Chapter five:-Multivibrators

A MULTIVIBRATOR is an electronic circuit that switches rapidly by means of positive feedback between two or more states. Its basically a two amplifier circuit. A multivibrator generates square, pulse, triangular waveforms. Also called as nonlinear oscillators or function generators.

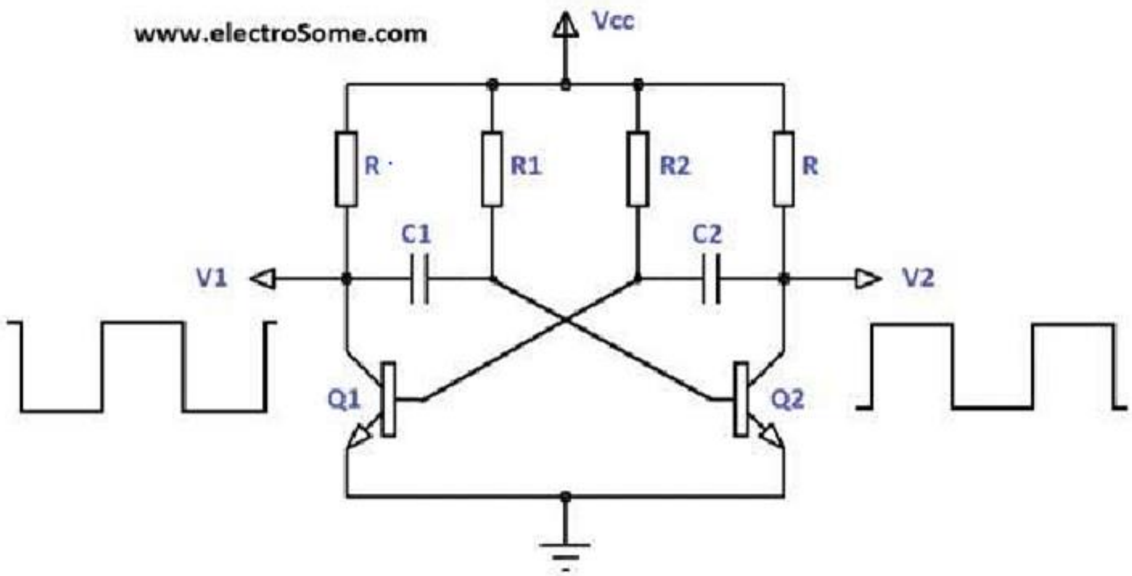
Multivibrators types

1. Monostable Monostable is also called one shot multivibrator. Monostable multivibrator has one stable state and one quasi stable state (astable state). In the multivibrator the output of first stage is given to the second stage and the second stage output is again feed back to the first stage by this the cutoff state will become saturate and saturate state will become to cutoff. Because of the transition of states the multivibrator can be used as oscillators, timers and flip-flops.When an external trigger applied to the circuit, the multivibrator will jump to quasi stable state from stable state. After the period of time it will automatically set back to the stable state, for returning to the stable state multivibrator does not require any external trigger. The time period to returning to stable state circuit is always depends on the passive elements in the circuit(resistor and capacitor values)

2. Bistable • The bistable multivibrator has two absolutely stable states. It will remain in whichever state it happens to be until atrigger pulse causes it to switch to the other state. For instance, suppose at any particular instant, transistor Q1 is conducting and transistor Q2 is at cut-off. If left to itself, the bistable multivibrator will stay in this position for ever. However, if an external pulse is applied to the circuit in such a way that Q1 is cut-off and Q2 is turned on, the circuit will stay in the new position. Another trigger pulse is then required to switch the circuit back to its original state. In other words a multivibrator which has both the state stable is called a bistable multivibrator. It is also called flip-flop,trigger circuit or binary. The output pulse is obtained when, and why a driving (triggering) pulse is applied to the input. A full cycle of output is produced for every two triggering pulses of correct polarity and amplitude.

3. Astable An Astable Multivibrator or a Free Running Multivibrator is the multivibrator which has no stable states.Its output oscillates continuously between its two unstable states

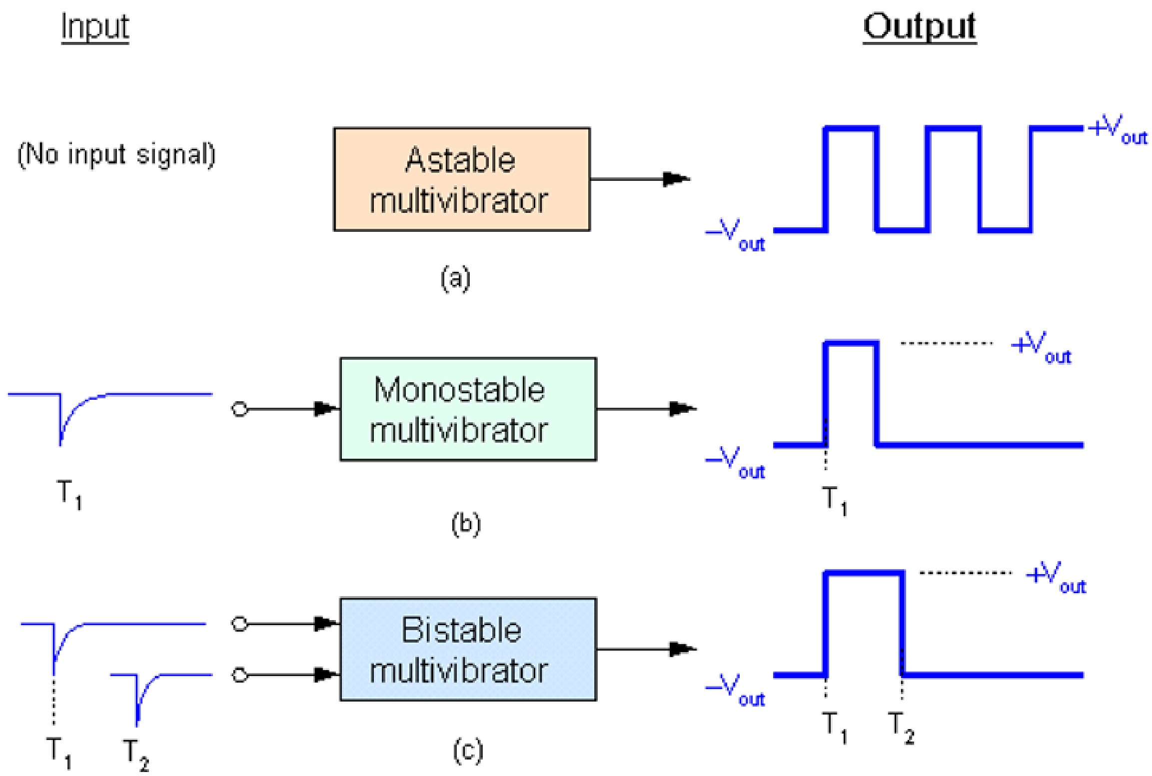
without the aid of external triggering.The time period of each states are determined by Resistor Capacitor (RC) time constant



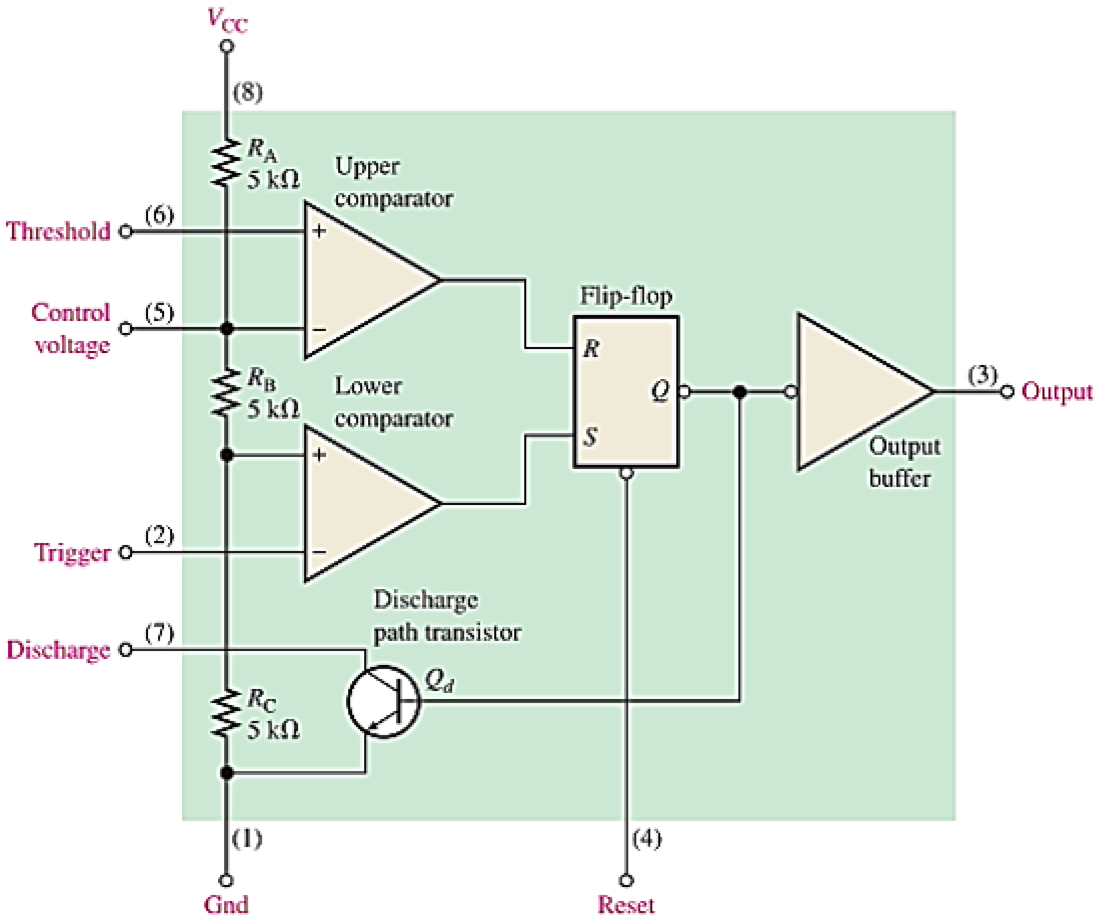
· In the above diagram we can find two transistors which is wired as a switch.

Working

When the circuit is switched on one transistor will driven to saturation (ON) and other will driven to cutoff (OFF). Consider Q1 is ON and Q2 is OFF. During this time Capacitor C2 is charging to Vcc through resistor R. Q2 is OFF due to the -ive voltage from the discharging capacitor C1 which is charged during the previous cycle. So the OFF time of Q2 is determined by R1C1 time constant.



MULTIVIBRATORS USING 555 TIMER

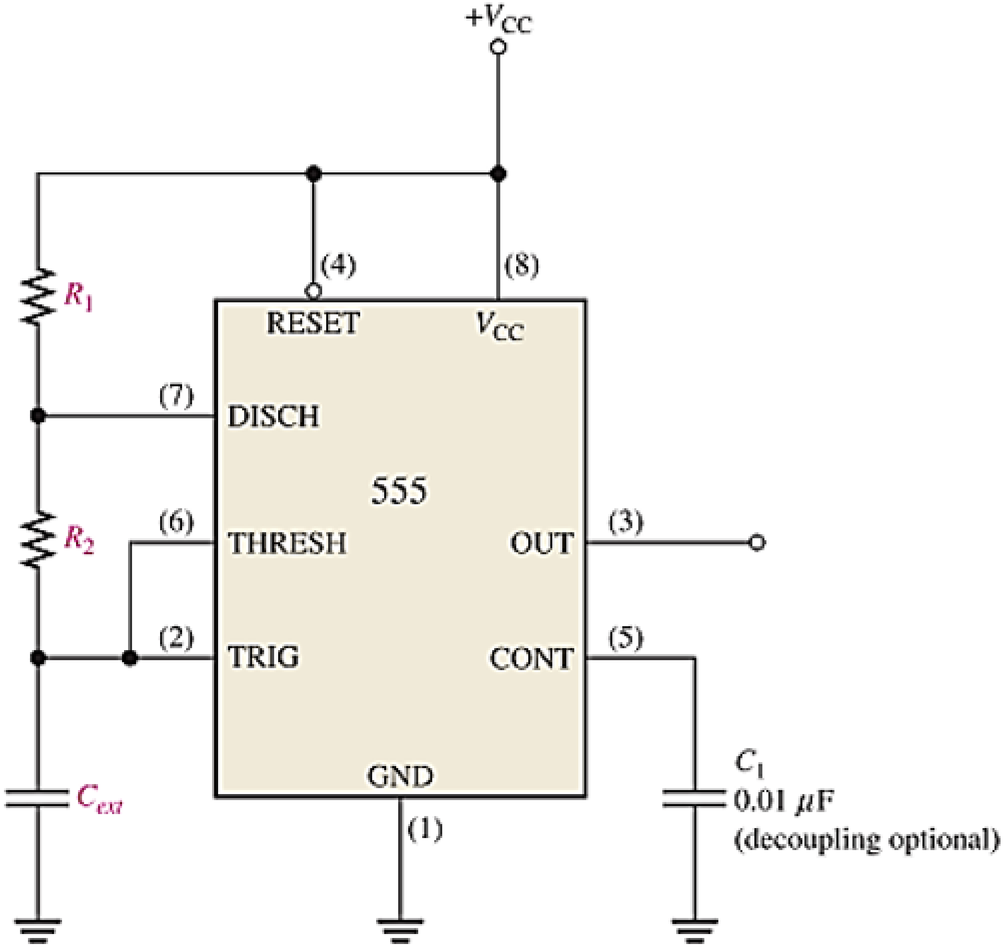


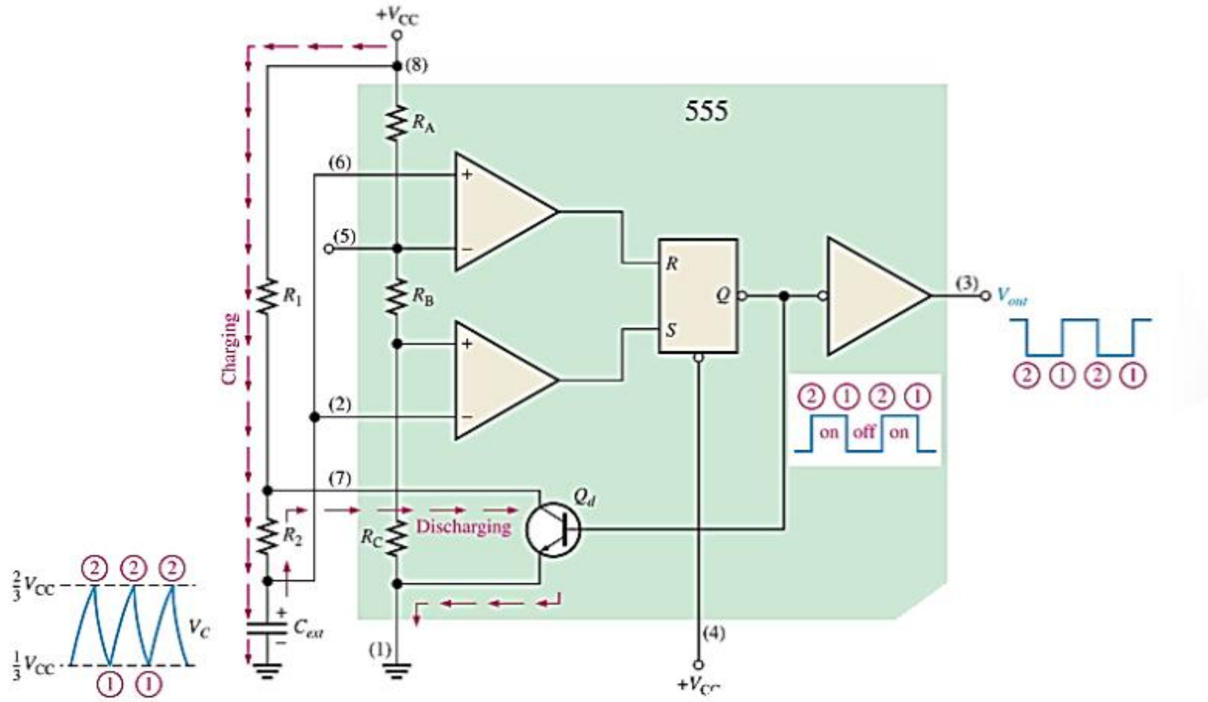
The 555 timer consists basically of two comparators, a flip-flop, a discharge transistor, and a resistive voltage divider.

• The flip-flop (bistable multivibrator) is a digital device, a two-state device whose output can be at either a high voltage level (set, S) or a low voltage level (reset, R). The state o

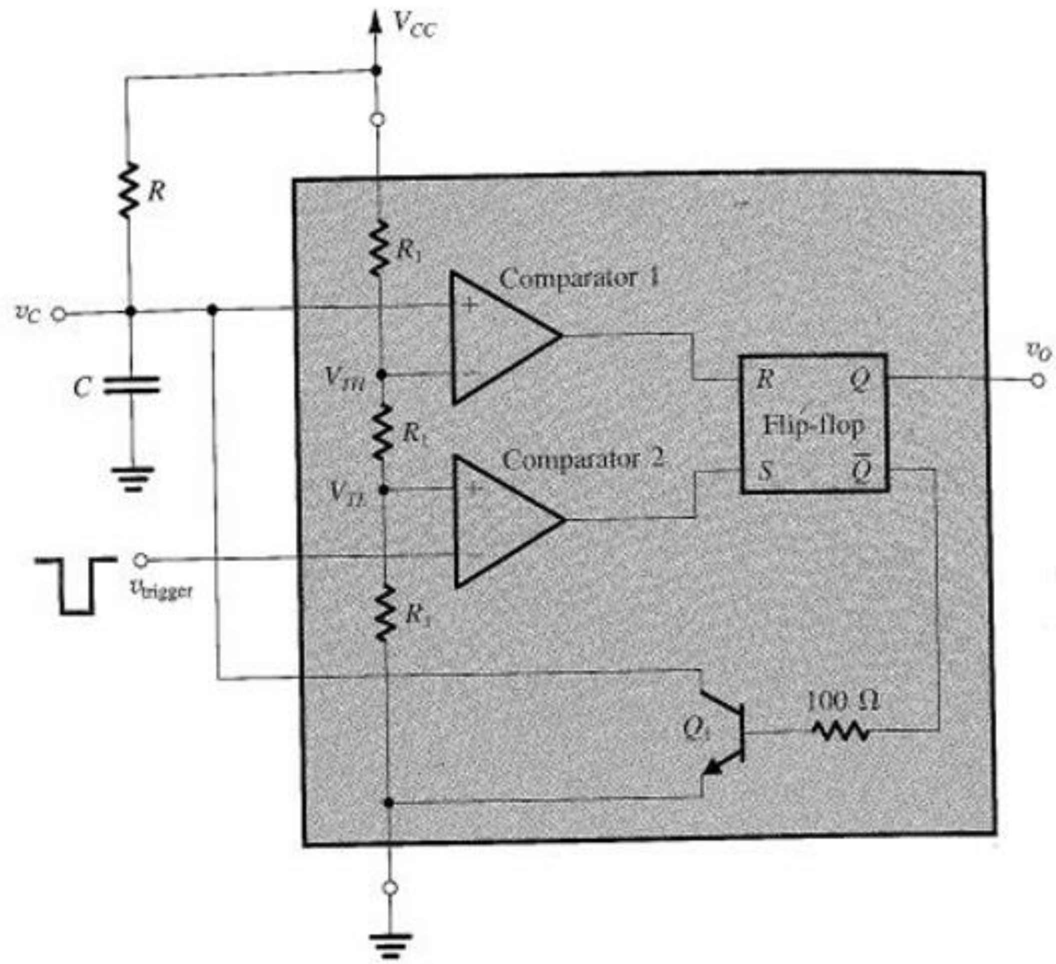
555 Astable

555 as an astable or free-running multivibrator, which is essentially a square-wave oscillator. f the output can be changed with proper input signals.


+V_{CC}
(4)
(8)
R_1
RESET
V_{CC}
(7)
DISCH
555
R_2
(6)
THRESH
OUT
(3)
(2)
TRIG
CONT
(5)
C_1
C_{ext}
GND
0.01 μF
(1)
(decoupling optional)

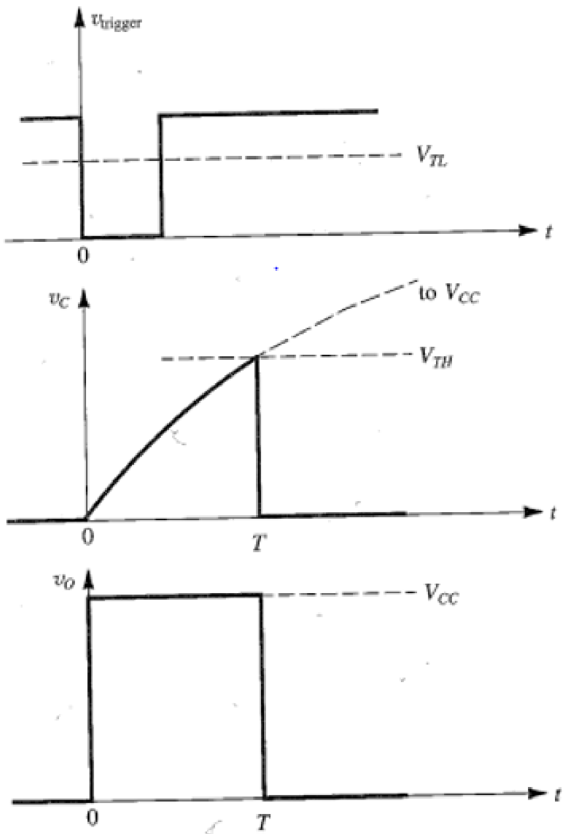


555 Monostable Multivibrator



V_{CC}
R
R_1
Comparator 1
v_C
C
V_{TH}
R_1
Comparator 2
V_{TL}
$v_{trigger}$
R_1
R
Q
Flip-flop
S
$\overline{Q}$
v_O
100 Ω
Q_1

(a)



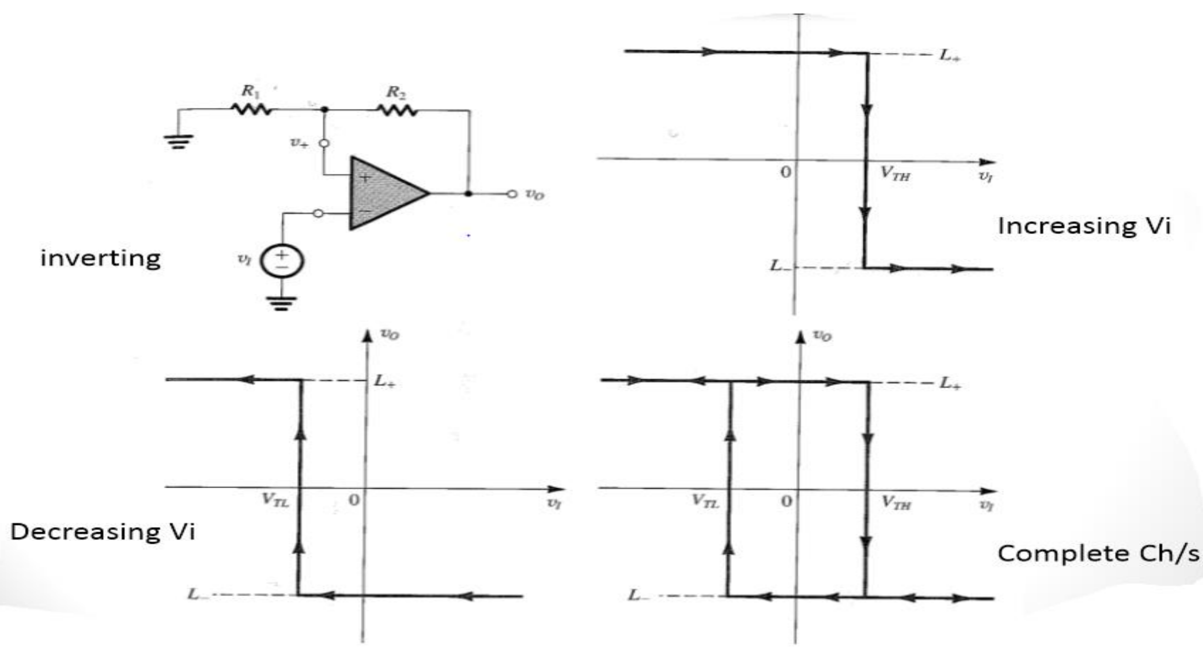
$$v_C = V_{CC}(1 - e^{-t/CR})$$

Substituting $v_C = V_{TH} = \frac{2}{3}V_{CC}$ at $t = T$ gives

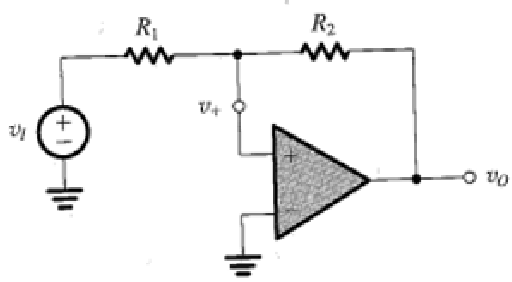
$$T = CR \ln 3 \simeq 1.1CR$$

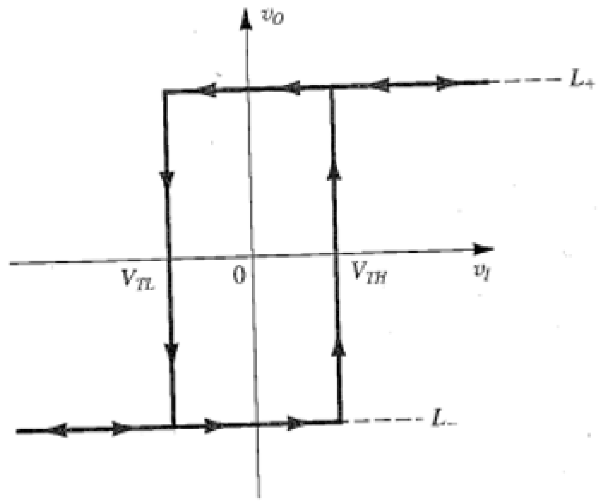
MULTIVIBRATORS USING OP-AMP

Bistable Circuit and Transfer Characteristic



Bistable with non inverting transfer ch/s





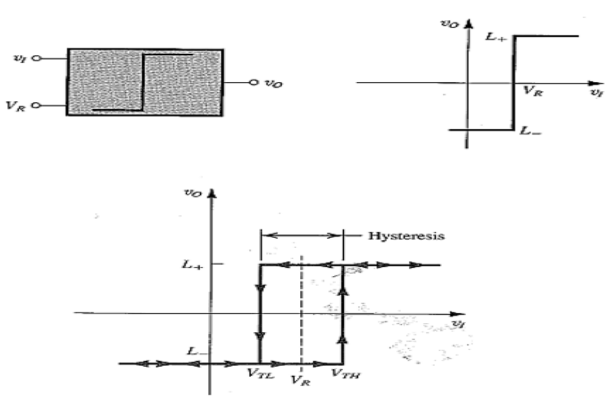
$$v_+ = v_I \frac{R_2}{R_1 + R_2} + v_O \frac{R_1}{R_1 + R_2}$$

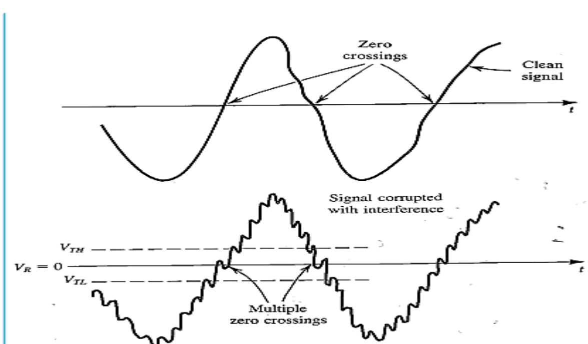
Feed fraction

$$V_{TL} = -L_+(R_1/R_2)$$

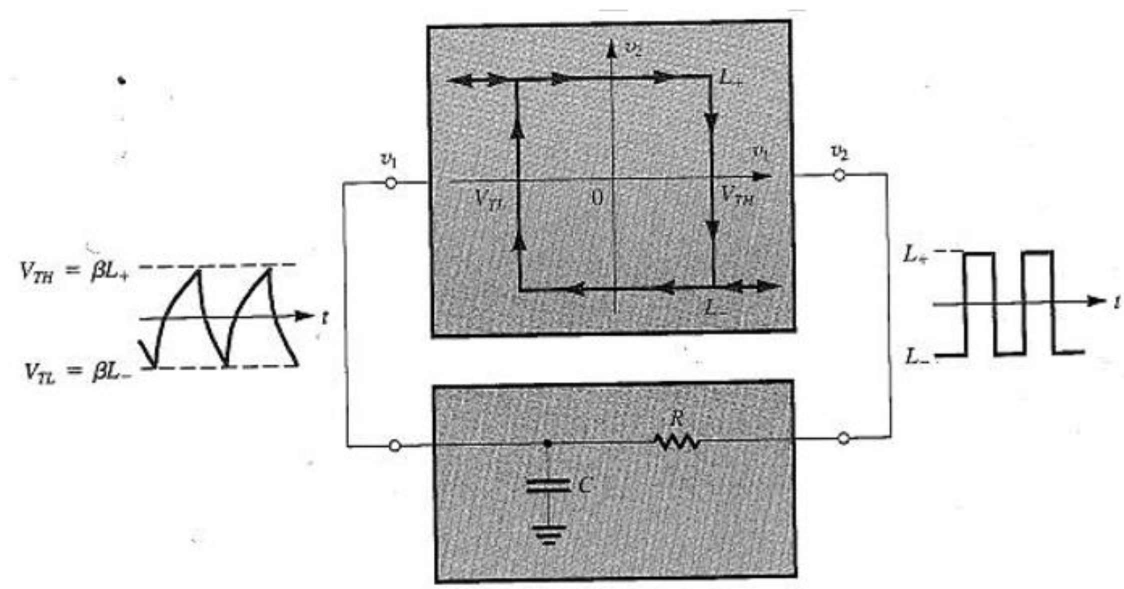
$$\beta \equiv R_1/(R_1 + R_2)$$

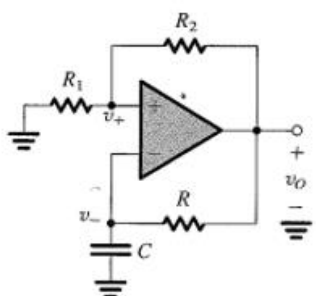
Application of bistable as comparator (Schmit-Trigger)

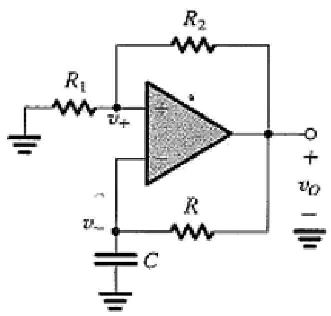


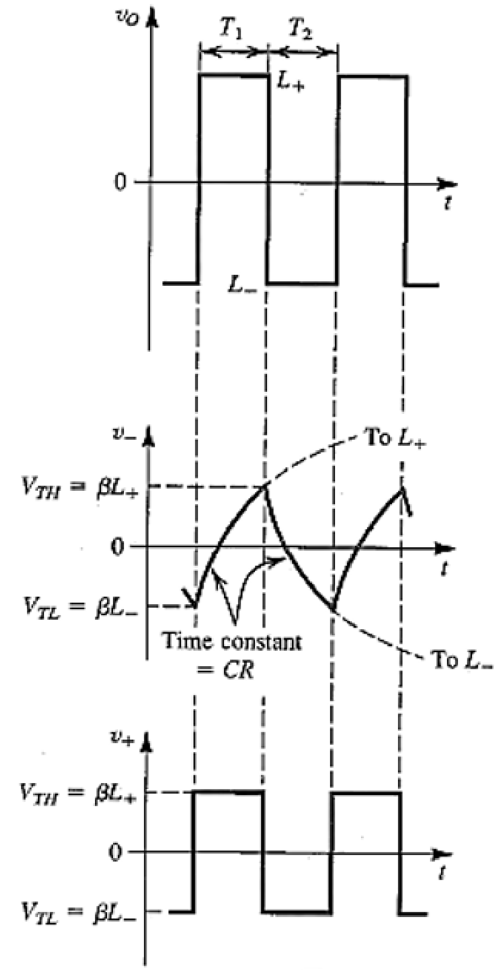


Astable









Voltage across capacitor:

$$v_- = L_+ - (L_+ - \beta L_-)e^{-t/\tau}$$

Substituting $v_- = \beta L_+$ at $t = T_1$ gives

$$T_1 = \tau \ln \frac{1 - \beta(L_-/L_+)}{1 - \beta}$$

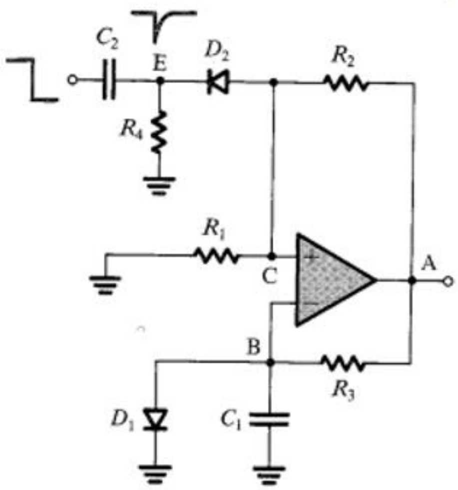
$$v_- = L_- - (L_- - \beta L_+)e^{-t/\tau}$$

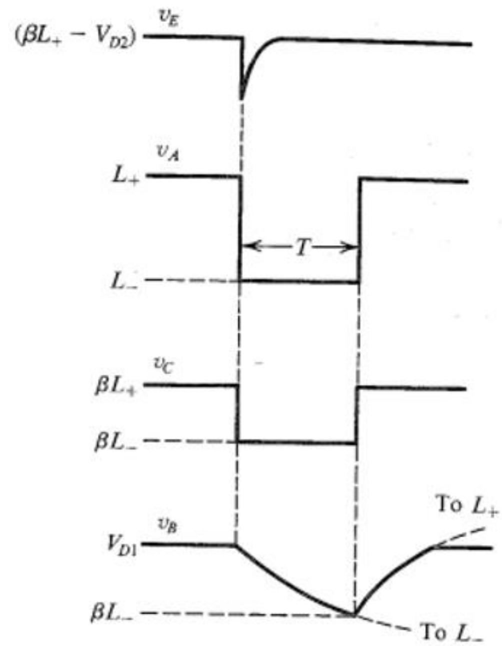
$$T_2 = \tau \ln \frac{1 - \beta(L_+/L_-)}{1 - \beta}$$

$$T = T_1 + T_2. \qquad \boxed{T = 2\tau \ln \frac{1 + \beta}{1 - \beta}}$$

$$\tau = CR.$$

Monostable circuit





$$v_B(t) = L_- - (L_- - V_{D1})e^{-t/C_1R_3}$$

by substituting $v_B(T) = \beta L_-$,

$$\beta L_- = L_- - (L_- - V_{D1})e^{-T/C_1R_3}$$

$$T = C_1R_3 \ln\left(\frac{V_{D1} - L_-}{\beta L_- - L_-}\right)$$

$$\boxed{T \simeq C_1R_3 \ln\left(\frac{1}{1-\beta}\right)}$$

DESIGN EXAMPLE 15.9

Objective: Design a monostable multivibrator to produce a given pulse width.

Specifications: The circuit with the configuration shown in Figure 15.37 is to be designed to produce an output pulse that is 1 μs wide. Assume parameters of $V_P = 10\,\text{V}$, $V_\gamma = 0.7\,\text{V}$ and $R_1 = R_2 = 20\,\text{k}\Omega$.

Choices: Assume an ideal comparator is available. Use standard-valued element values in the final design.

Solution: Since $V_\gamma \ll V_P$ and $R_1 = R_2$, then from Equation (15.92), we have

$$T = 0.69\tau_x$$

or

$$\tau_X = R_XC_X = \frac{T}{0.69} = \frac{1}{0.69} = 1.45\,\mu\text{s}$$

If $R_X = 10\,\text{k}\Omega$, then $C_X = 145\,\text{pF}$.

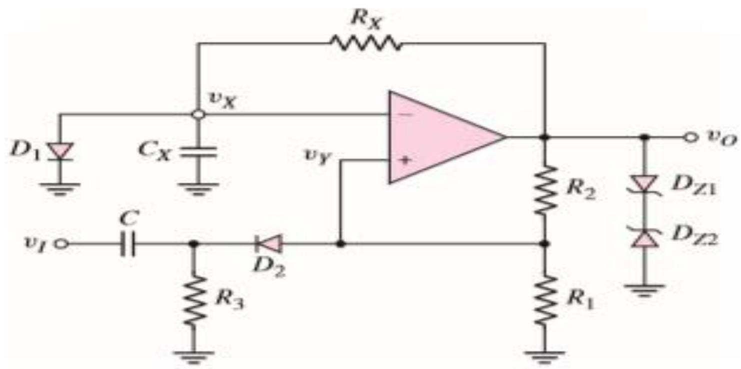


Figure 15.37 Schmitt trigger monostable multivibrator

EXERCISE PROBLEM

***Ex 15.9:** For the monostable circuit shown in Figure 15.37, the parameters are: $V_P = 12\,\text{V}$, $V_\gamma = 0.7\,\text{V}$, $C_X = 0.1\,\mu\text{F}$, $R_1 = 10\,\text{k}\Omega$, and $R_2 = 90\,\text{k}\Omega$. (a) Find the value of R_X that will result in a $50\,\mu\text{s}$ output pulse. (b) Using the results of part (a), find the recovery time. (Ans. (a) $R_X = 3.09\,\text{k}\Omega$ (b) $47.9\,\mu\text{s}$)