MULTIVIBRATORS

A multivibrator is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flip-flops. It is characterized by two amplifying devices (transistors,electron tubes or other devices) cross-coupled by resistors or capacitors. The name "multivibrator" was initially applied to the free-running oscillator version of the circuit because its output waveform was rich in harmonics.[1] There are three types of multivibrator circuits depending on the circuit operation:Multivibrator: it is a two state device in which the transition between the states is taken place.

Multivibrators are broadly classified as

1. Bistable multi or Flip-Flop
2. Monostable multi or One shot multi
3. Astable multi or Free running multi

Multivibrators find extensive use in digital and switching applications.

1. bistable multivibrator : It is a multivibrator with two stable states in which the transition between the states is taken place by using some external excitation or triggering.

Here coupling elements are only **resistors.**

2.Monostable multivibrator : It is a multivibrator with one stable state and one quasi stable state in which the transition between stable state to quasi stable state is taken place by using some external excitation or triggering.

Here coupling elements are both **resistors and capacitors**.

3.astable multivibrator: It is a multivibrator with two quasi stable states in which the transition between the states is taken place without using any external excitation or triggering.

Here coupling elements are only **capacitors.**

BISTABLE MULTIVIBRATORS :

it is also named as **flip-flop** or **binary** or **Eccles-jordan circuit** or **scale of two circuit**

We consider two types of Bistable multivibrator circuits.

1. Fixed bias binary 2. Self bias binary

Fixed bias binary: The circuit shown in fig is fixed bias binary

Operation :

Consider I_1 and I_2 are currents due to Transistors Q1and Q2 and V_{C1} and V_{C2} are voltages at collector terminals of corresponding transistors.

Where $V_{C1} = V_{CC} - I_1 R_C$

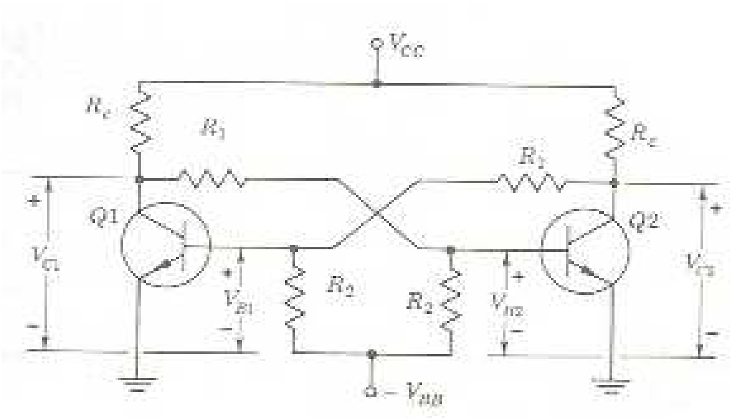
$V_{C2} = V_{CC} - I_2 R_C$

Also assume that both transistors are identical transistors.

So due to the symmetry of the circuit $I_1 = I_2$.

current flowing

Through Q1 is further increases and due to the less coupling voltage current flowing through Q2 is further reduces. Then V_{C1} is still reduce and is further increases.



This process is repeated until **Q1 ON(saturation) and Q2 OFF(cutoff).**

This is one of the stable state of binary.

To induce a transition from this stable state to other there is a need of triggering.

By applying suitable triggering signal we can get other stable state ,that is

Q2 ON(saturation) and Q1 OFF(cutoff).

Design of fixed bias binary:

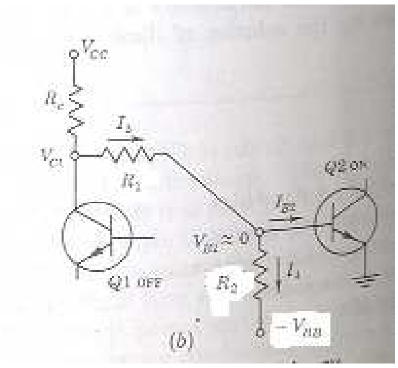
The circuit shown above is a symmetrical one. if we design this for one stable state is automatically true for other state.

So consider stable state of binary is Q1 OFF and Q2 ON.

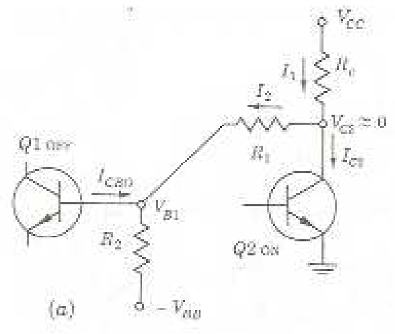
Here we need to select all the components to satisfy above stable state.

To design any multivibrator circuit there is a need to draw base and collector circuits of ON transistor.(to make our analysis as an easy one)

Base circuit of Q2



Collector circuit of Q2



To keep Q1 is in OFF state , $V_{BE1} < V_{BE(cutoff)}$

From the collector circuit of Q2 , V_{BE1} = V_{BE1} due to $V_{CE(sat)}$ + V_{BE} due to $-V_{BB}$

V_{BE1} due to $V_{CE(sat)}$ $= \dfrac{V_{CE(sat)} R_2}{R_1 + R_2}$

V_{BE1} due to $- V_{BB}$ $= \dfrac{-V_{BB} R_1}{R_1 + R_2}$

$$V_{BE1} = \frac{-V_{BB} R_1}{R_1 + R_2} + \frac{V_{CE(sat)} R_2}{R_1 + R_2}$$

So $$\frac{-V_{BB} R_1}{R_1 + R_2} + \frac{V_{CE(sat)} R_2}{R_1 + R_2} < V_{BE(cutoff)} \text{ ------- (1)}$$

To keep Q2 is in ON state, $I_{B2} \geq I_{B2(\min)}$

Where $$I_{B2(\min)} = \frac{I_{C2}}{h_{FE}}$$

From the collector circuit of Q2 , $I_{C2} = I_1 - I_2$

$$I_{C2} = \left(\frac{V_{CC} - V_{CE(sat)}}{R_C}\right) - \left(\frac{V_{CE(sat)} - (-V_{BB})}{R_1 + R_2}\right)$$

$$I_{B2(\min)} = \frac{1}{h_{FE}}\left(\left(\frac{V_{CC} - V_{CE(sat)}}{R_C}\right) - \left(\frac{V_{CE(sat)} - (-V_{BB})}{R_1 + R_2}\right)\right) \text{--------(2)}$$

From the base circuit of Q2 , $I_{B2} = I_3 - I_4$

$$I_{B2} = \left(\frac{V_{CC} - V_{BE(sat)}}{R_C + R_1}\right) - \left(\frac{V_{BE(sat)} - (-V_{BB})}{R_2}\right)$$

Therefore, we know the necessary condition to keep the transistor in ON state is

Components (R_1 ,R_2 ,R_C,V_{CC},V_{BB},R_C)should be selected to satisfy equations (1) &(3)

Expressions for steady state voltages and currents :

Assume that V_{C1} , V_{B1} are voltages at collector and base terminals of Q1 respectively.

And V_{C2} , V_{B2} are voltages at collector and base terminals of Q2 respectively.

And also I_{C1} , I_{C2}, I_{B1} , I_{B2} are the collector and base currents of corresponding transistors.

Consider stable state of fixed bias binary is **Q1 OFF & Q2 ON**

Here , $V_{C1} = V_{CC} - I_3 R_C$ where $I_3 = \dfrac{V_{CC} - V_{BE(sat)}}{R_C + R_1}$ (from base circuit of Q2

$$V_{C2} = V_{CE(sat)}$$

$$V_{B1} = \frac{-V_{BB} R_1}{R_1 + R_2} + \frac{V_{CE(sat)} R_2}{R_1 + R_2}$$

$$V_{B2} = V_{BE(sat)}$$

$$I_{C1} \approx 0 \qquad , \qquad I_{B1} \approx 0$$