Analog Electronics

Course No: AE-2

Lec: 555 timers and Multi-vibrators

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Formerly **Pandit Deendayal Petroleum University**

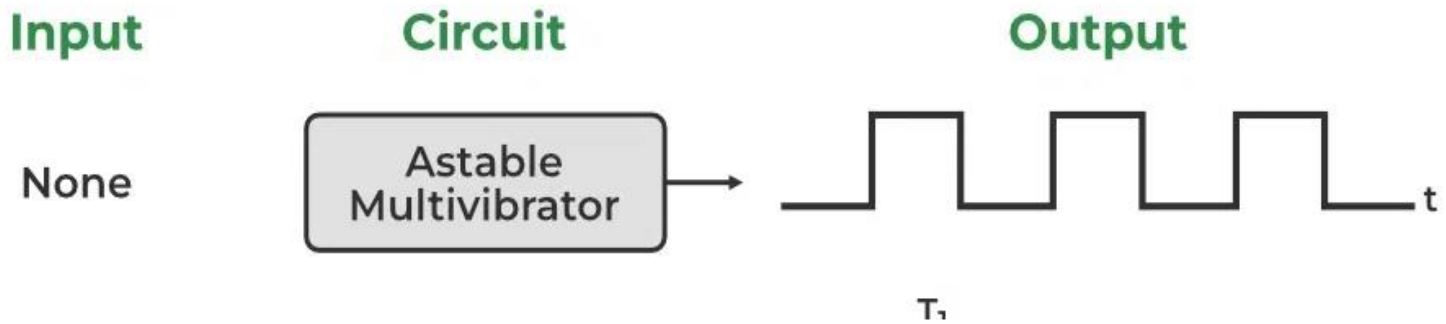
Multivibrators:

- **Multivibrators** are electronic circuits used to generate, store, or process binary signals (i.e., signals with two stable states: HIGH and LOW). They are commonly used in timing applications, pulse generation, and waveform shaping.

- Are of three types: **Astable, Mono-stable, Bi-stable**

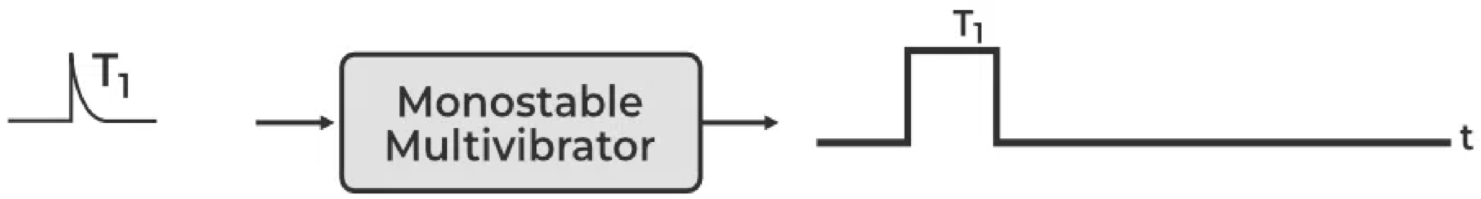
Astable Multivibrator

- Has **no stable state→** free-running multivibrator.
- Continuously switches between HIGH and LOW states.
- Used as an oscillator or clock generator.



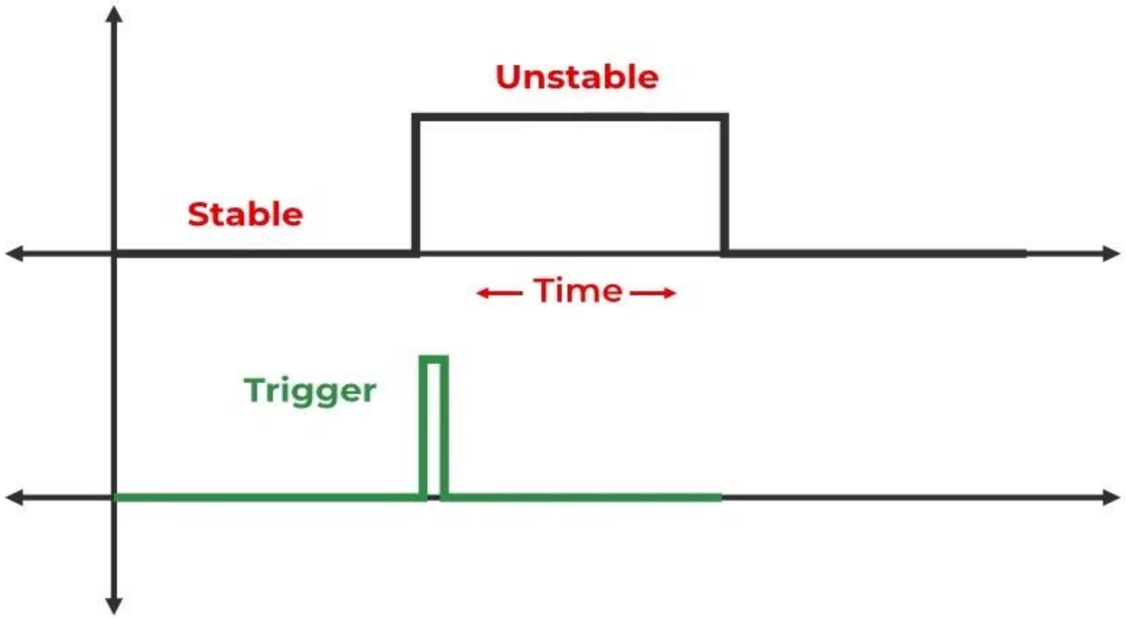
Mono-stable Multivibrator

• A monostable multivibrator, also called a one-shot multivibrator, is a circuit that responds to an external trigger by producing a single pulse with a set duration.



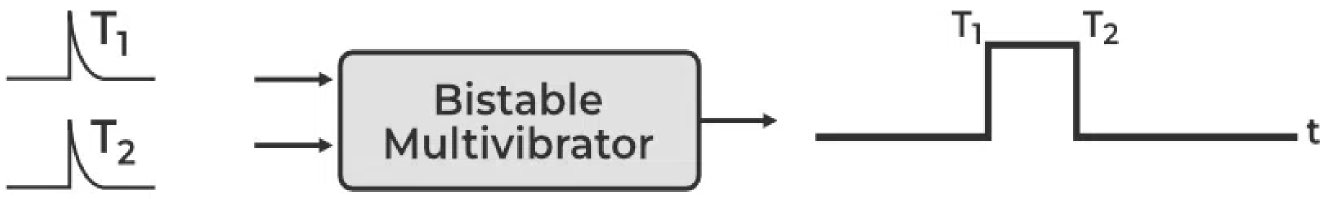
•The circuit returns to its stable condition after a certain amount of time and generates a single output pulse.

•By altering the values of the resistors and capacitors in the circuit, the output pulse's duration can be changed.



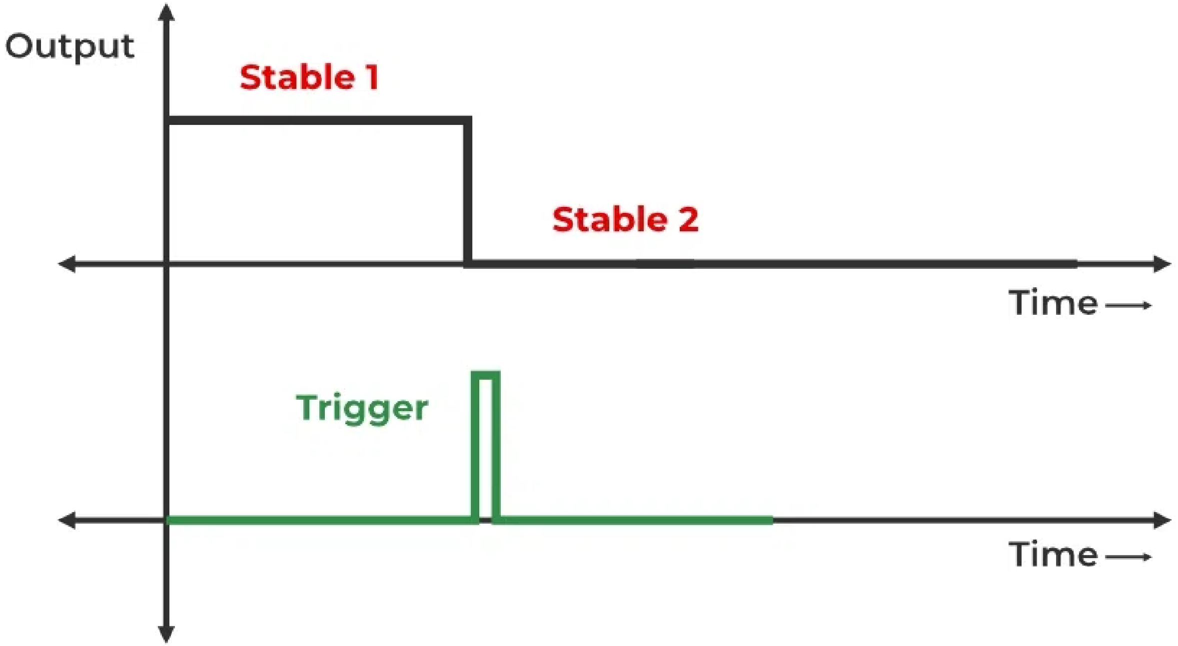
Bi-stable Multivibrator

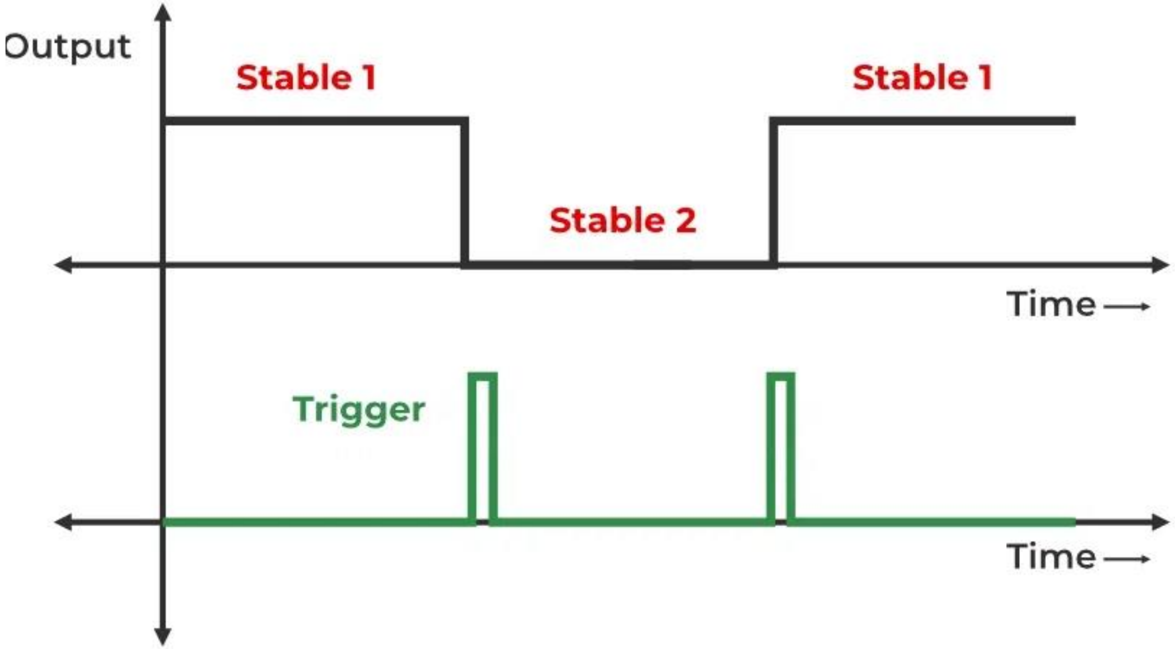
- A circuit with two stable states that can alternately exist indefinitely. .



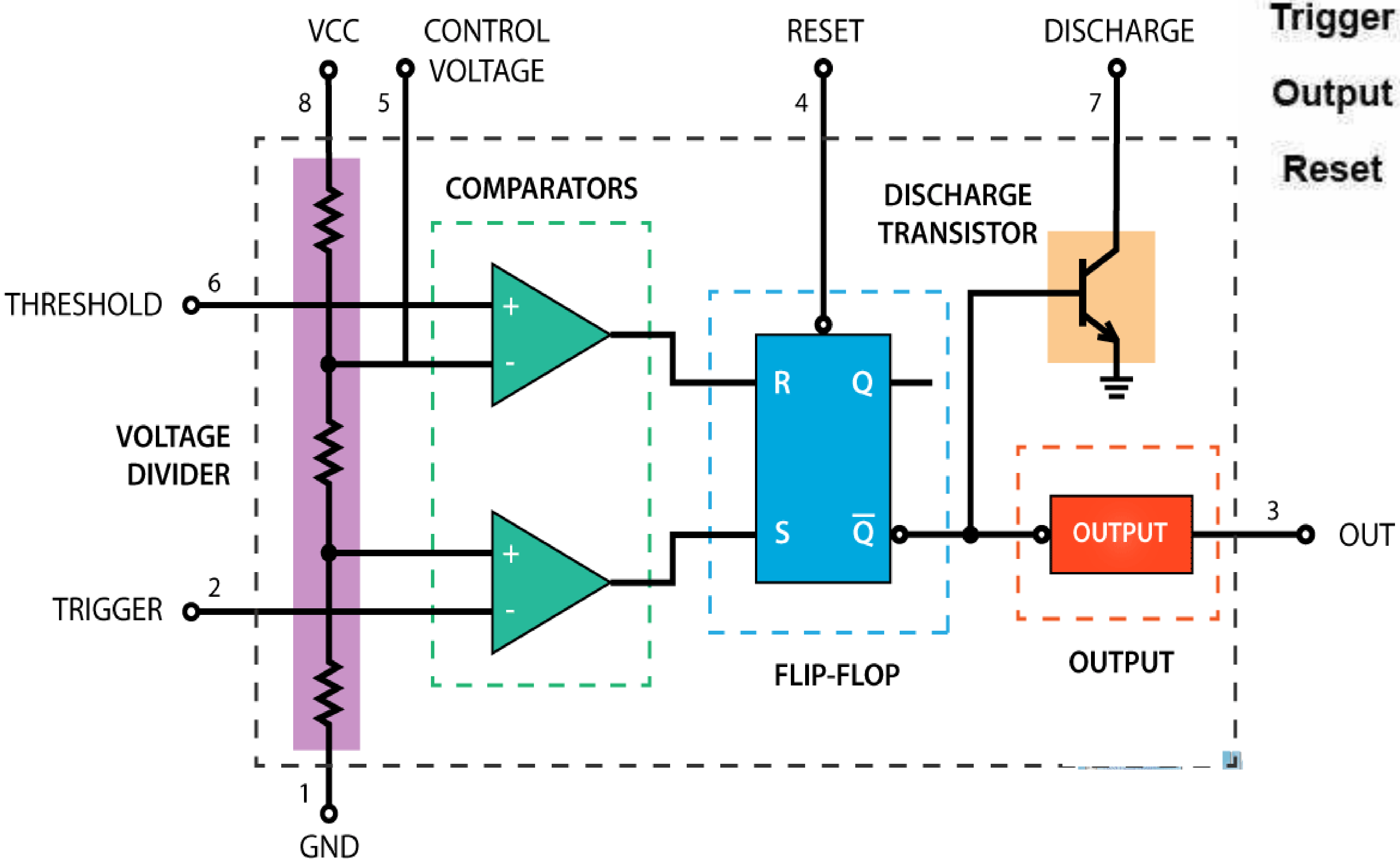
- A signal from outside causes it to change from one stable condition to another.

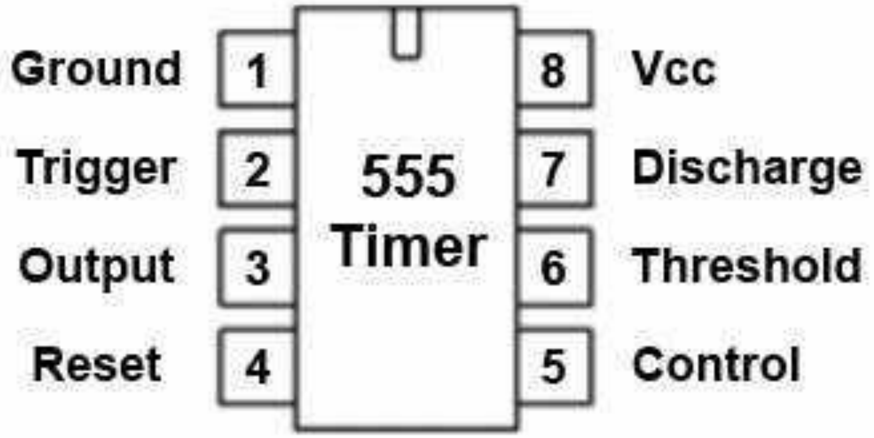
- The circuit will stay in its stable state until another trigger signal enters it.





555 Timer:

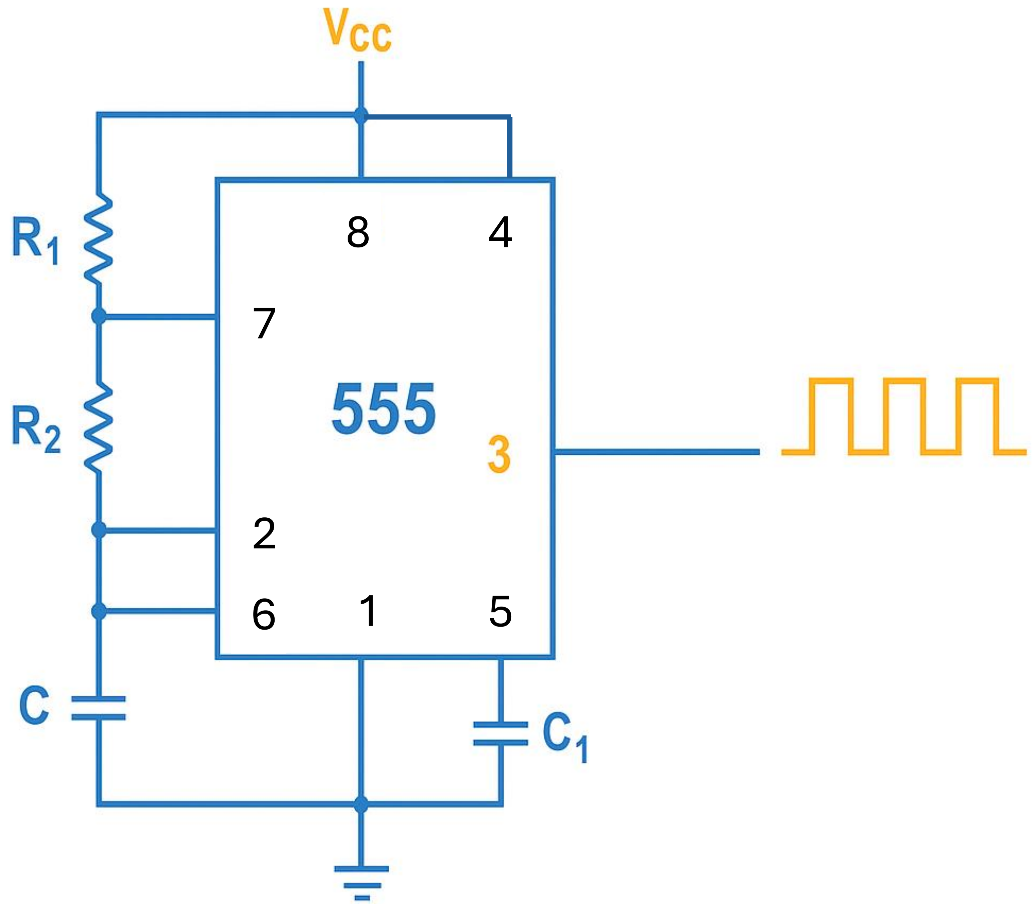

VCC
CONTROL VOLTAGE
RESET
DISCHARGE
8
5
4
7
COMPARATORS
DISCHARGE TRANSISTOR
THRESHOLD
6
+
-
R
Q
VOLTAGE DIVIDER
S
Q̄
OUTPUT
3
OUT
TRIGGER
2
FLIP-FLOP
OUTPUT
1
GND


Ground 1
Trigger 2
Output 3
Reset 4
555 Timer
8 Vcc
7 Discharge
6 Threshold
5 Control

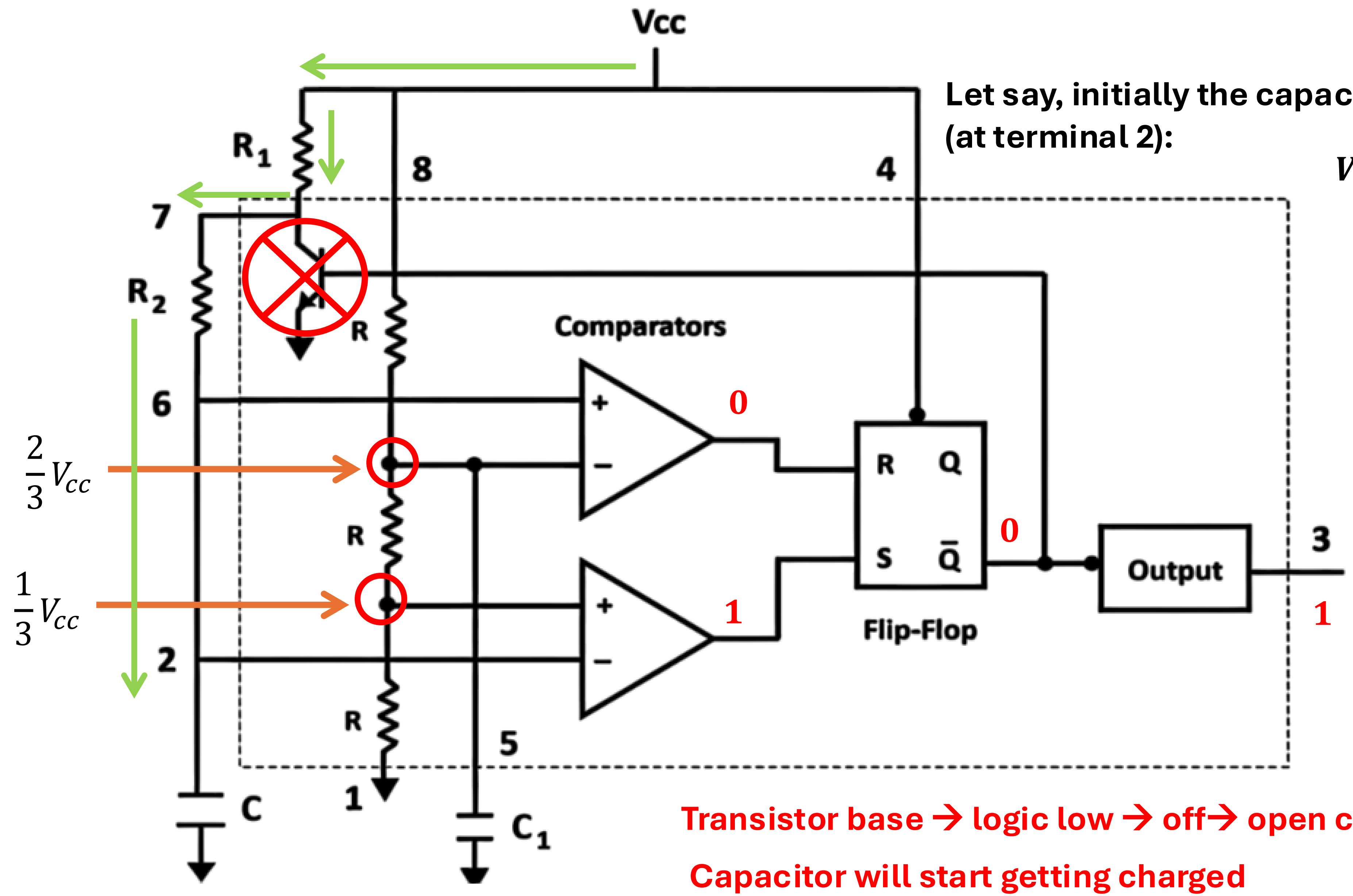

NE555

Astable Multivibrator using 555 timer:

1 – Ground
2 – Trigger
3 – Output
4 – Reset
5 – Control
6 – Threshold
7 – Discharge
8 – Vcc



Astable Multivibrator using 555 timer:



Let say, initially the capacitor (C) is uncharged (at terminal 2):

$$V_2 = V_6 = 0\ volt$$

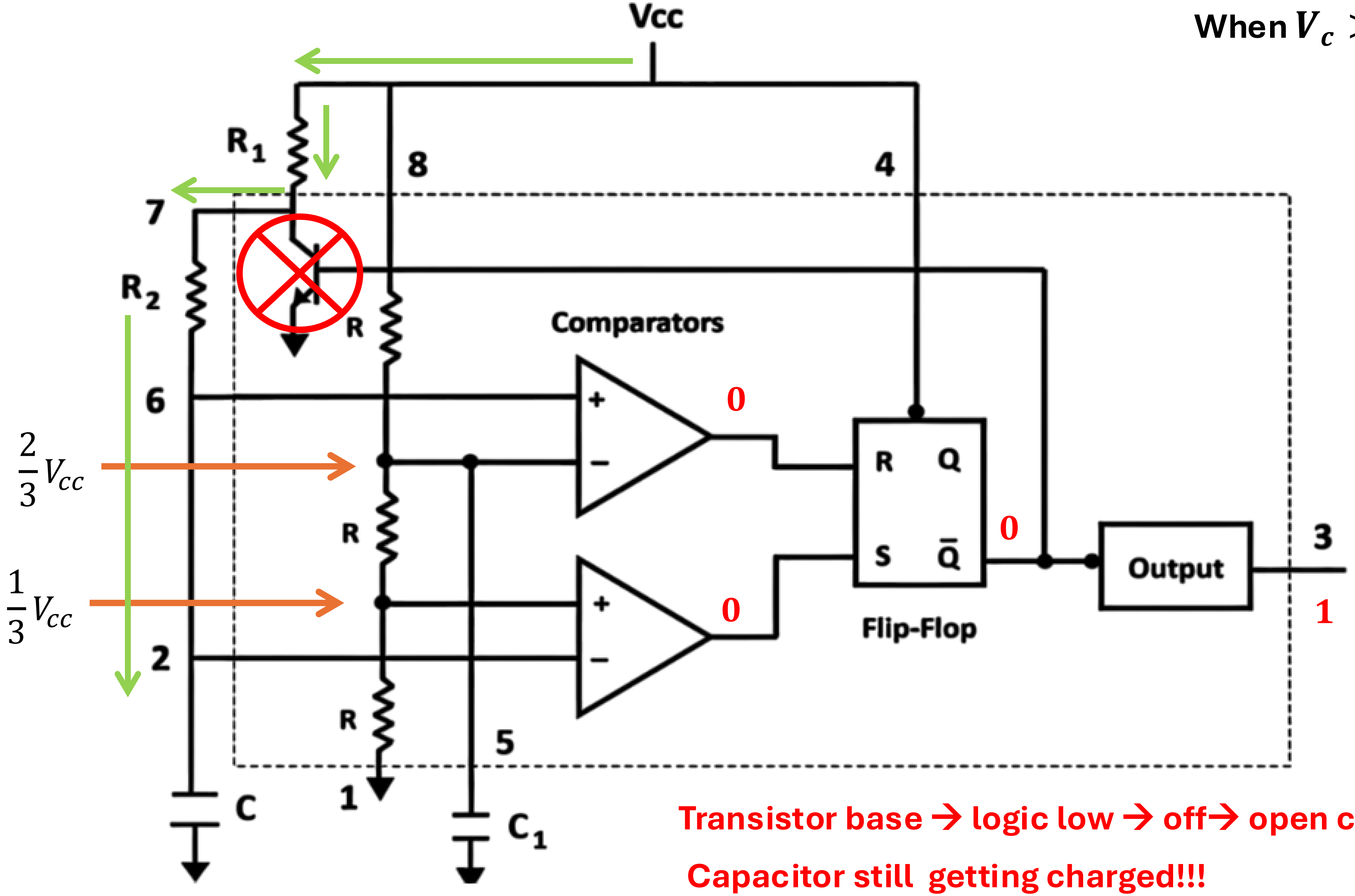
$$Q = 1, Q' = 0$$

Transistor base → logic low → off→ open ckt

Capacitor will start getting charged

Astable Multivibrator using 555 timer:

When $V_c > \frac{1}{3} V_{cc}$



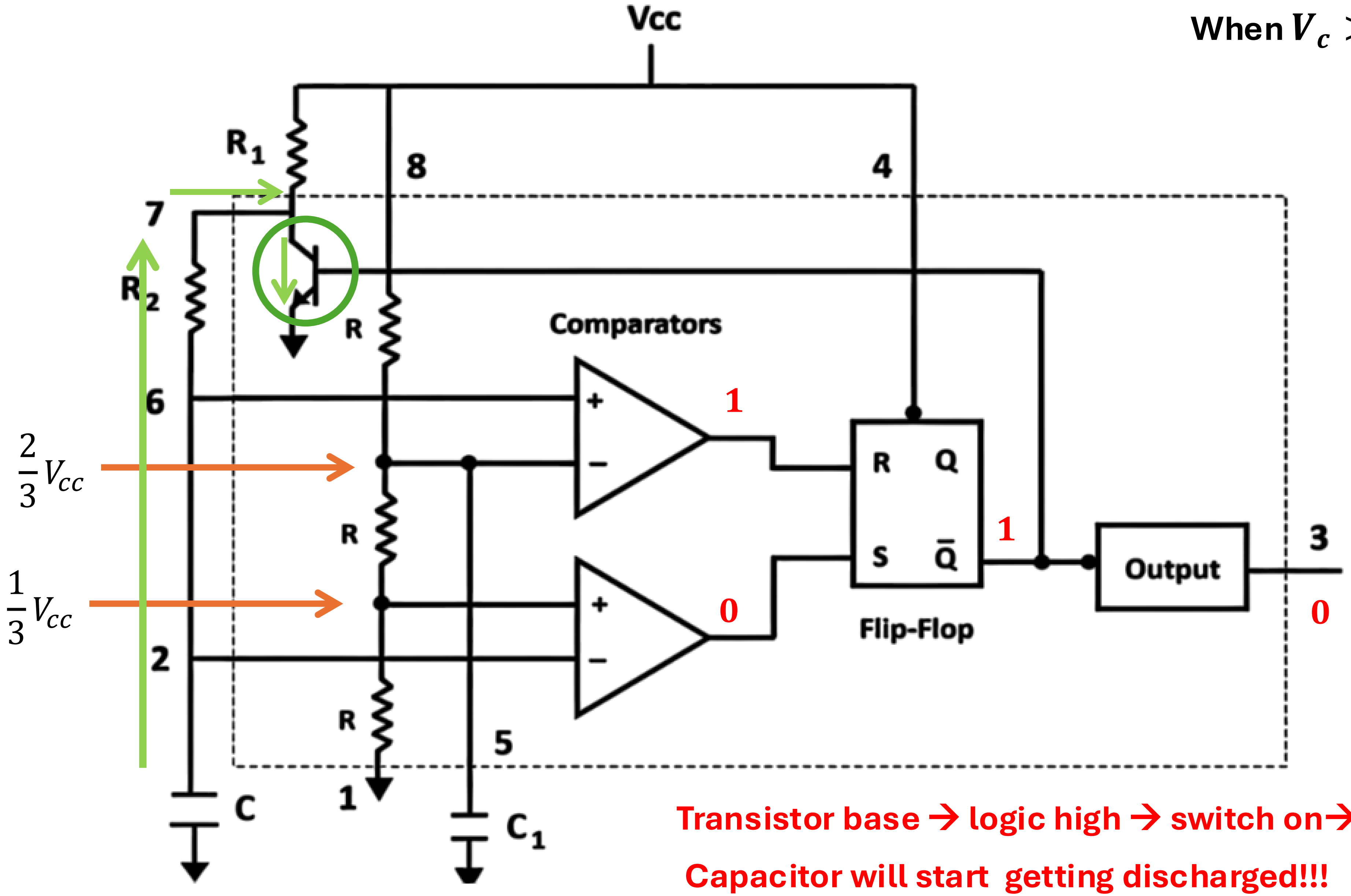
$Q = 1, Q' = 0$

Transistor base → logic low → off→ open ckt

Capacitor still getting charged!!!

Astable Multivibrator using 555 timer:

When $V_c > \frac{2}{3} V_{cc}$

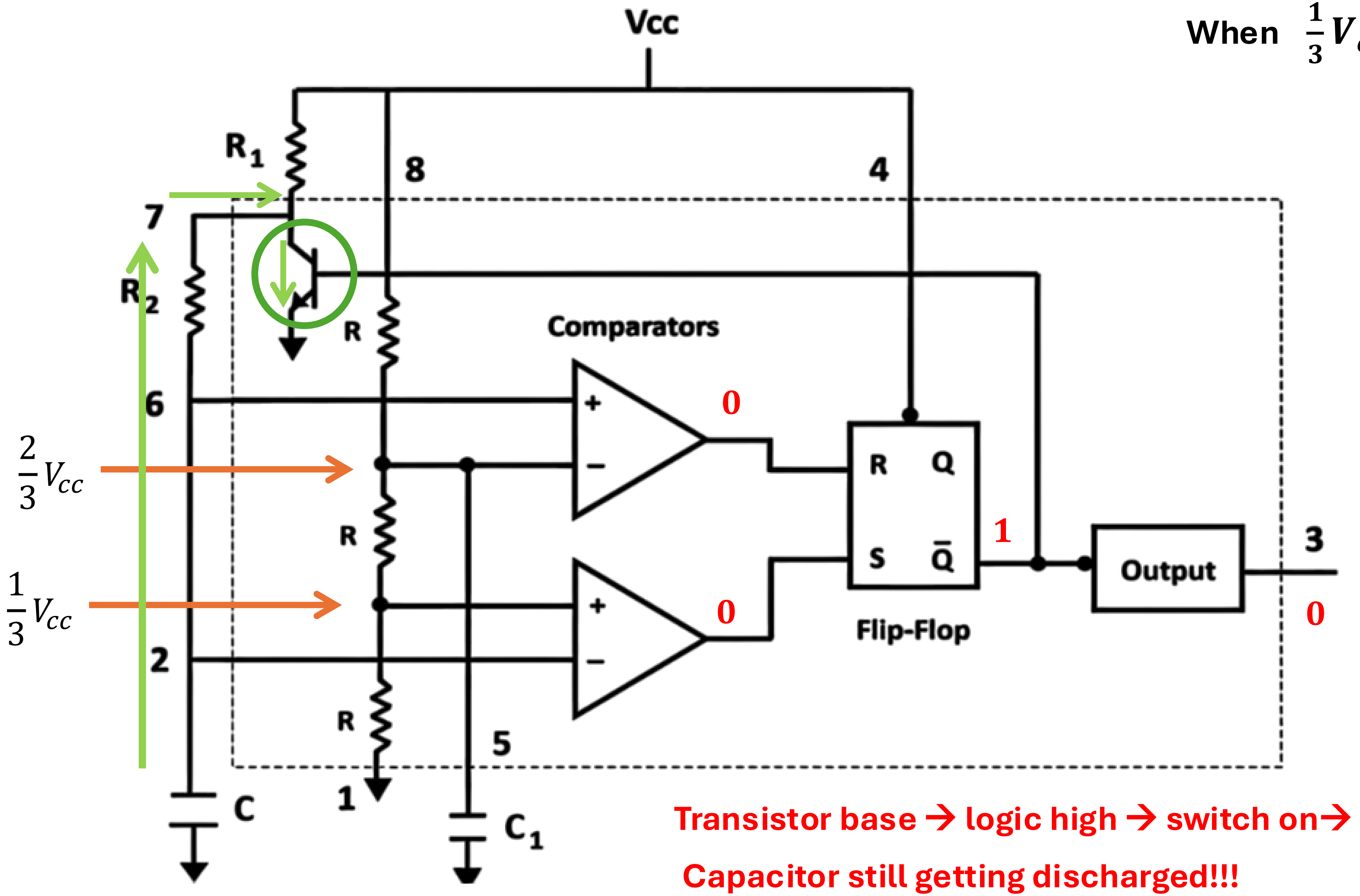


$Q = 0, Q' = 1$

Transistor base → logic high → switch on→ closed ckt

Capacitor will start getting discharged!!!

Astable Multivibrator using 555 timer:



When $\frac{1}{3}V_{cc} < V_c < \frac{2}{3}V_{cc}$

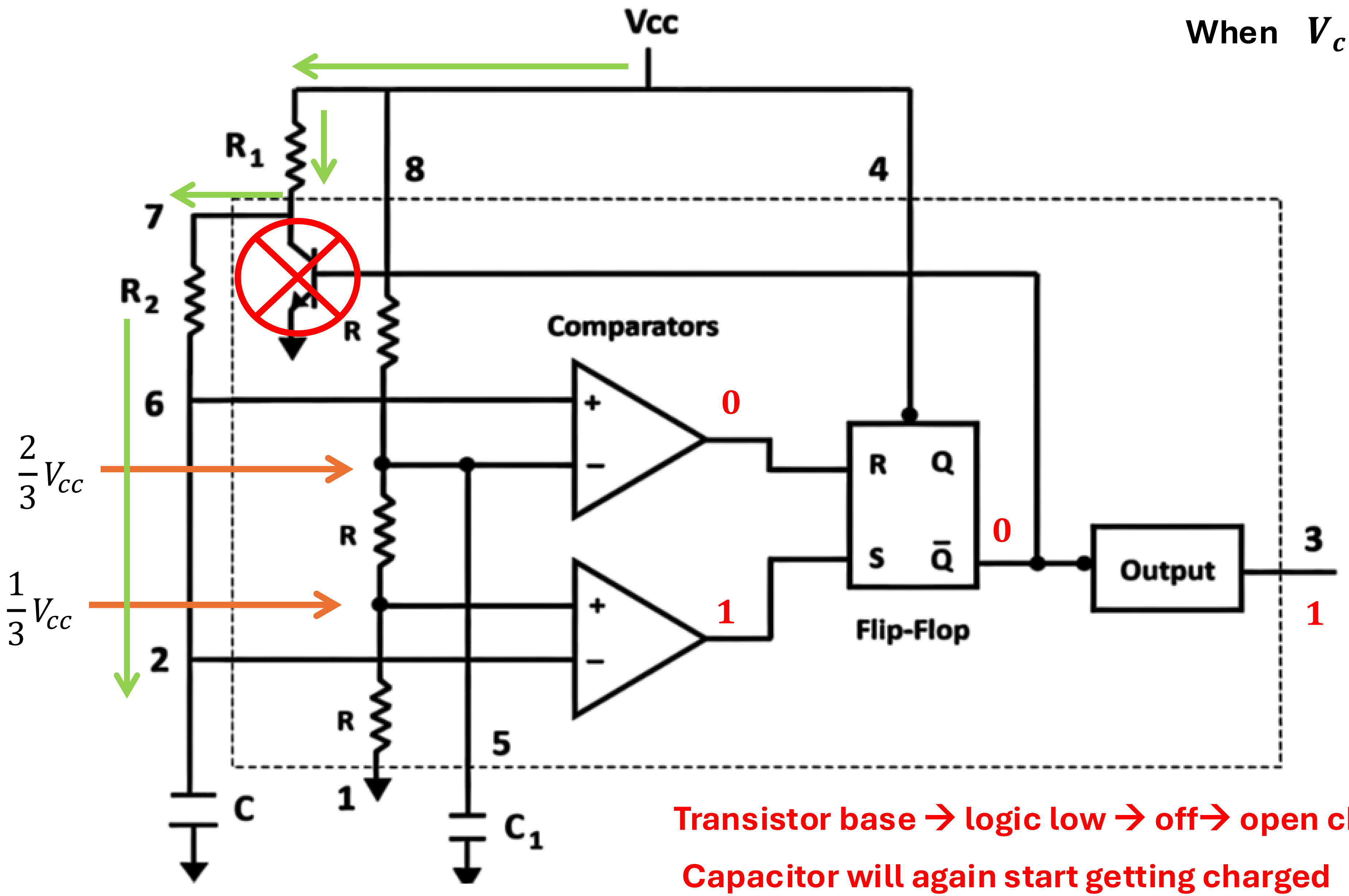
$Q = 0, Q' = 1$

Transistor base → logic high → switch on → closed ckt

Capacitor still getting discharged!!!

Astable Multivibrator using 555 timer:

When $V_c < \frac{1}{3}V_{cc}$

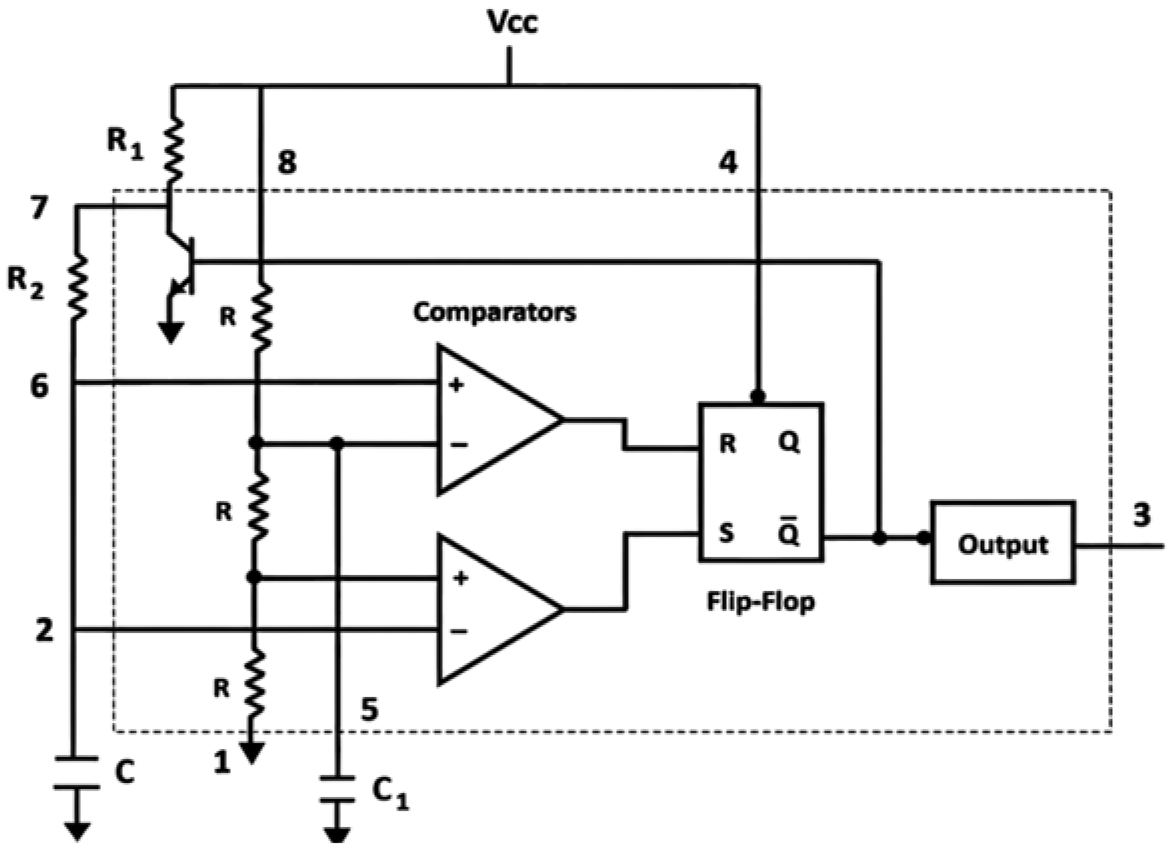


$Q = 1, Q' = 0$

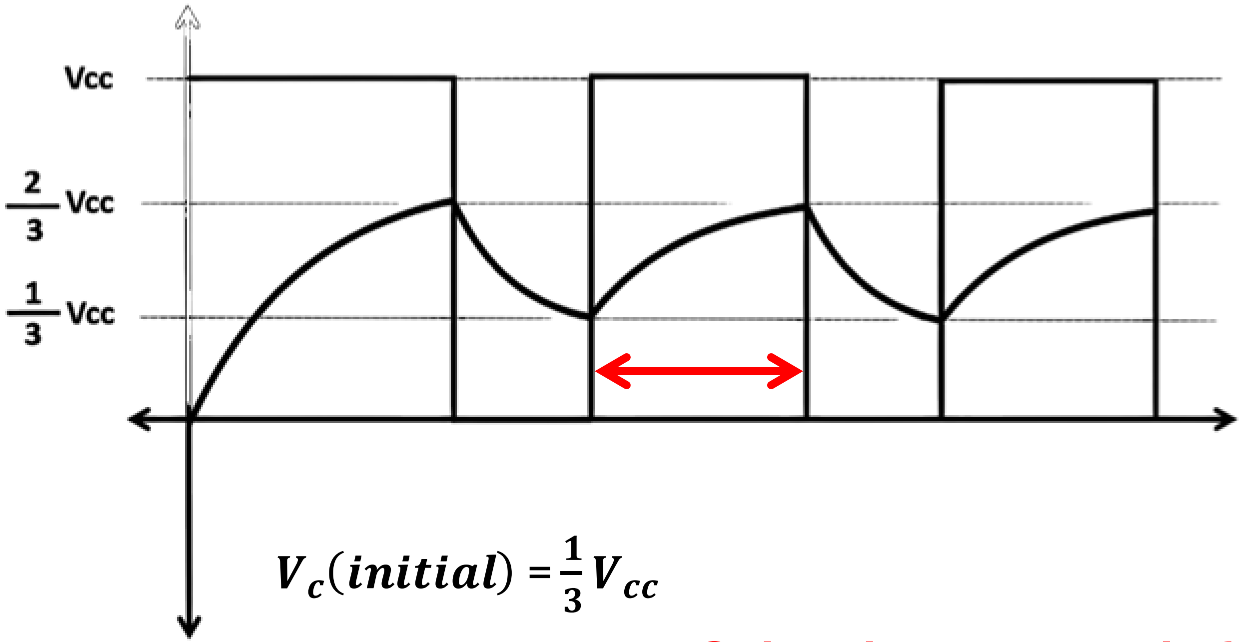
Transistor base → logic low → off → open ckt

Capacitor will again start getting charged

Astable Multivibrator using 555 timer:



Let calculate charging time:



$V_c(initial) = \frac{1}{3} V_{cc}$

$V_c(final) = V_{cc}$

$R' = R_1 + R_2$

Solve the eq. at end of charging boundary condition!!!

$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{\frac{-t}{R'C}}$$

Astable Multivibrator using 555 timer:

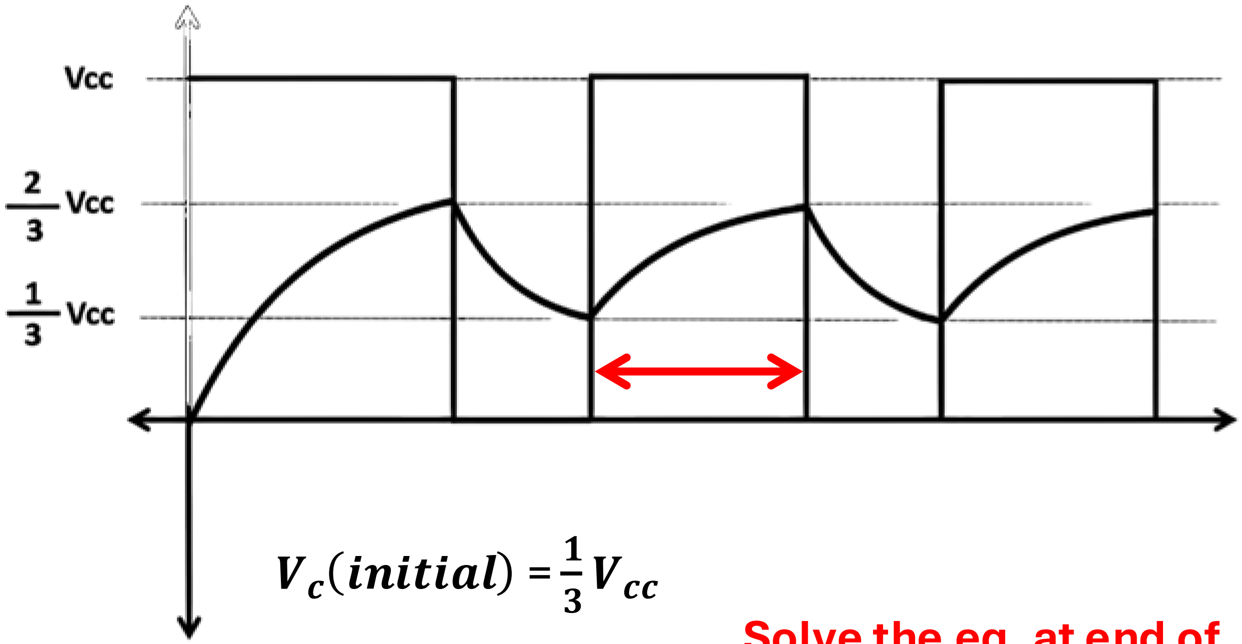
$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{\frac{-t}{R'C}}$$

Let calculate charging time:

$$\frac{2}{3}V_{cc} = V_{cc} + (\frac{1}{3}V_{cc} - V_{cc})e^{\frac{-t_1}{(R_1+R_2)\times C}}$$

$$-\frac{1}{3}V_{cc} = -\frac{2}{3}V_{cc}\, e^{\frac{-t_1}{(R_1+R_2)\times C}}$$

$$\boxed{t_1 = ln(2) \times (R_1 + R_2) \times C}$$



$V_c(initial) = \frac{1}{3}V_{cc}$

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$R' = R_1 + R_2$

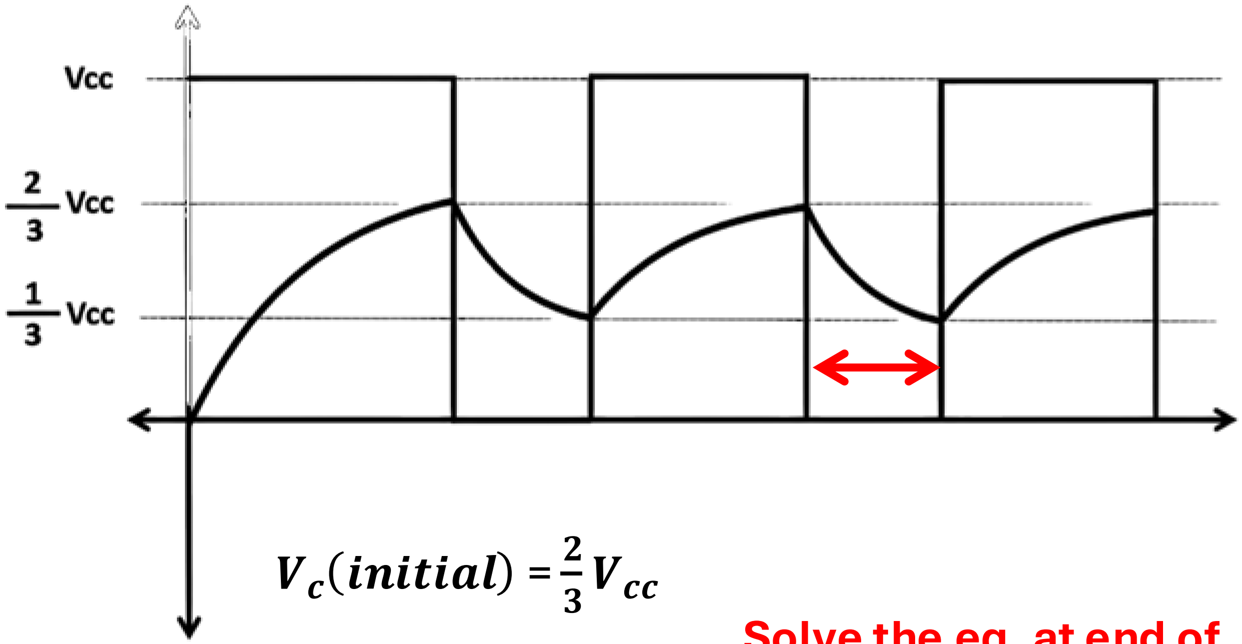
Solve the eq. at end of charging boundary condition!!!

$$\boxed{t_1 = ln(2) \times (R_1 + R_2) \times C}$$

Astable Multivibrator using 555 timer:

$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{\frac{-t}{R'C}}$$

Let calculate discharging time:



$$\frac{1}{3}V_{cc} = 0 + (\frac{2}{3}V_{cc} - 0)e^{\frac{-t_2}{R_2 \times C}}$$

$$\frac{1}{3}V_{cc} = \frac{2}{3}V_{cc}\, e^{\frac{-t_2}{R_2 \times C}}$$

$$\boxed{t_2 = ln(2) \times R_2 \times C}$$

$V_c(initial) = \frac{2}{3}V_{cc}$

$V_c(final) = 0$

$R' = R_2$

Solve the eq. at end of discharging boundary condition!!!

Calculate the time-period of the pulse!!!