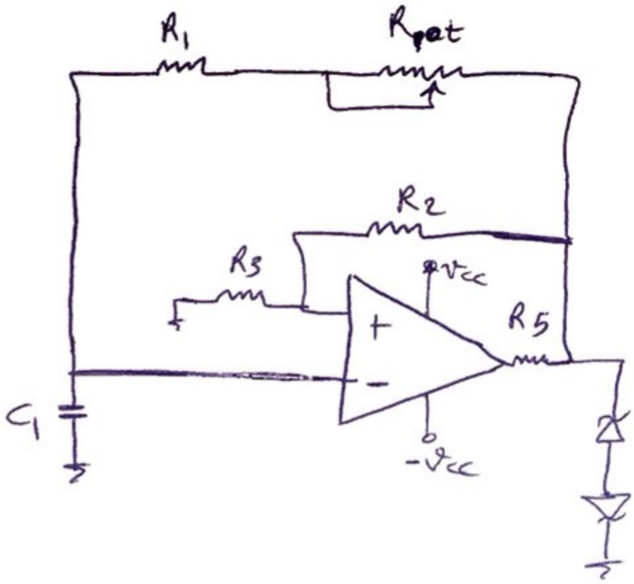
بخش ۱)



$v_o = v_{OH}$

$$v^+ > v^- \longrightarrow v^+ = \frac{R_3}{R_3+R_2} v_{OH} = UTP$$

$$v_C(t) = v^-(t) = v_C(\infty) + \left(v_C(0^+) - v_C(\infty)\right) e^{-t/\tau}$$

$$\Rightarrow v_C(T_1) = v_{OH} + \left(\frac{R_3}{R_2+R_3} v_{OL} - v_{OH}\right) e^{-T_1/\tau}$$

$$\Rightarrow \tau = (R_1 + R_{pot})C_1 \longrightarrow T_1 = \tau \ln\left(\frac{(v_{OH}-v_{OL})R_3 + R_2 v_{OH}}{R_2 v_{OH}}\right)$$

$$\boxed{v_{OL} = v_o} \longrightarrow v^- > v^+$$

$$v^+ = \frac{R_3}{R_3+R_2} v_{OL} = LTP$$

$$\Rightarrow T_2 = \tau \ln\left(\frac{(v_{OL}-v_{OH})R_3 + R_2 v_{OL}}{R_2 v_{OL}}\right)$$

$R_2 = R_3 = 10k\Omega \xleftarrow[\text{if}]{\text{فرض}} = \begin{cases} LTP = -2.7v \\ UTP = 2.7v \end{cases}$

$$f = \frac{1}{\cancel{T}_{\,T_1+T_2}} \Rightarrow \begin{cases} f = 5kHz \longrightarrow T = 0.2ms \longrightarrow T_1 = T_2 = 0.1ms \\ f = 50Hz \longrightarrow T = 20ms \longrightarrow T_1 = T_2 = 10ms \end{cases}$$

$$\begin{matrix} (R_1 + R_{pot})C_1 = 91\mu s \\ (R_1 + R_{pot})C_1 = 9.1ms \end{matrix} \longrightarrow C_1 = 10nF \overset{\text{فرض}}{\Longrightarrow} \begin{cases} R_1 + R_{pot} = 910k\Omega \\ R_1 + R_{pot} = 9.1K\Omega \end{cases}$$

$I_{o\,max} = 20mA \Longrightarrow \dfrac{15-5.4}{R_5} < 20mA$

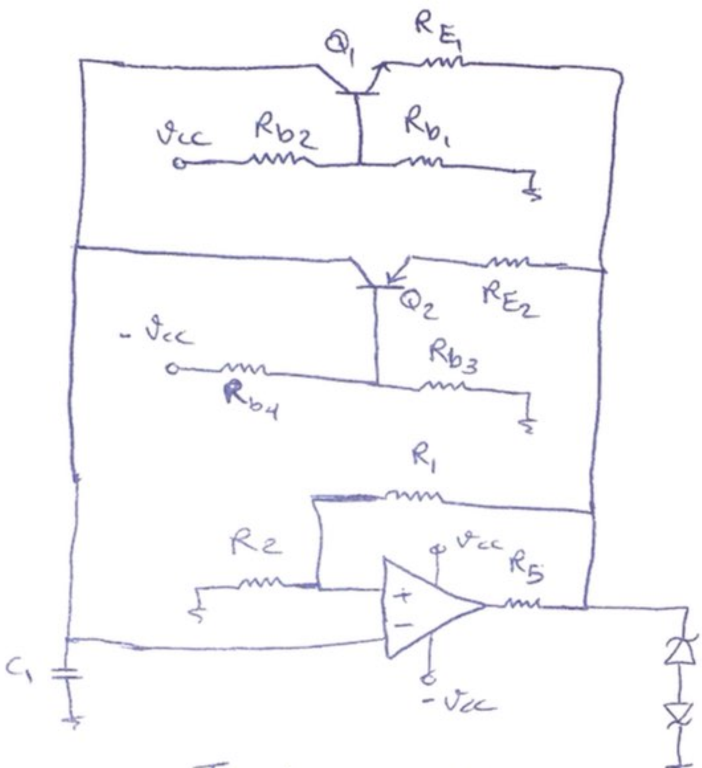
$\Rightarrow R_5 > 0.48 K\Omega$

$\dfrac{15-5.4}{R_5} > 5 + \dfrac{5.4}{20} + 0.89 \rightarrow R_5 < 1.55$

$\rightarrow R_5 = 1.5K$

$R_{pot} = 0-900 K\Omega \qquad R_1 = 91 K\Omega$

بخش 2)



$f = 1KHZ$

$T = 1ms \longrightarrow T_1 = T_2 = 0.5ms$

$v_{OH} = 5.4v \qquad v_{OL} = -5.4v$

مثلثی پیک - پیک $= \pm 2v \longrightarrow \begin{cases} \dfrac{R_2}{R_2+R_1} v_{OH} = 2 \\ \dfrac{R_2}{R_2+R_1} v_{OL} = -2 \end{cases} \longrightarrow \dfrac{R_2}{R_2+R_1} = \dfrac{2}{5.4} \begin{cases} R_1 = 3.4 K\Omega \\ R_2 = 2K\Omega \end{cases}$

هنگام شارژ شدن خازن ←

فرض

$I_2 = C_1 \dfrac{\Delta v}{T_1} = C_1 \dfrac{\dfrac{R_2}{R_2+R_1} v_{OH} - \dfrac{R_2}{R_2+R_1} v_{OL}}{T_1} \Rightarrow C_1 = 100nF \Rightarrow I_2 = 0.8 mA$

فرض

$I_2 = \dfrac{v_{OH} - v_{EQ_2}}{R_{E_2}} \longrightarrow R_{E_2} = 47K\Omega \longrightarrow v_{EQ_2} = 1.64v$

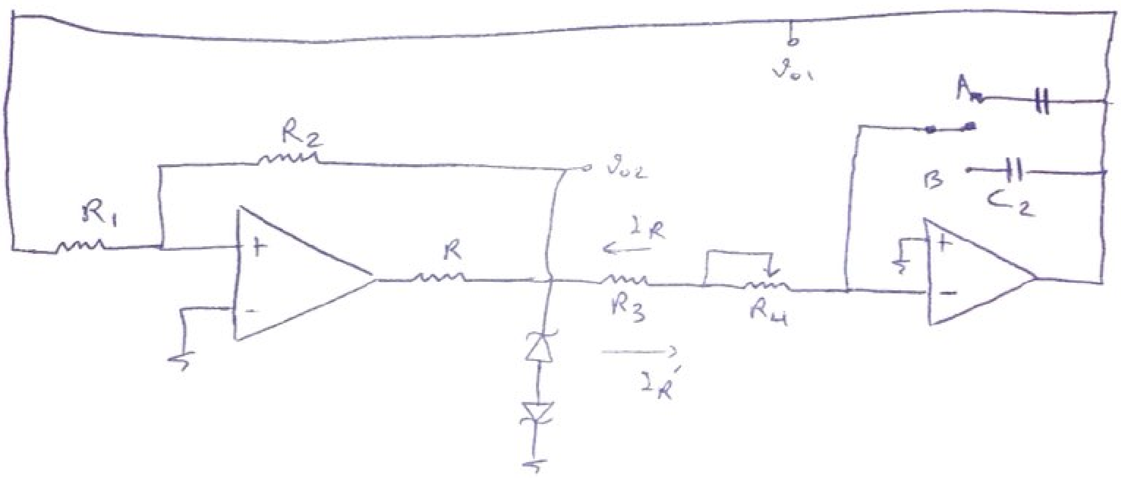
$$I_1 = \frac{v_{EQ_1} - v_{oL}}{R_{E_1}} \longrightarrow \overset{\text{فرض}}{R_{E_1} = 4.7\,K\Omega} \Rightarrow v_{EQ_1} = -1.64\,v$$

$$\frac{R_{b_1}}{R_{b_1} + R_{b_2}} \times (-v_{EE}) = -1.64 + 0.7$$

$$\Rightarrow \begin{cases} R_{b_1} = R_{b_3} = 1\,K\Omega \\ R_{b_2} = R_{b_4} = 14\,K\Omega \end{cases}$$

$$\frac{R_{b_3}}{R_{b_3} + R_{b_4}} \times v_{cc} = 1.64 - 0.7$$

بخش 3)



$$v_{oH} = -v_{oL} = 5.4$$

$$\begin{cases} UTP = 1 \\ LTP = -1 \end{cases} \longrightarrow \text{داده شده سوال} \qquad UTP = \frac{R_1}{R_2}(-v_{oL}) \longrightarrow \frac{R_1}{R_2} = \frac{1}{5.4} \Rightarrow \begin{cases} R_1 = 1\,K\Omega \\ R_2 = 5.4\,K\Omega \end{cases}$$

$$I_R = \frac{-v_{oL}}{R} = C\frac{\Delta v_o}{t_1} \longrightarrow t_1 = RC\,\frac{UTP - LTP}{-v_{oL}} \Rightarrow \begin{cases} R = R_3 + R_4 \\ C = A\ ,\ B \end{cases}$$

$$I_R' = \frac{v_{oH}}{R} = C\frac{\Delta v_{o2}}{t_2} \longrightarrow t_2 = RC\,\frac{UTP - LTP}{v_{oH}}$$

$$A = 10\,HZ < f < 100\,HZ \longrightarrow 10\,ms < T < 100\,ms \Rightarrow 5\,ms < t_1 - t_2 < 50\,ms$$

$$B = 100\,HZ < f < 1\,KHZ \longrightarrow 1\,ms < T < 10\,ms \Rightarrow 0.5\,ms < t_1 - t_2 < 5\,ms$$

$$\text{فرض} \begin{cases} C_1 = 10\,\mu F \\ C_2 = 1\,\mu F \end{cases} \Rightarrow R_3 = 1\,K\Omega \Rightarrow R_4 = 0.35\,K\Omega - 112.5\,K\Omega$$