ASTABLE MULTIVIBRATOR USING 555 TIMER

555 Timer as Astable Multivibrator

1 - Ground

2 - Trigger

3 - Output

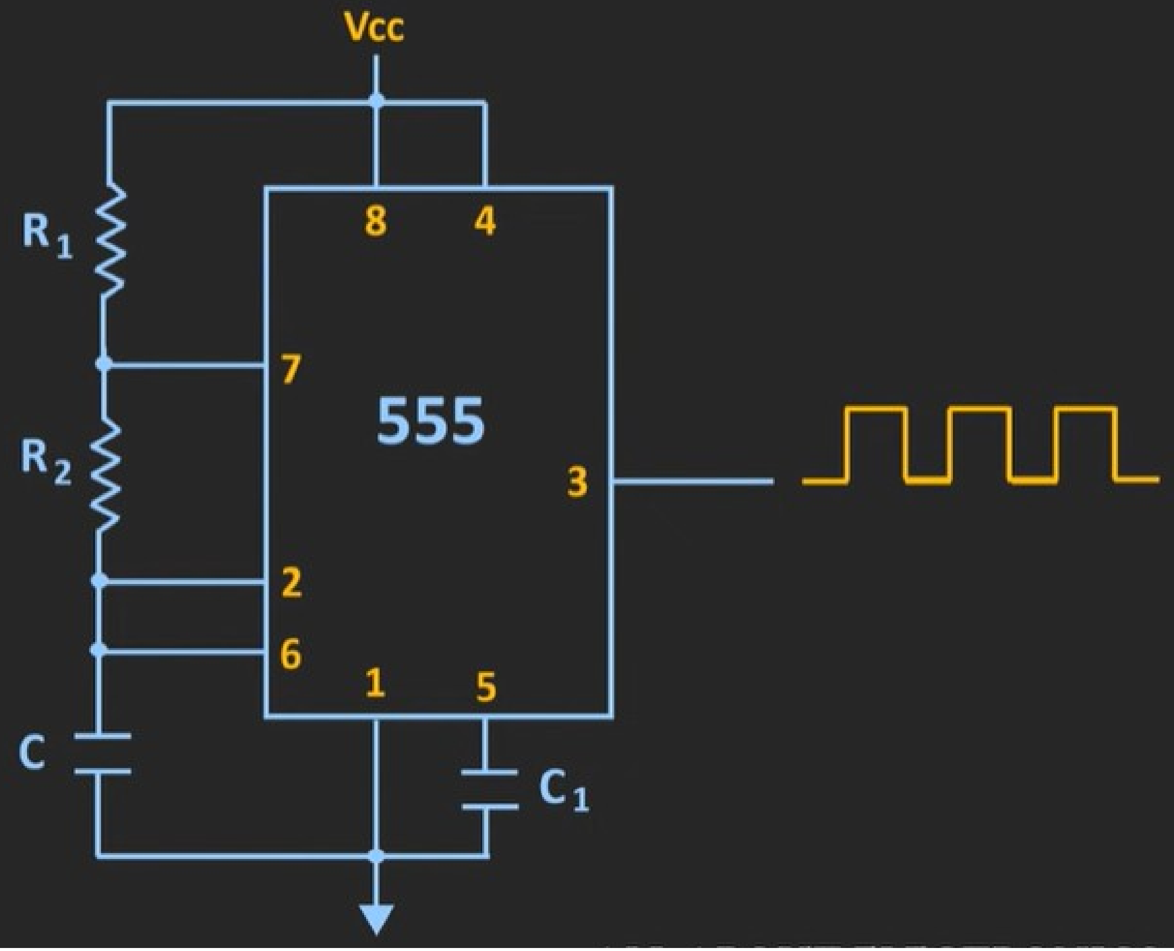
4 - Reset

5 - Control

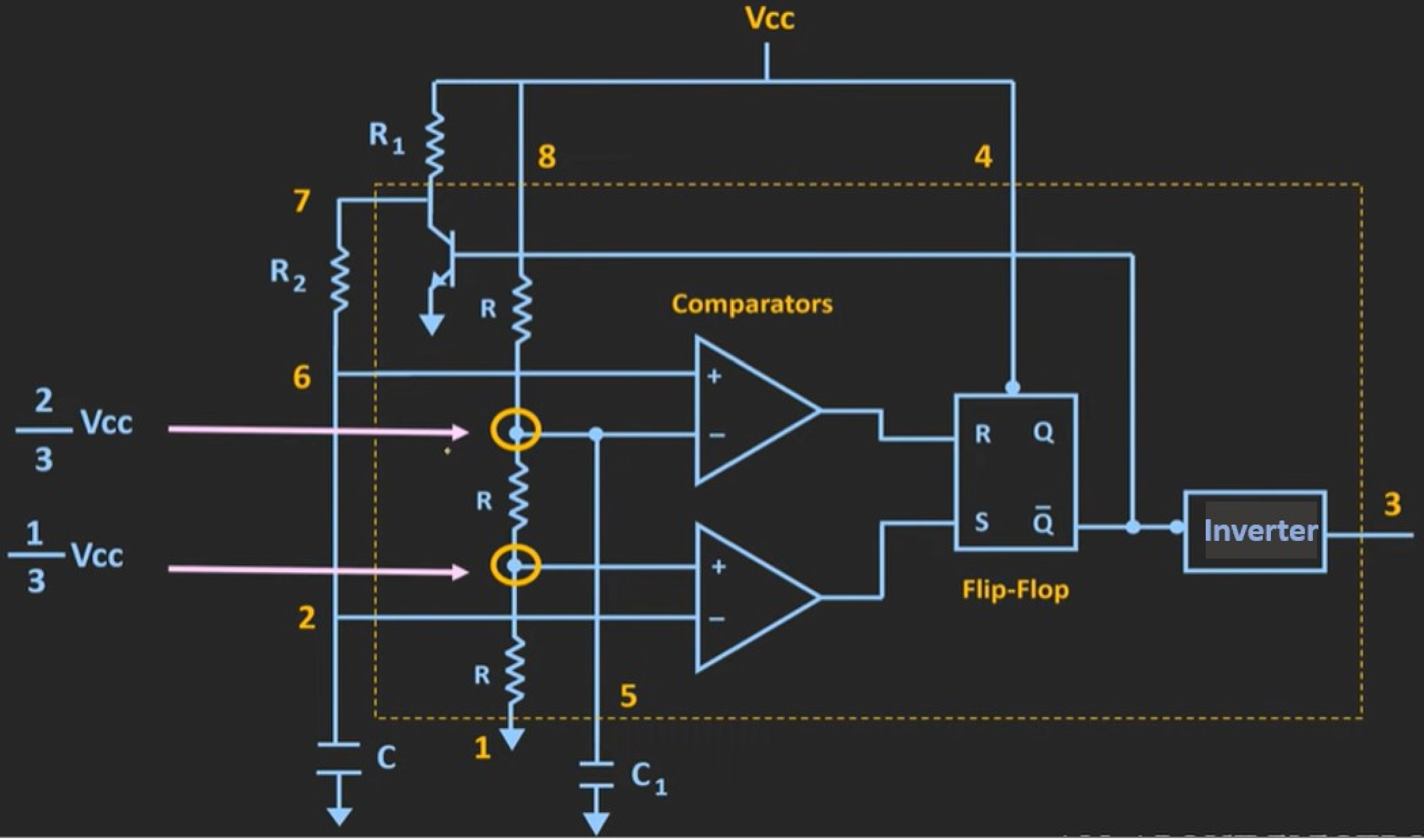
6 - Threshold

7 - Discharge

8 - Vcc



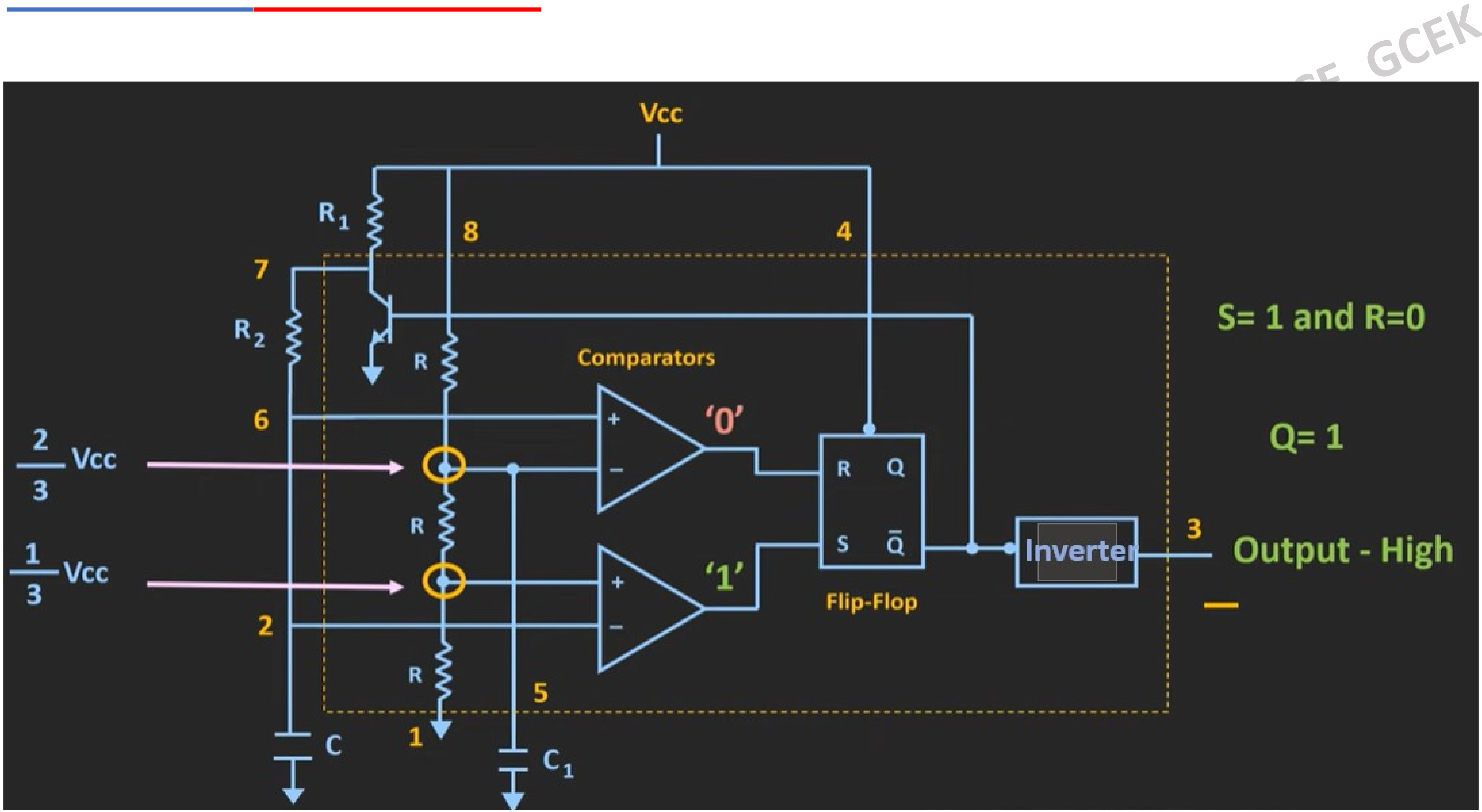
555 Timer as Astable Multivibrator

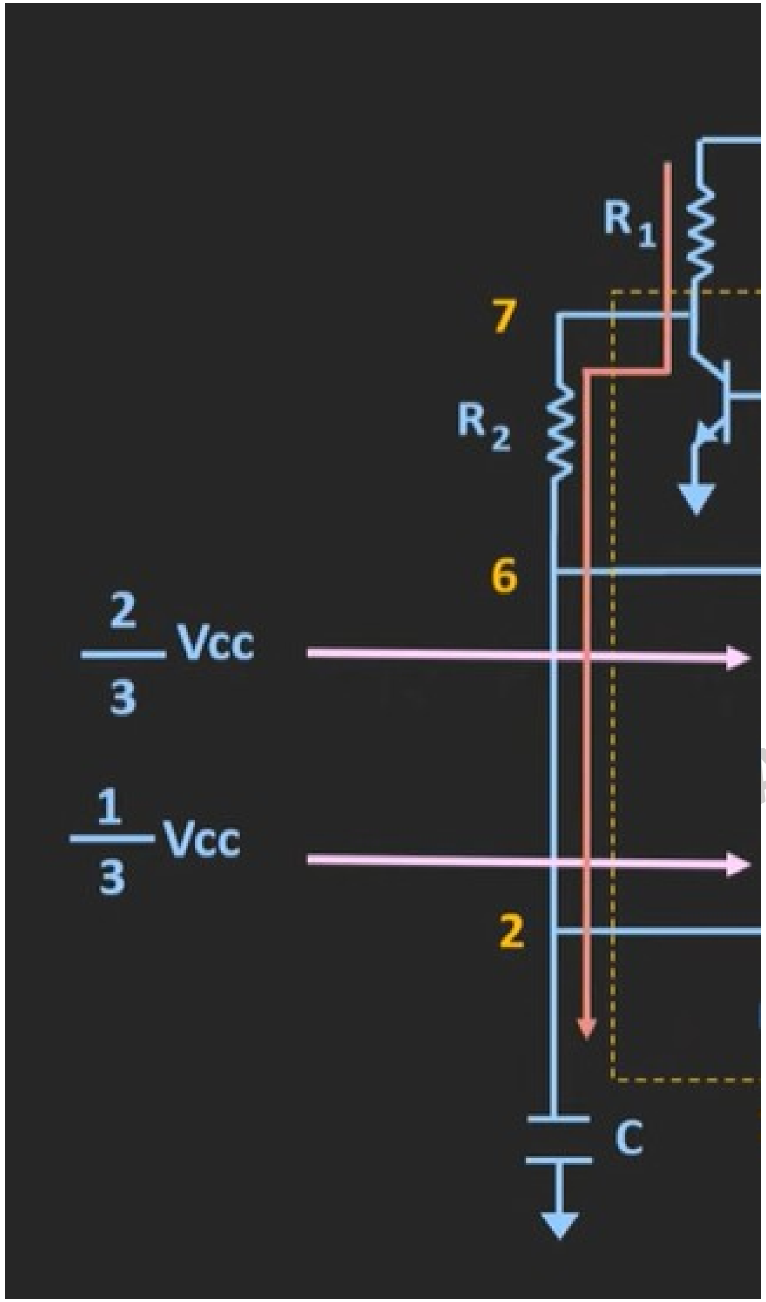


Case 1: V2=V6=0

- Whenever the ckt is jz turned on, cap C will be fully uncharged.
- ie V at pin 2 & 6 will be =0.
- so upper comparator(UC) o/p = 0
- Lower comparator(LC) o/p = 1
- S=1 and R=0 ----------o/p Q=1------o/p of 555 timer = logic HIGH (1)
- When Q=1, so transistor Q1 will be in OFF condition. So cap C starts charging thru R1 and R2.

Case 1: V2=V6=0


Vcc
R1
8
4
7
R2
R
Comparators
6
'0'
+
−
R
Q
S
Q̄
2/3 Vcc
1/3 Vcc
R
'1'
Inverter
3
Flip-Flop
2
R
5
C
1
C1
S= 1 and R=0
Q= 1
Output - High



Gradually V at pin 2 & 6 will start increasing.

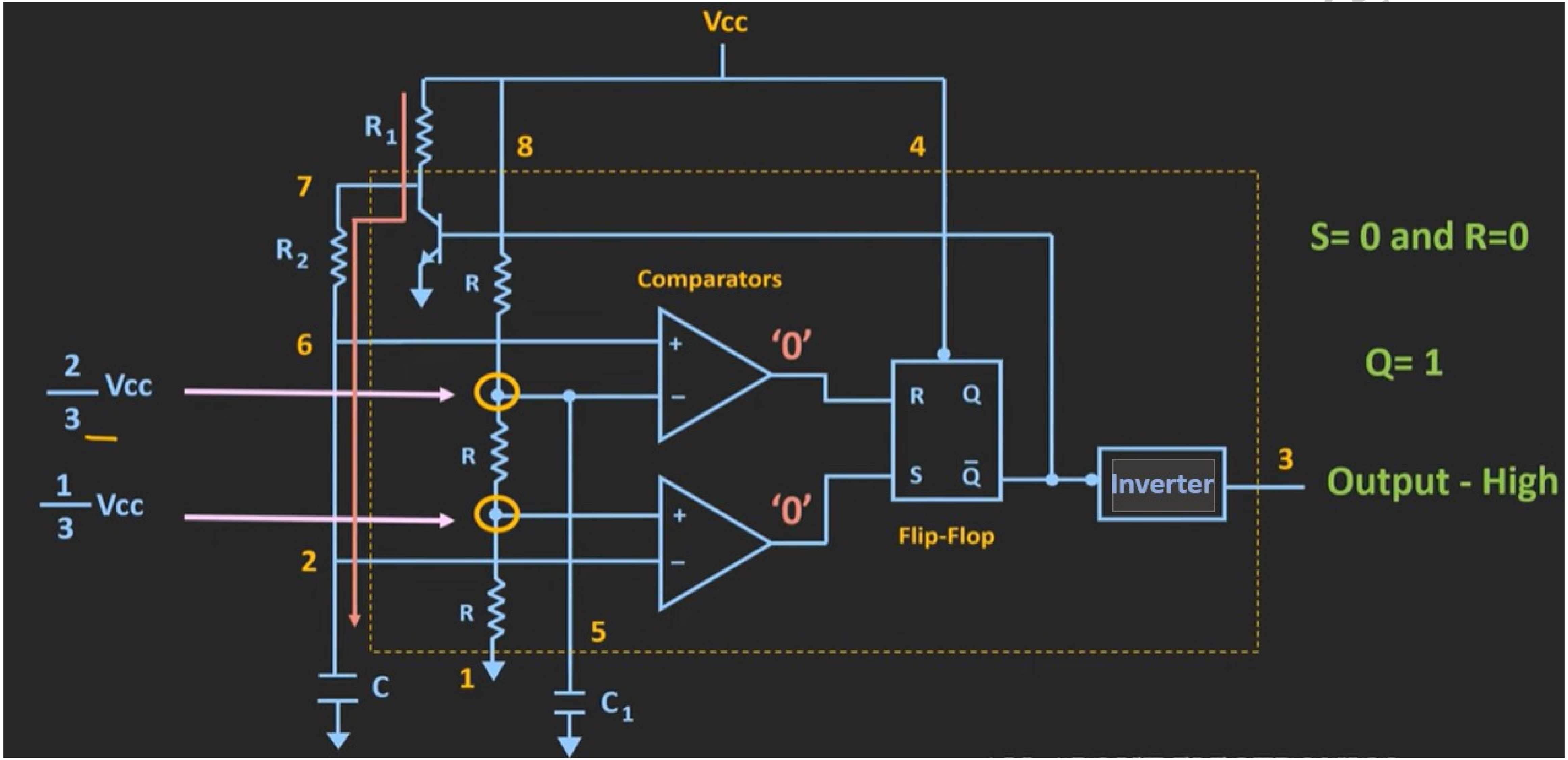
Case 2: 1/3 Vcc < V2=V6 < 2/3 Vcc

Whenever V at pin 2 > 1/3 Vcc, o/p of LC =0.

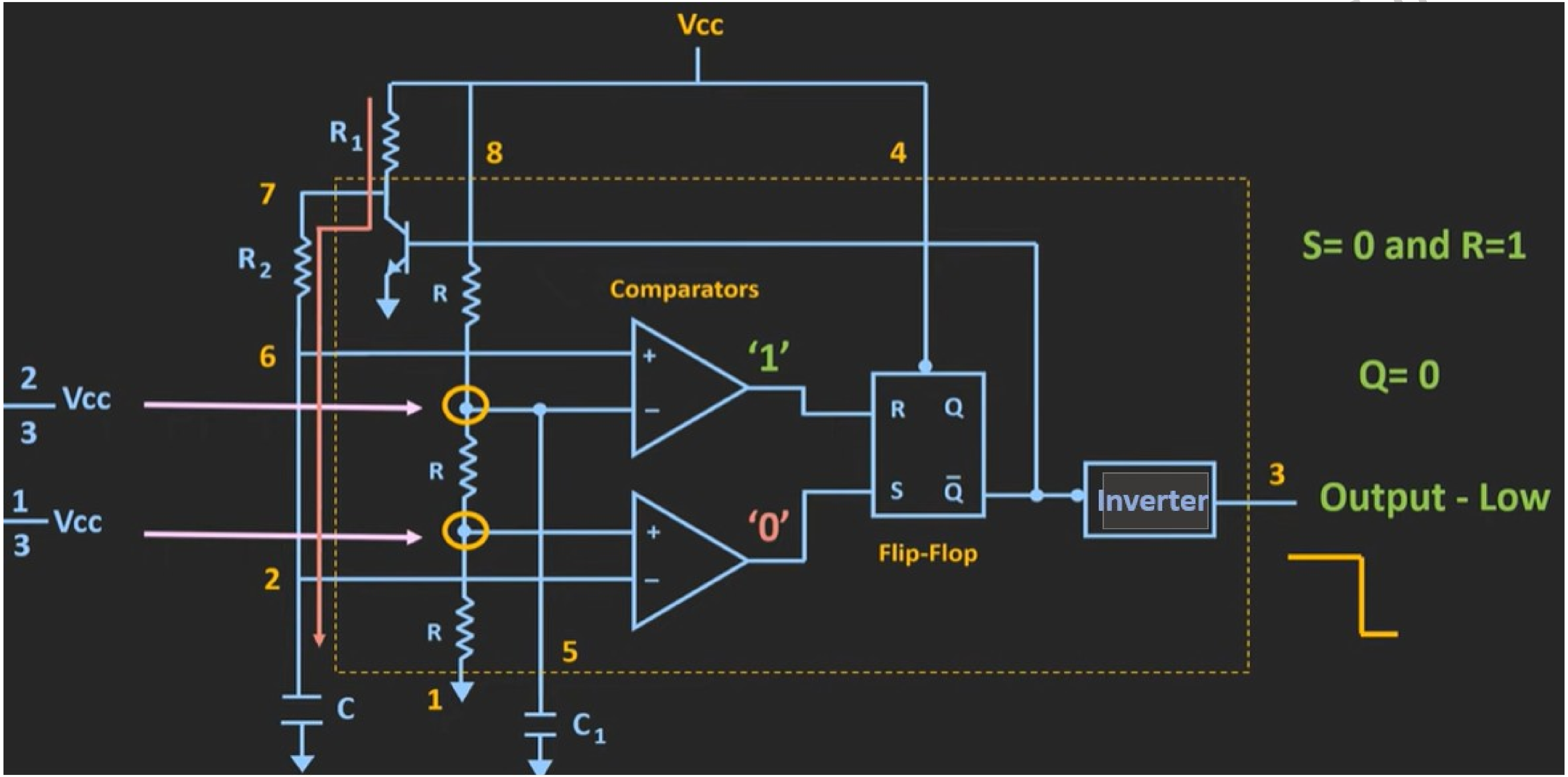
Let V at pin 6 < 2/3 Vcc, then o/p of UC = 0.

S=0 and R=0 ----o/p Q =1 (previous state). Timer o/p = High.

Case 2: 1/3 Vcc < V2=V6 < 2/3 Vcc



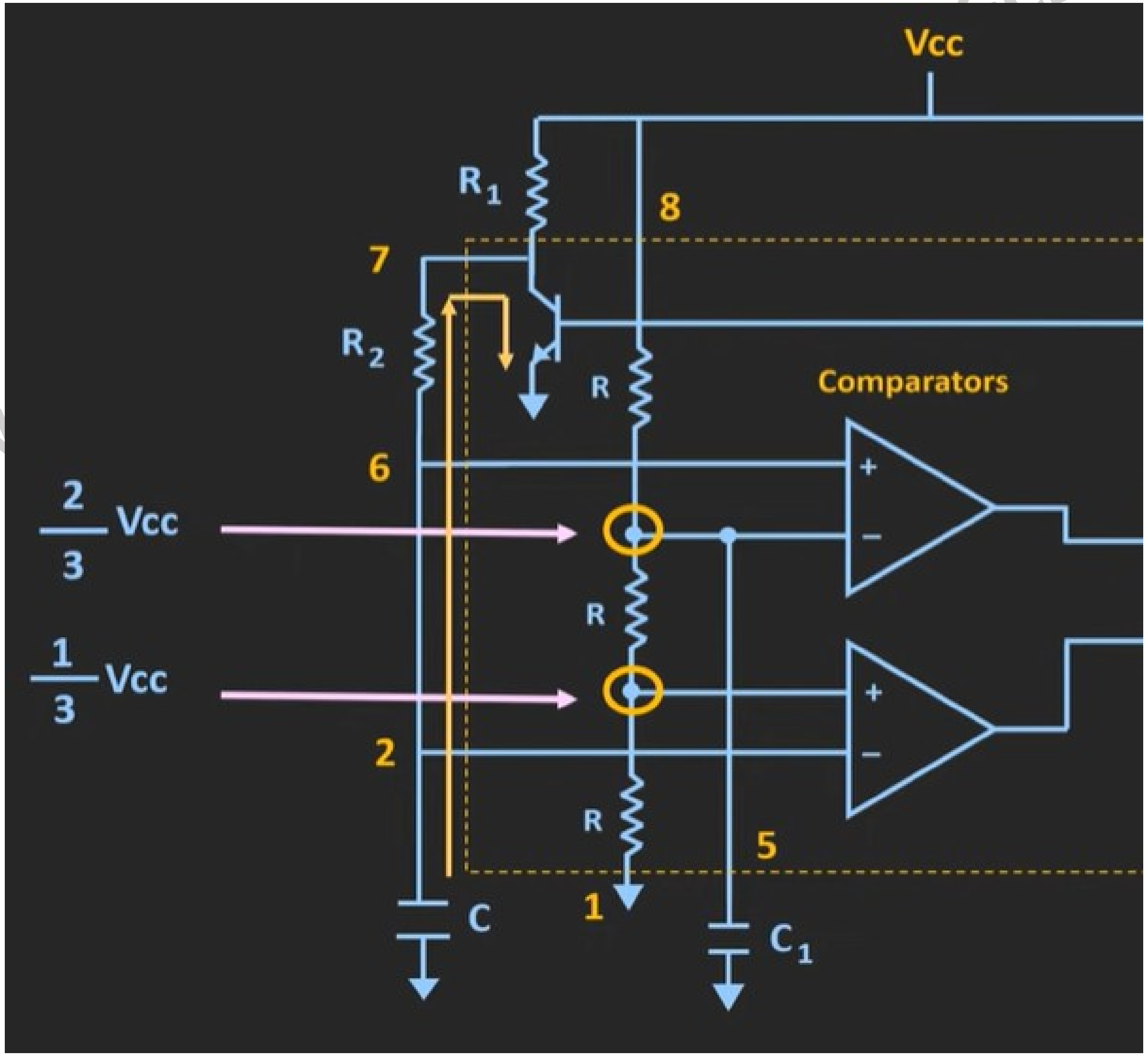
Case 3: V_c > 2/3 Vcc



- When o/p Q=0, so transistor Q1 will be in ON condition. So cap C starts discharging thru Q1.
- V_c starts decreasing.

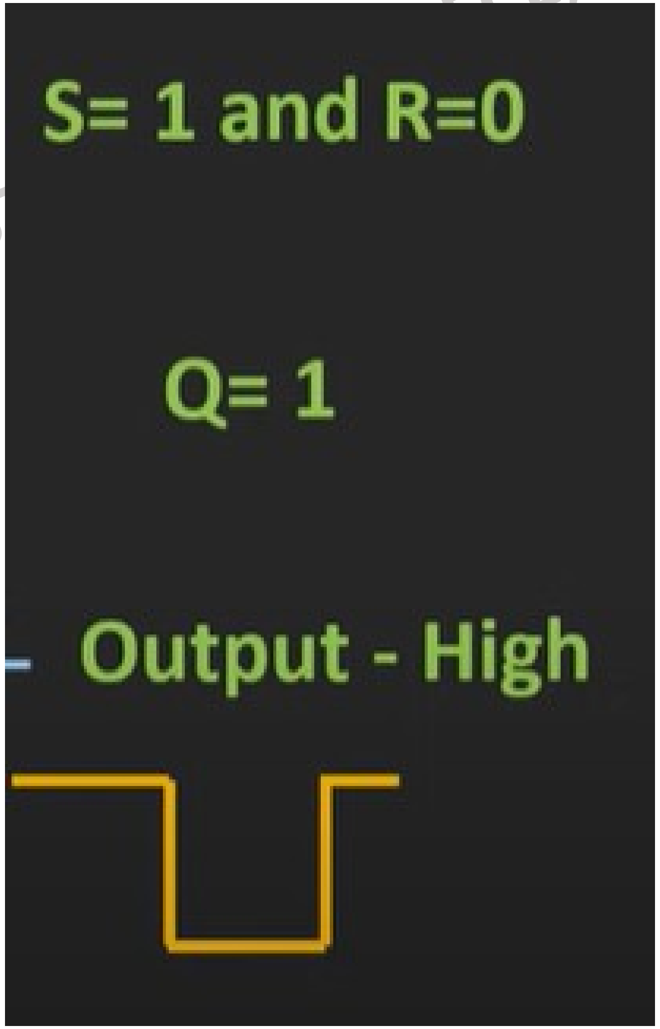
Case 4:

- As soon as V goes jz < 2/3 Vcc, then o/p of UC = 0.
- o/p of LC =0
- S=0, R=0 --- Q=0 (previous)
- o/p of timer = 0
- Q1 still ON.

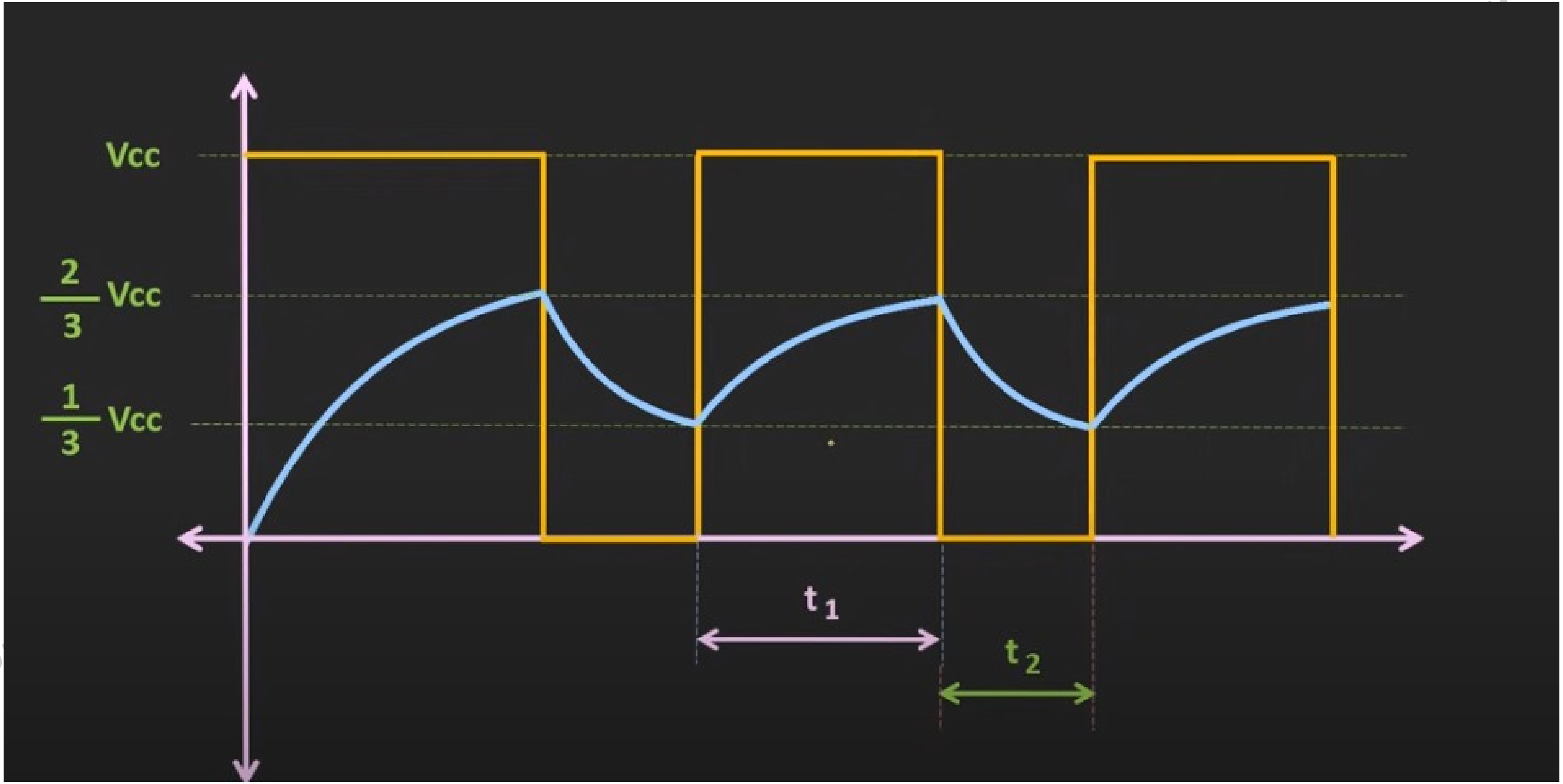


Case 5: when V_c goes jz < 1/3 Vcc

- o/p of LC =1
- o/p of UC = 0
- S=1, R=0 ---- Q=1 .
- o/p of timer = logic High.
- When o/p Q=1, so transistor Q1 will be in OFF condition. So cap C starts charging thru R1 & R2.



- In this way, cap is charging btw 1/3 Vcc and 2/3 Vcc.
- Bcoz of this charging & discharging of cap, we will see a transition in the o/p V.
- During charging process, whenever V_c > 2/3 Vcc, there is a transition in the o/p from logic high to logic low.
- During discharging process, whenever V_c < 1/3 Vcc, there is a transition in the o/p from logic low to logic high.


Vcc
2/3 Vcc
1/3 Vcc
t1
t2

- Time t_1 – time for which o/p of timer remains HIGH
- Time t_2 – time for which o/p of timer remains LOW

$$t_1 > t_2$$

- Time t_1 - time taken by cap to charge from 1/3 Vcc to 2/3 Vcc
- Time t_2 - time taken by cap to discharge from 2/3 Vcc to 1/3 Vcc

$$t_1 = 0.693\ (R1 + R2)\ C$$

$$t_2 = 0.693\ R2\ C$$

$$T = t_1 + t_2 = 0.693\ (R1 + 2R2)\ C$$

$t_1 > t_2$

- Charging is thru R1 and R2
- Discharging thru R2 only.
- **Duty cycle is always > 50%**

- For 50 % duty cycle(symm square wave), R1 shud be =0. But in this case, pin 7 is directly connected to Vcc and extra current will flow thru Q1 when it is ON. This may damage Q1 and hence the timer.

$$t_1 = 0.693\,(R1 + R2)\,C$$

$$t_2 = 0.693\,R2\,C$$

$$T = t_1 + t_2 = 0.693\,(R1 + 2R2)\,C$$

$$\text{Duty Cycle} = \frac{t_1}{T}$$

$$\text{Duty Cycle} = \frac{R1 + R2}{R1 + 2R2}$$

Astable Multivibrator (50 % Duty Cycle)

1 - Ground

2 - Trigger

3 - Output

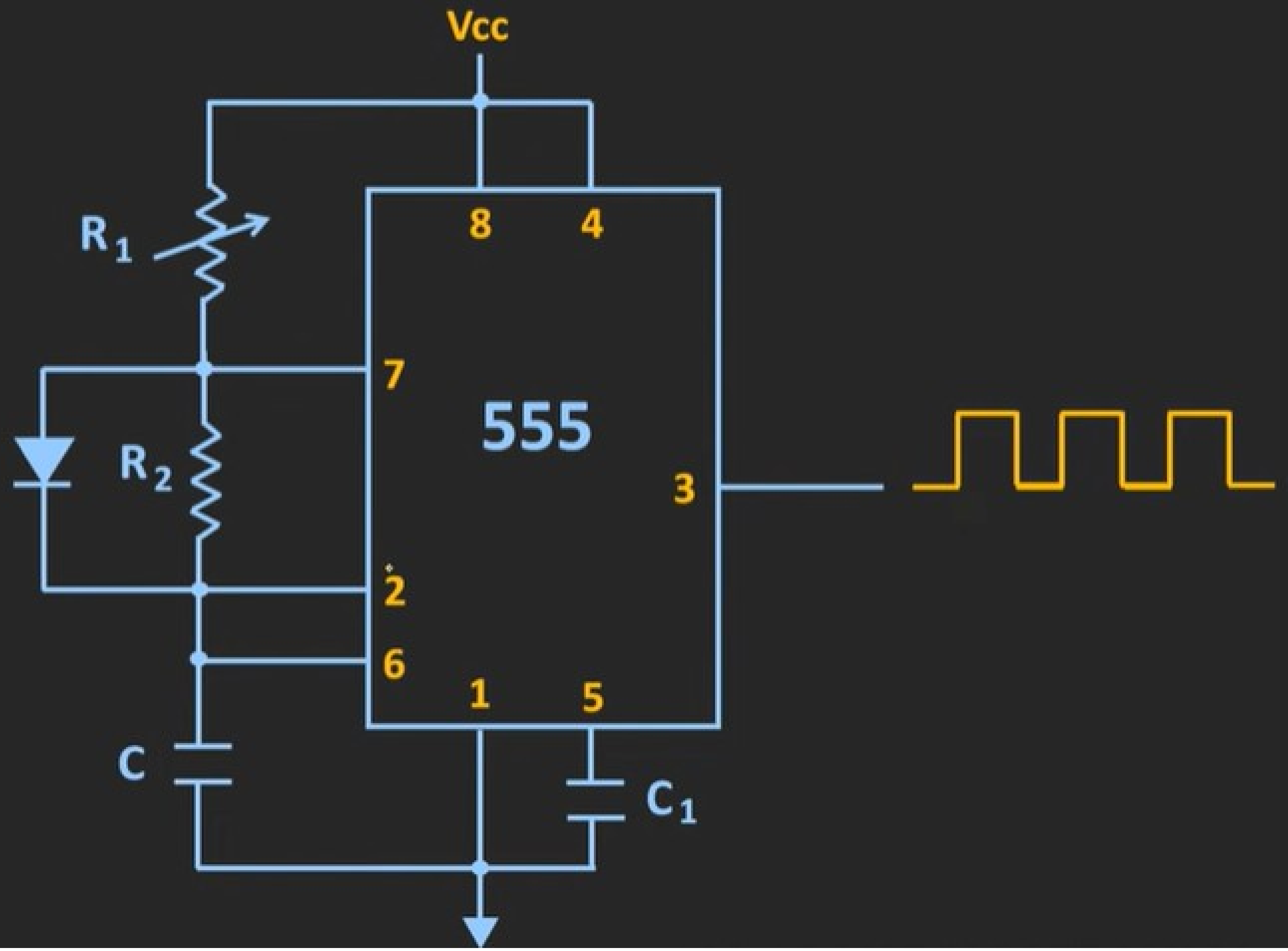
4 - Reset

5 - Control

6 - Threshold

7 - Discharge

8 - Vcc



- During the charging of this capr, diode will be ON.
- Fwd res of diode $R_D < R_2$. so C will charge thru R1 and D.

$$t_1 = 0.693(R_1+R_D)C$$

- During the discharging of this capr, diode will be OFF.
- C will discharge thru R_2.

$$t_2 = 0.693R_2C$$

- If we adjz R1 value such that $(R_1+R_D) = R_2$, then duty cycle =50%

- Or if we assume diode is ideal, $R_D = 0$.

$$t_1 = 0.693R_1C$$

$$t_2 = 0.693R_2C$$

- Duty cycle = R1 / (R1+R2)
- If we take R1 = R2, then duty cycle =50%
- If we take R1 > R2, then duty cycle >50%
- If we take R1 < R2, then duty cycle <50%

Design

$V_c(t) = V_F + (V_I - V_F)$

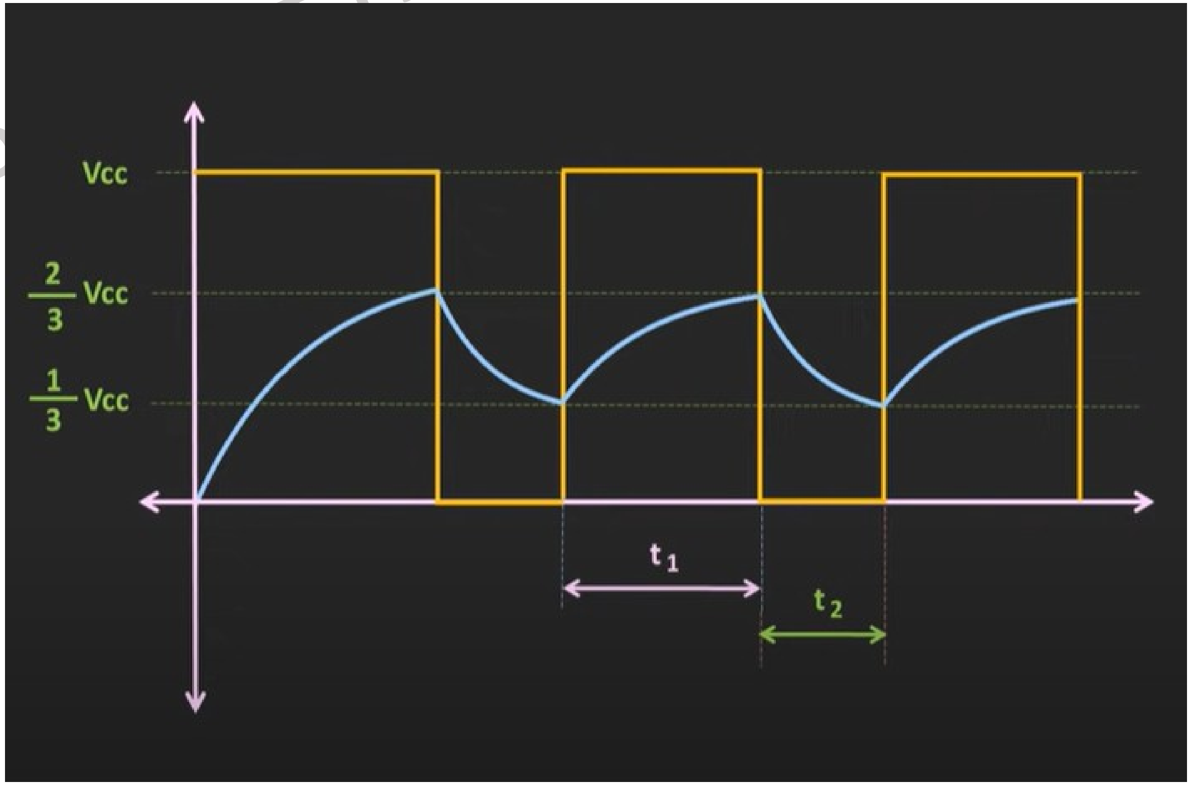
To find t_1

$V_I = 1/3\ V_{cc}$

$V_F = V_{cc}$

$V_c(t) = 2/3\ V_{cc}$

$R' = R_1 + R_2$



$$t_1 = 0.693\,(R_1 + R_2)\,C$$

To find t_2

$V_I = 2/3\ V_{cc}$

$V_F = 0$

$V_c(t) = 1/3\ V_{cc}$

$R' = R_2$

$$t_2 = 0.693\,R_2 C$$

- Total time $T = t_1 + t_2$

$$T = 0.693\,(R_1 + 2R_2)\,C$$

- Frequency $f =$

- Duty cycle = = =

Duty cycle =