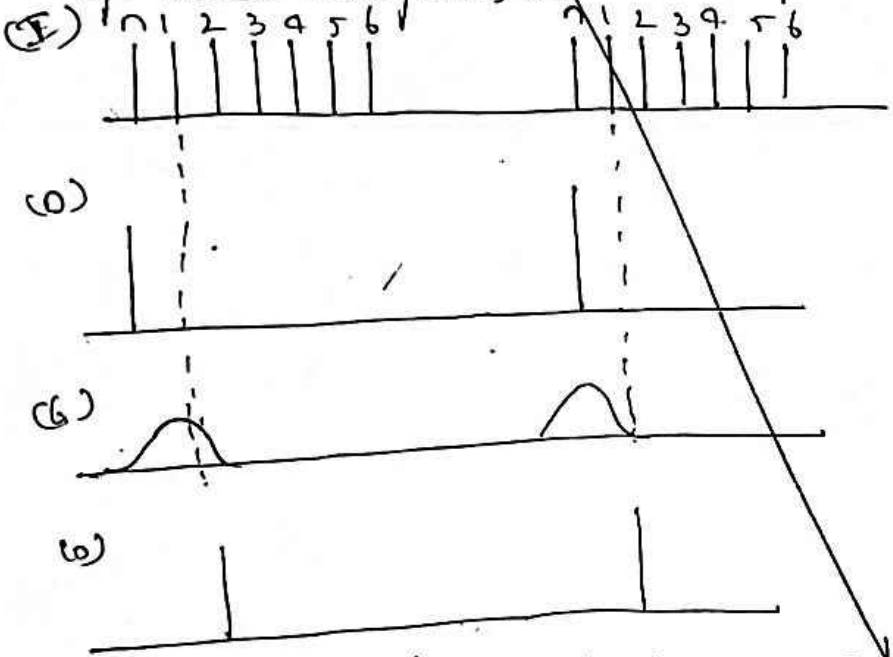


Fig: block diagram of divider without phase jitter



The train of regularly spaced i/p pulses (I) is applied to the divider i/p.

The o/p of the divider consist of the pulses (a) These pulses gives to gating wave form generator or pulse wave form generator which is usually a monostable