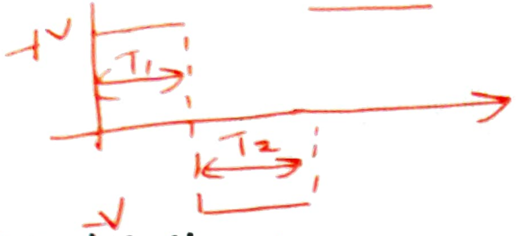
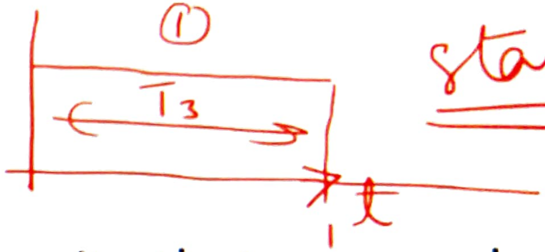
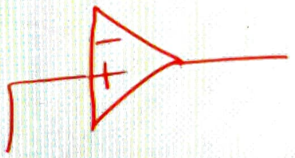


Multivibrators



stable

- Multivibrators are a group of regenerative circuits that are used extensively in timing applications.
- They are wave shaping circuits which give symmetric or asymmetric square output.
- They have two states either stable or quasi-stable depending on the type of the multivibrator
  - Astable (free-running)
  - Monostable (oneshot)



$\pm V_{sat}$

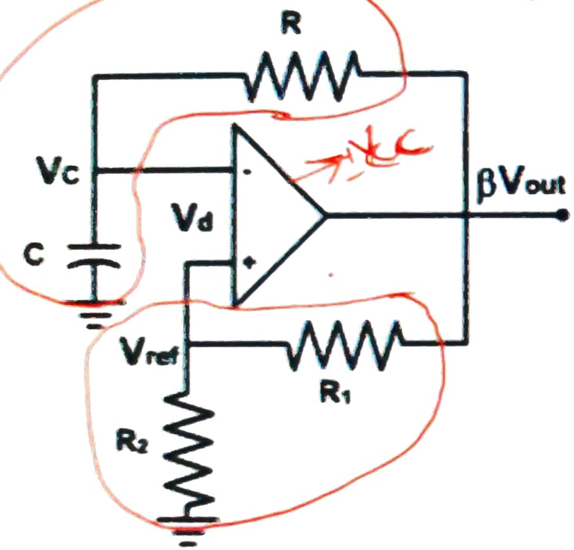
- All the three circuits operate by using positive feedback to drive the op-amp into saturation

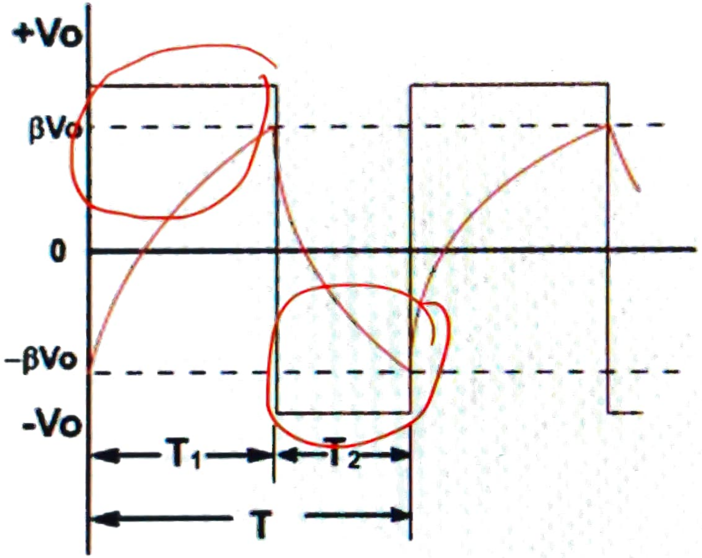
Astable Multivibrator

- It is a free running oscillator
- It has two quasi-stable states, therefore oscillates between these two states
- External signal is **NOT** required to produce the change in state.
- The two states are stable only for a limited period of time and the circuit switches between them
- The output alternates between positive and negative saturation values

there is no external signal

Square wave generator (Astable multivibrator)





$$\beta = \frac{R_2}{R_1 + R_2}$$

Square wave generator (Astable multivibrator)

- Let, $v_o = +V_{sat}$

Voltage across the capacitor t=0

$$v_c(t) = V_f + (V_i - V_f)e^{-t/RC}$$

t=0 initial

Final value, $V_f = +V_{Sat}$

Initial value, $V_i = -\beta V_{Sat}$ 0

$$\therefore v_c(t) = V_{Sat} - V_{Sat}(1+\beta)e^{-t/RC}$$

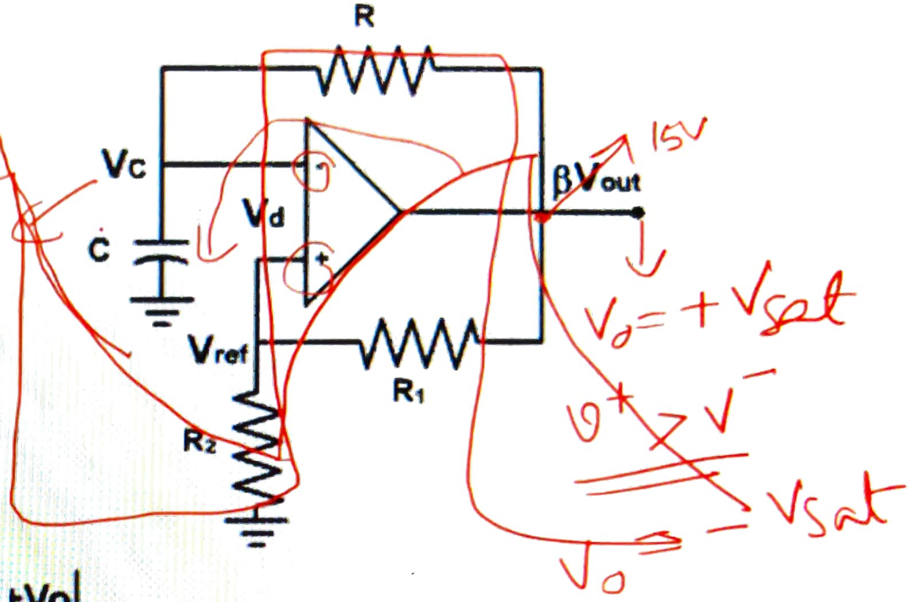
At $t = T_1$

$$v_c(T_1) = \beta V_{sat}$$

$$\beta V_{sat} = V_{Sat} - V_{Sat}(1+\beta)e^{-T_1/RC}$$

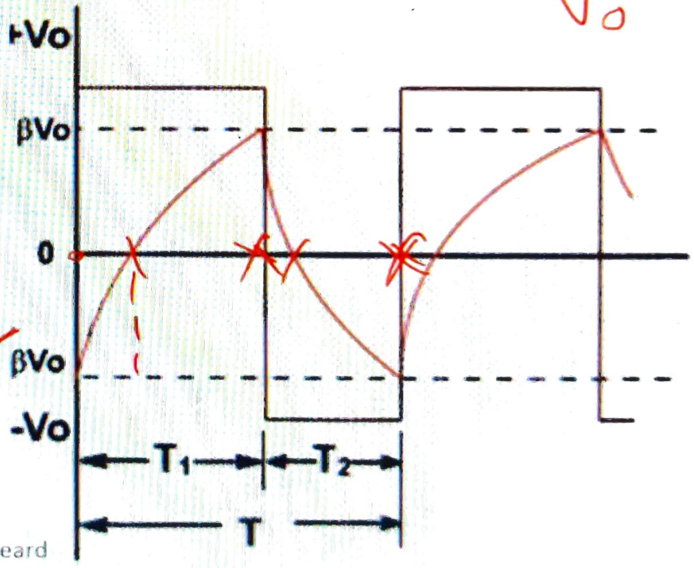
Solving

$$T_1 = RC\ln\left(\frac{1+\beta}{1-\beta}\right)$$



$1+R/2$

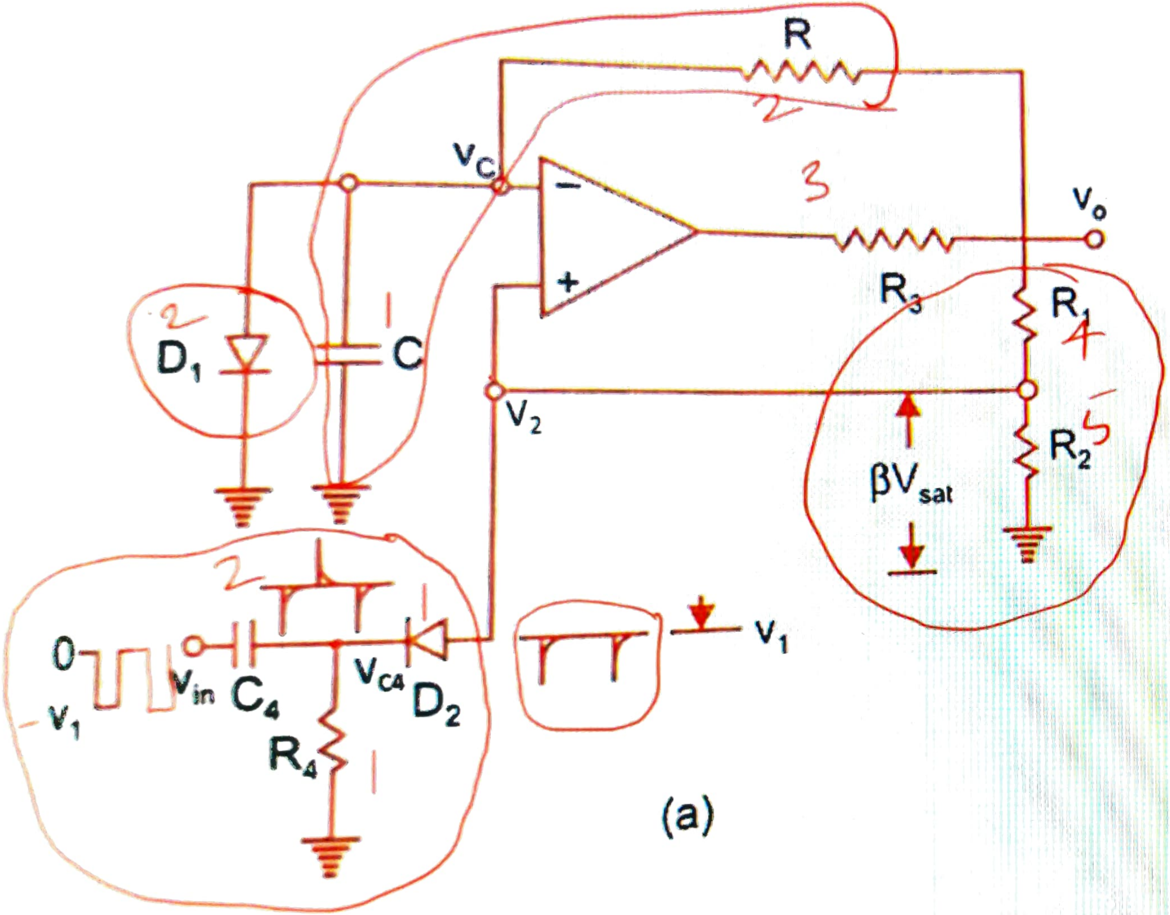
$1-R/2$



Monostable Multivibrator

- The circuit has one stable state and one quasi-stable state.
- The circuit remains in its stable state untill an external triggering pulse causes a transition from stable state to the quasi-stable state.
- The circuit comes back to its stable state after a time period T.
- The circuit therefore generates a single output pulse in response to an input pulse and is referred to as a oneshot or single shot.
- An external trigger pulse is generated due to the charging and discharging of the capacitor.
- This trigger pulse produces the transition in the original stable state.
- MMV generates a single pulse of specified duration in response to each external trigger signal.

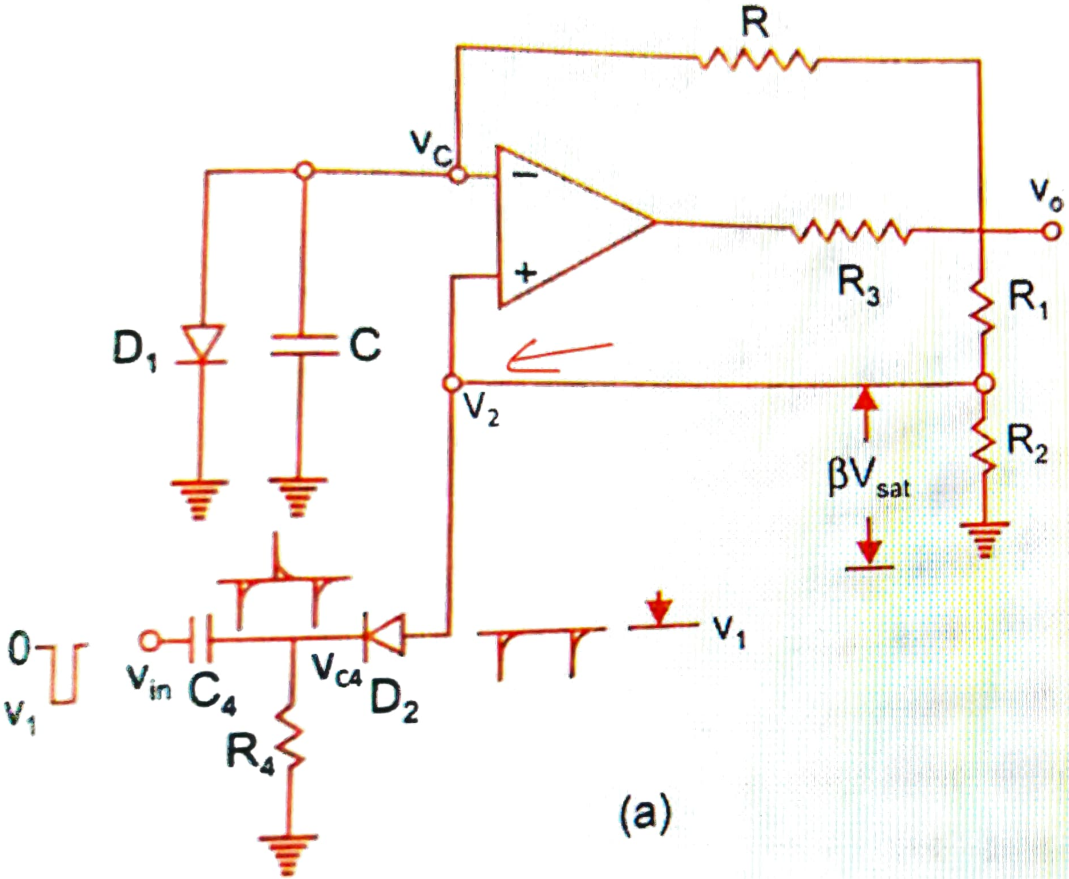
Monostable multivibrator



(a)

- Operational amplifier
- Two power supplies to the operational amplifier
- Resistors
- Two capacitors
- Two diodes

Monostable multivibrator



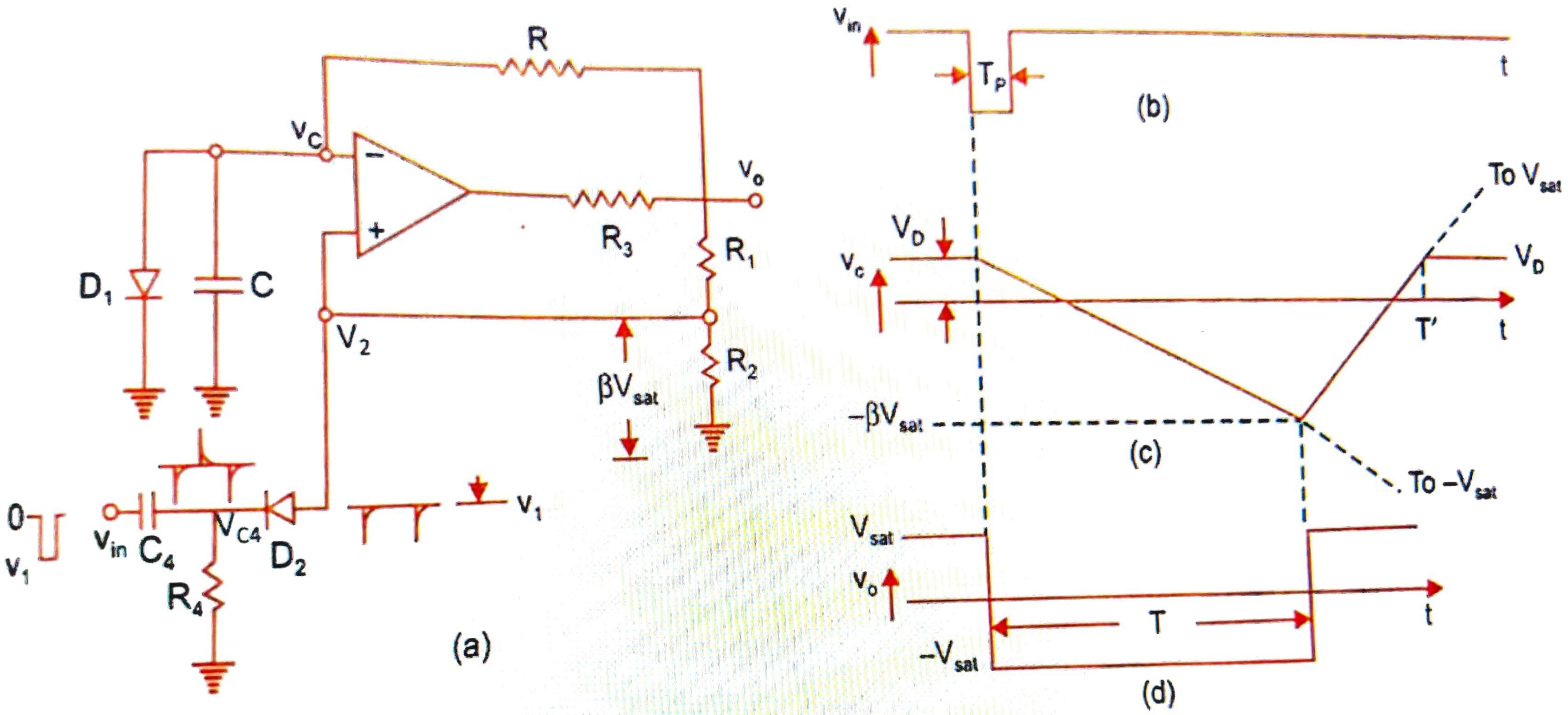
(a)

- Operational amplifier
- Two power supplies to the operational amplifier
- Resistors
- Two capacitors
- Two diodes

$$V_2 = \frac{R_2}{R_1+R_2} V_0$$

$$V_0 \rightarrow \begin{matrix} +V_{sat} \\ -V_{sat} \end{matrix}$$

Monostable multivibrator



(a) Monostable multivibrator (b) Negative going triggering signal
(c) Capacitor waveform (d) Output voltage waveform

Monostable multivibrator

Voltage across the capacitor

$$v_c(t) = V_f + (V_i - V_f)e^{-t/RC}$$

Final value, $V_f = -V_{Sat}$

Initial value, $V_i = V_D$

$$\therefore v_c(t) = -V_{Sat} + (V_D + V_{Sat})e^{-t/RC}$$

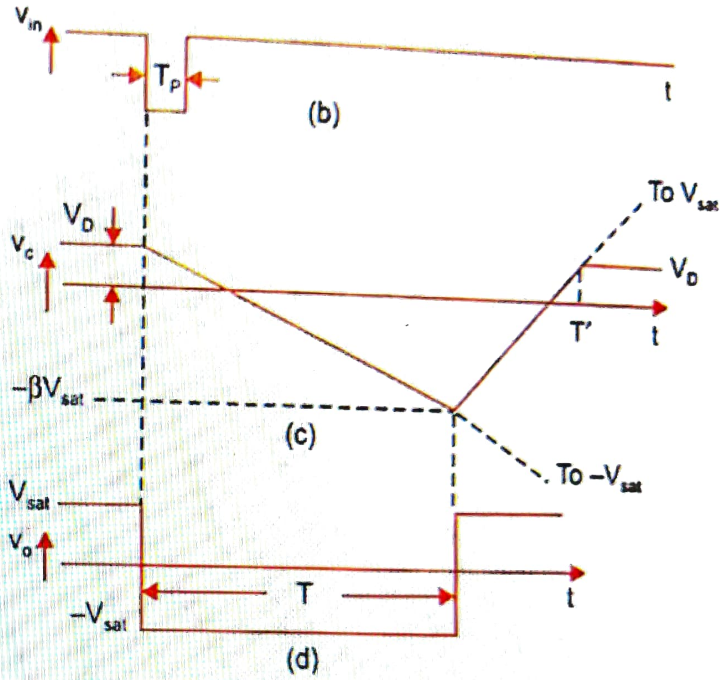
At t = T

$$v_c(T) = -\beta V_{sat}$$

$$-\beta V_{sat} = -V_{Sat} + (V_D + V_{Sat})e^{-T/RC}$$

Solving

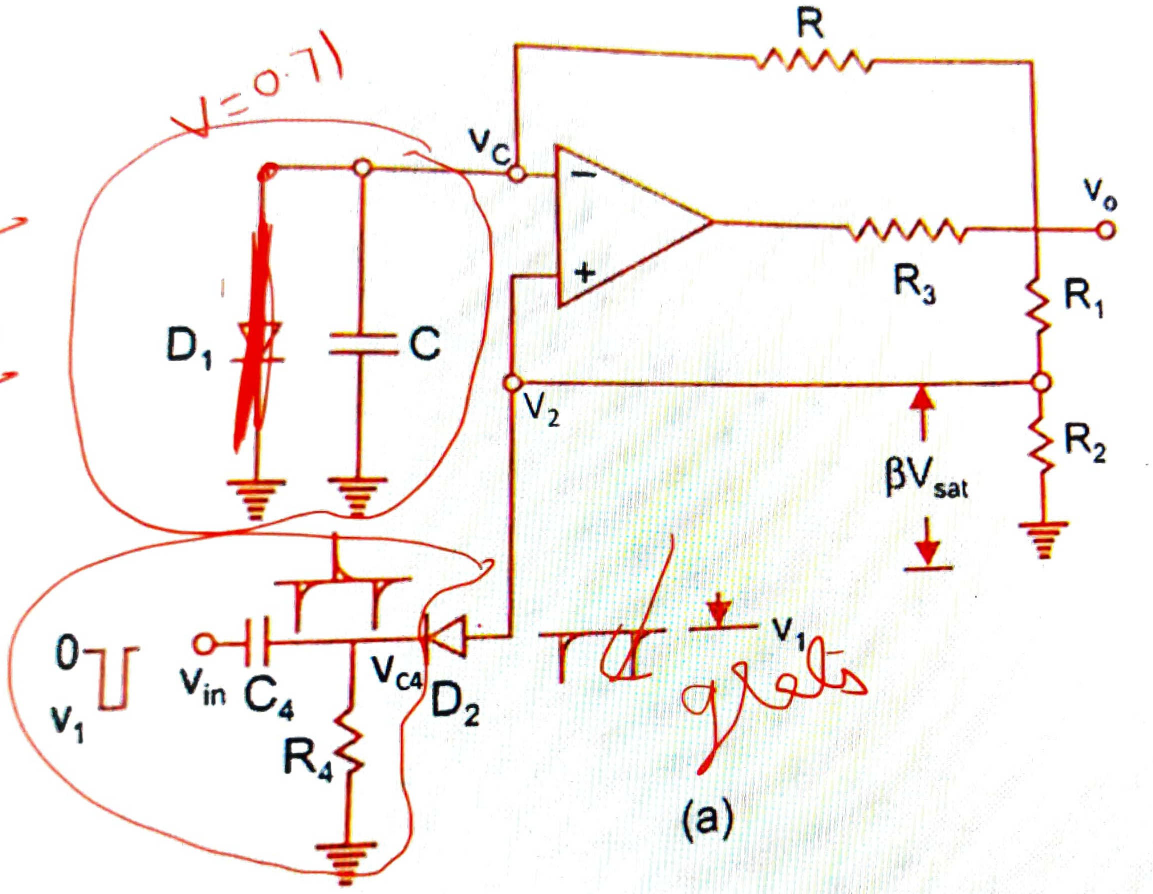
$$T = RC \ln\left(\frac{1 + \frac{V_D}{V_{Sat}}}{1-\beta}\right)$$



Vsat – 15V

Vc ↑ 0.7V

cut-off



(a)

Monostable mult

Voltage across the capacitor

$$v_c(t) = V_f + (V_i - V_f)e^{-t/RC}$$

Final value, $V_f = -V_{Sat}$

Initial value, $V_i = V_D$

$$\therefore v_c(t) = -V_{Sat} + \left(V_D + V_{Sat}\right)e^{-t/RC}$$

At t = T

$$v_c(T) = -\beta V_{sat}$$

$$-\beta V_{sat} = -V_{Sat} + \left(V_D + V_{Sat}\right)e^{-T/RC}$$

Solving

$$T = RC\ln\left(\frac{1+\dfrac{V_D}{V_{Sat}}}{1-\beta}\right)$$