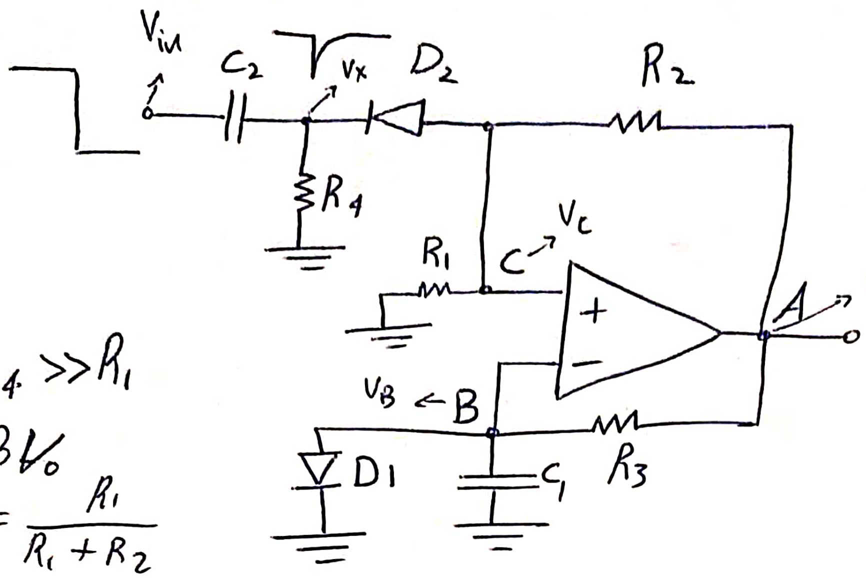
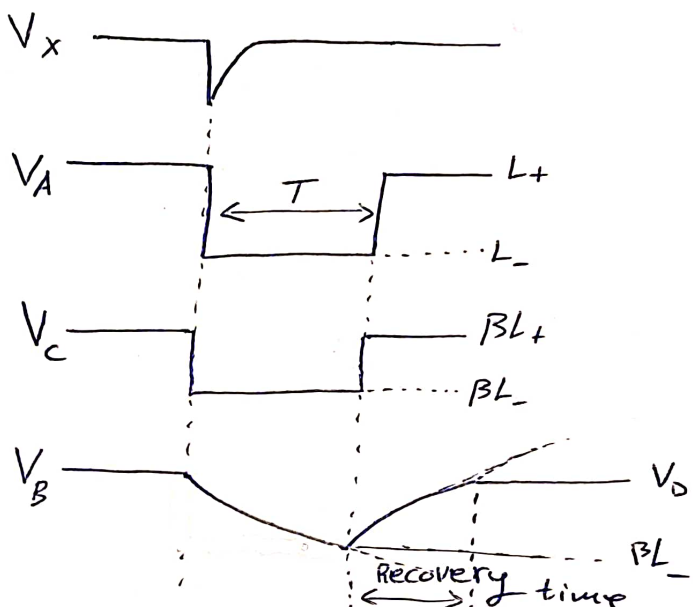
Monostable Multivibrator :



* Assume $R_4 >> R_1$
↳ $V_c \simeq \beta V_o$
↳ $\beta = \dfrac{R_1}{R_1 + R_2}$



* when -ve pulse is applied at V_{in} ⟹ C_2 discharges forcing V_x to drop.
↳ this will force D_2 to conduct & forces V_c to drop.

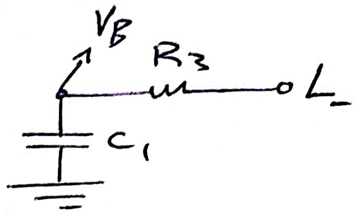
when V_c reaches V_{D1}, V_A will switch to L_- ⟹ D_2 now will cutoff & C_1 will start to discharge through R_3 (note that it's initial value is V_D → due to diode D_1).

→ C_1 will continue discharging until $V_B \leq \beta L_-$, at this pt. the op-amp will switch V_A to L_+ & C_1 starts to charge again tell it reaches V_{D1}.

To determine the width of pulse T:

T is the same time the capacitor C_1 takes to discharge from $+V_{D1}$ to βL_-.

$\because$ $V_A = L_-$ during the discharge



$$\Rightarrow V_B = V_{SRC} + (V_{initial} - V_{SRC})e^{-t/\tau}, \quad \tau = R_3 C_1$$

$$= L_- + (V_{D1} - L_-)e^{-\frac{t}{R_3 C_1}}$$

at $t = T \Rightarrow V_B = \beta L_-$

$$\Rightarrow \beta L_- = L_- + (V_{D1} - L_-)e^{-\frac{T}{R_3 C_1}}$$

$$\Rightarrow \beta L_- - L_- = (V_{D1} - L_-)e^{-\frac{T}{R_3 C_1}}$$

$$\Rightarrow e^{\frac{T}{R_3 C_1}} = \frac{V_{D1} - L_-}{\beta L_- - L_-}$$

$$\Rightarrow \frac{T}{R_3 C_1} = \ln\left(\frac{V_{D1} - L_-}{\beta L_- - L_-}\right)$$

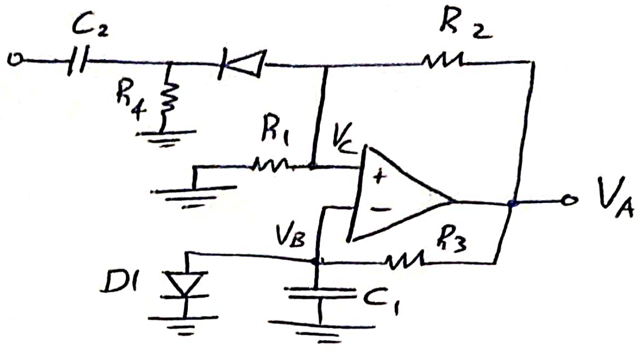
$$\Rightarrow \boxed{T = R_3 C_1 \ln\left(\frac{V_{D1} - L_-}{\beta L_- - L_-}\right)}$$

if $|L_-| >> V_{D1}$:

$$\Rightarrow T \simeq R_3 C_1 \ln\left(\frac{1}{1-\beta}\right)$$

Q1 For a monostable ct. 1) find the value of R_3 that will result in a 100-μs o/p pulse for $C_1 = 0.1\,\mu F$, $\beta = 0.1$, $V_D = 0.7V$, & $L_+ = -L_- = 12V$.

2) Calculate the recovery time.



Sol:

1) $\because$ $T = R_3 C_1 \ln\left(\dfrac{V_{D1} - L_-}{\beta L_- - L_-}\right)$

$$\Rightarrow R_3 = \frac{100 * 10^{-6}}{0.1 * 10^{-6} * \ln\left(\frac{0.7+12}{-(0.1)(12)+12}\right)} = 6.17\ K\Omega$$

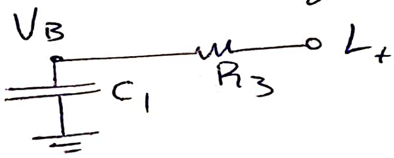
2) during the recovery of C_1 voltage, C_1 will charge through R_3 & until it reaches V_{D1}.

from ($V_A = L_+$)

D1 will clamp the voltage at V_{D1}

$$\Rightarrow V_B(t) = V_{SRC} + (V - V_{SRC})e^{-t/\tau}, \quad \tau = R_3 C_1$$

$V_{SRC} \rightarrow L_+$, $V \rightarrow V_0$



$$\Rightarrow V_B(t) = L_+ + (\beta L_- - L_+)e^{-t/R_3 C_1}$$

at $t = T_{recovery}$ $\Rightarrow V_B = V_{D1}$

$\beta L_- = (0.1)(-12) = -1.2$

$$\Rightarrow V_{D1} = L_+ + (\beta L_- - L_+)e^{-\frac{T_{recovery}}{R_3 C_1}}$$

$$\Rightarrow e^{+\frac{T_{recovery}}{R_3 C_1}} = \frac{\beta L_- - L_+}{V_{D1} - L_+}$$

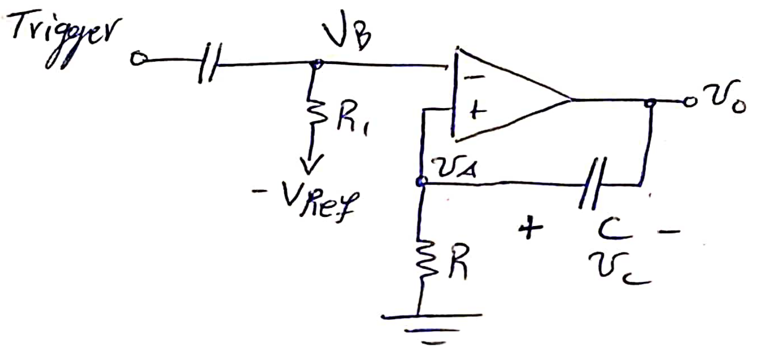
$$\Rightarrow T_{recovery} = R_3 C_1 \ln\left(\frac{\beta L_- - L_+}{V_{D1} - L_+}\right) = (6.17 \times 10^3 \times 0.1 \times 10^{-6}) \ln\left(\frac{-13.2}{0.7 - 12}\right)$$

$$= 95.89\ \mu s$$

$\underline{\underline{Q_2}}$:

The given ct. shows a monostable multivibrator ct. given that in it's stable state, $V_o = L_+$, $V_A = 0$, & $V_B = -V_{Ref}$. The ct. can be Triggered by applying a +ve input pulse of height greater than V_{Ref}. For normal operation, $R_1 C_1 << RC$. show the resulting waveforms of v_o & v_A. Also show that the pulse generated at the output will have a width T given by :

$$T = RC \ln\left(\frac{L_+ - L_-}{V_{Ref}}\right)$$



$\underline{\underline{Sol}}$:

$\because v_c = v_{final} + (v_{initial} - v_{final}) e^{-t/\tau}$

Voltage across C

$v_{final} \rightarrow -L_-$, $v_{initial} \rightarrow -L_+$

$\tau = RC$

$\Rightarrow v_c = -L_- + (L_- - L_+) e^{-t/\tau}$

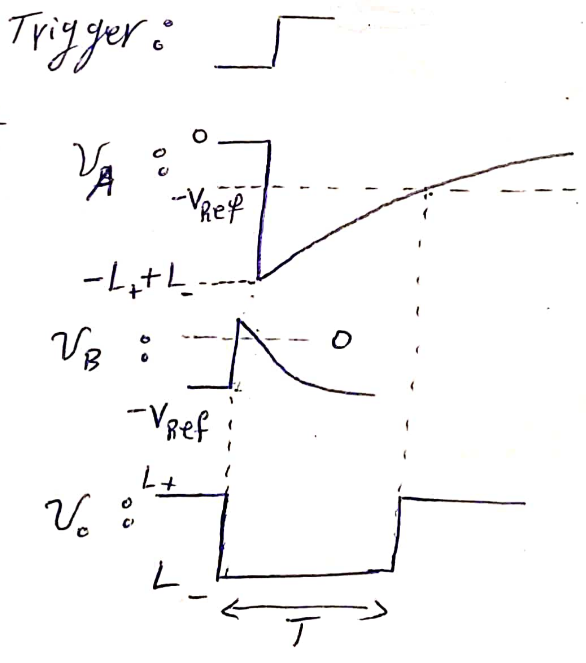
$\because v_A = v_c + v_o$

$\Rightarrow v_A = v_c + L_-$

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

at $t = T \Rightarrow v_A = -V_{Ref}$

$-V_{Ref} = (L_- - L_+) e^{-T/\tau}$



$$\Rightarrow e^{+T/\tau} = \frac{L_- - L_+}{-V_{Ref}} = \frac{L_+ - L_-}{V_{Ref}}$$

$$\Rightarrow T = \tau \ln\left(\frac{L_+ - L_-}{V_{Ref}}\right)$$

$$\Rightarrow \boxed{T = RC \ln\left(\frac{L_+ - L_-}{V_{Ref}}\right)}$$

↳ in this case the time of the pulse can be adjusted by changing V_{Ref}.