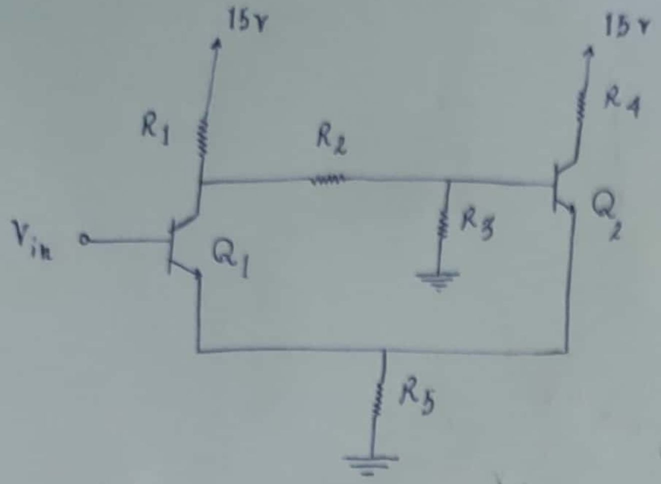
پاسخ تمرین های فصل ششم

.7

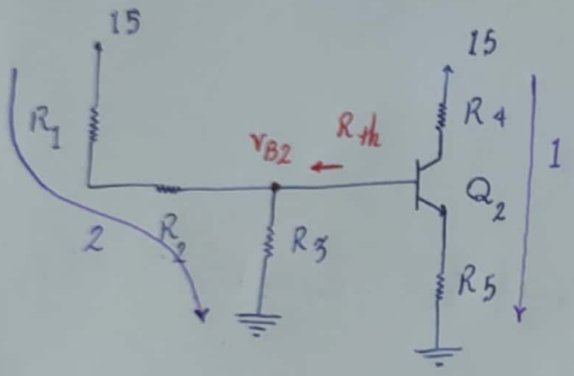


UTL = 6V

$I_C = 1mA$

$\beta \geq 90$

if $V_{in} < LTP$ Q_1 off Q_2 ON



$R_{th} = R_3 \parallel (R_1 + R_2)$

$UTL = V_E + \overset{0.5}{V_\gamma} \longrightarrow V_E = 5.5$

Q_2 : sat : $V_{CE} = 0.2$ فرض

$R_E = \frac{V_E}{I_C} \longrightarrow R_E = 5.5\,K\Omega$

$UTL \simeq V_{B2}$

$KVL @1: -15 + R_4 + 0.2 + 5.5 = 0 \longrightarrow R_4 = 9.3\,K\Omega$

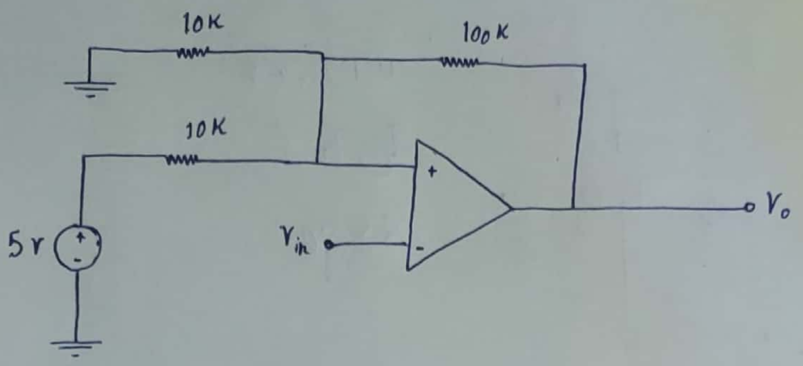
$I_B = \frac{I_C}{\beta} \longrightarrow I_B = 0.01mA$

$I_{R_3} = 0.1\, I_E \longrightarrow I_{R_3} = 0.1mA \longrightarrow R_3 = 60\,K\Omega$

$I_{R_2} = I_B + I_{R_3} = 0.11mA$

$KVL @2: -15 + (R_1 + R_2)0.11 + 6 = 0 \longrightarrow R_1 + R_2 = 81.8$

if $R_1 = 10\,K\Omega \longrightarrow R_2 = 71.8\,K\Omega$



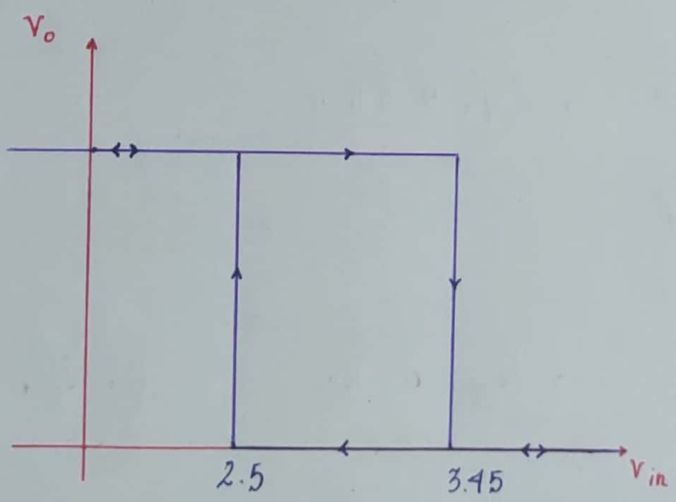
$$V^+ = \frac{\cancel{10^K \| 100^K} \rightarrow \simeq 10^K}{\underbrace{10^K + (10^K \| 100^K)}_{20^K}} \times 5 + \frac{\cancel{10^K \| 10^K} \rightarrow 5K}{\underbrace{100^K + (10^K \| 10^K)}_{105K}} \times V_o \longrightarrow$$ جمع آثار

$$V^+ = \frac{5}{2} + \frac{5}{105} V_o$$

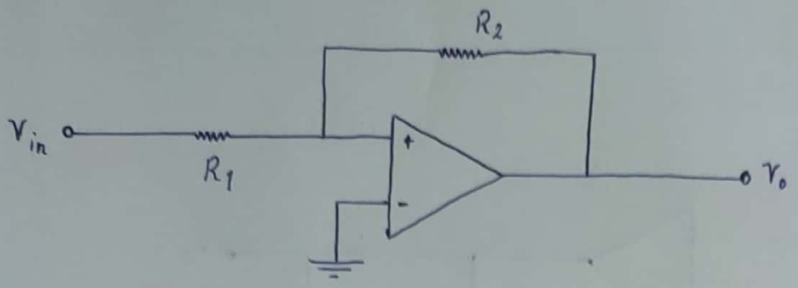
if $V_{in} > UTP \longrightarrow V^+ = \frac{5}{2} + \frac{5}{105} V_{CC} \longrightarrow$ if $V_{CC} = 20V \longrightarrow V^+ = 3.45V$

$UTP = 3.45V \longrightarrow V_o \simeq 0$

if $V_{in} < LTP \longrightarrow V^+ = \frac{5}{2} \longrightarrow V^+ = 2.5V \longrightarrow V_o = 20V$



.12



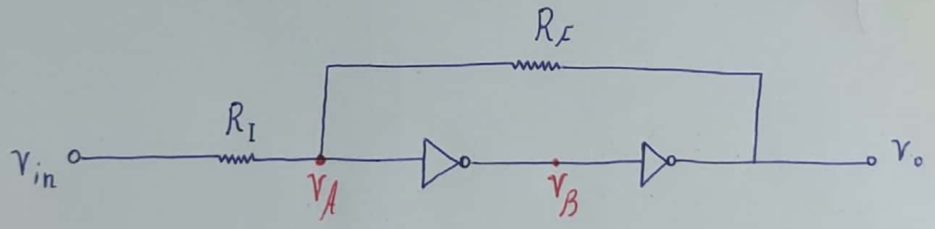
هرگاه $0 < V^+$ باشد خروجی به V_{CC} می‌رسد و هرگاه $0 > V^+$ باشد خروجی به V_{EE} می‌رسد.

$UTP = -V_{oL} \frac{R_1}{R_2}$ $\qquad$ $LTP = -V_{oH} \frac{R_1}{R_2}$

$UTP = 0 \longrightarrow V_{oL} = 0$

$LTP = -0.7 \longrightarrow \text{if } V_{oH} = 15\,V \longrightarrow \frac{R_1}{R_2} = 0.046 \longrightarrow R_1 = 1^K \longrightarrow R_2 = 21.7\,K\Omega$

.16



$\text{if} \quad V_{in} < 2.5 \longrightarrow V_A < 2.5 \longrightarrow V_B = 5\,V \longrightarrow V_o = 0$ 1

$\text{if} \quad V_{in} > 2.5 \longrightarrow V_A > 2.5 \longrightarrow V = 0 \longrightarrow V_o = 5\,V$ 2

برای حالت 1:

$$V_A = \frac{R_F}{R_I + R_F} V_{in} < 2.5 \longrightarrow V_{in} < \frac{2.5(R_I + R_F)}{R_F} \longrightarrow V_o = 0$$

برای حالت 2: در حالت 2 برای محاسبه V_A از جمع آثار استفاده می‌کنیم چون $V_o = 5$ است و

برای محاسبه V_A یک بار V_{in} را صفر می‌کنیم و بار دیگر V_o را صفر می‌کنیم

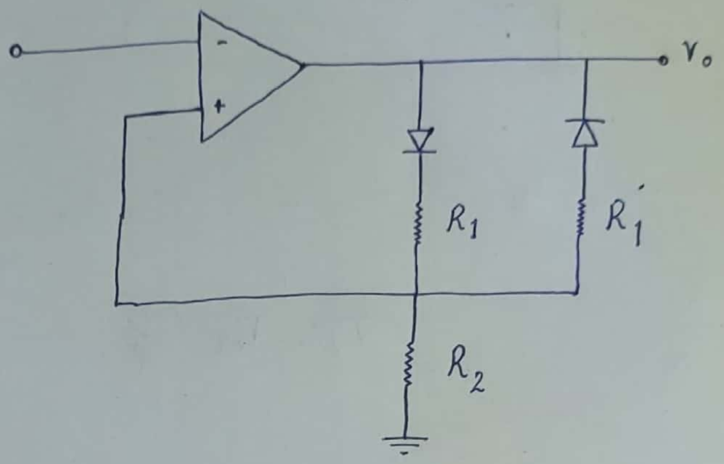
$$V_A = \frac{R_f}{R_f + R_I} V_{in} + \frac{R_I}{R_I + R_f} \times 5 > 2.5 \longrightarrow V_{in} > \frac{2.5(R_I + R_f)}{R_f} - \frac{5R_I}{R_f}$$

.21

$UTL = 4V$

$LTL = -3V$

$V_{CC} = \pm 18$

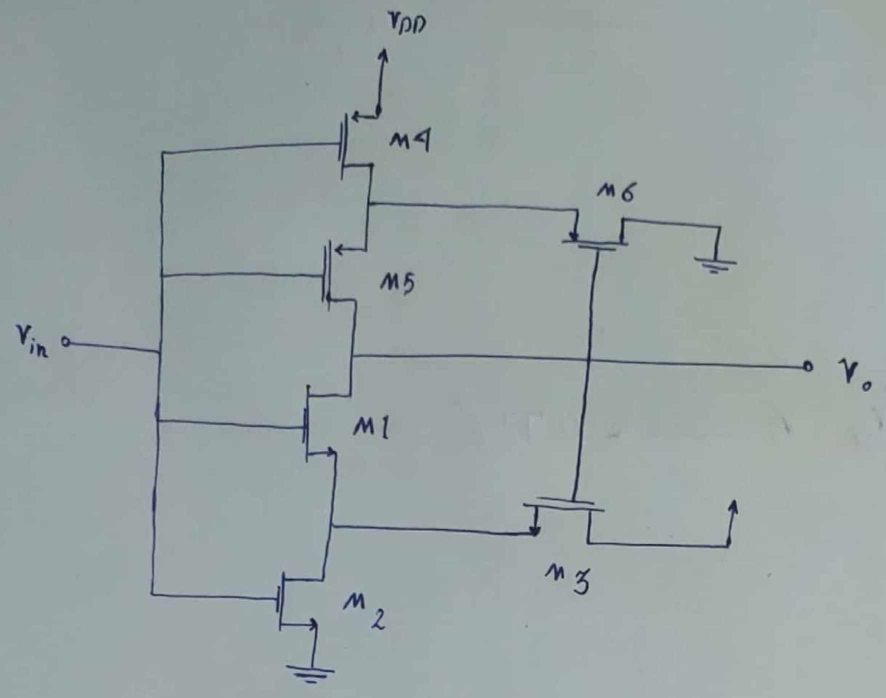


$$\left.\begin{aligned} UTP &= \frac{V_o - 0.7}{R_1 + R_2} \cdot R_2 \\ LTP &= \frac{-V_{EE} + 0.7}{R_1' + R_2} \cdot R_2 \end{aligned}\right\} \Longrightarrow$$

به جزوه مراجعه شود

$$\left.\begin{aligned} 4 &= \frac{18 - 0.7}{R_1 + R_2} \cdot R_2 \\ -3 &= \frac{-18 + 0.7}{R_1' + R_2} \cdot R_2 \end{aligned}\right\} \Longrightarrow \text{if } R_2 = 1^{K\Omega} \longrightarrow R_1 = 3.3K\Omega \longrightarrow R_1' = 4.76K\Omega$$

.24



$$\frac{K_2}{K_3} = \frac{8}{60} = \frac{2}{15}$$

$$\frac{K_4}{K_6} = \frac{20}{150} = \frac{2}{15}$$

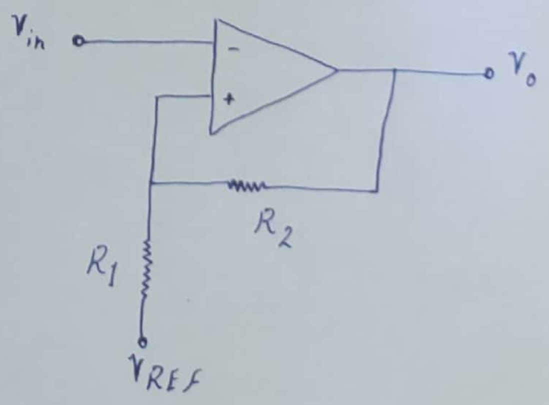
$$UTP = \frac{V_{DD} + \sqrt{\frac{K_2}{K_3}}\, V_t}{1 + \sqrt{\frac{K_2}{K_3}}} = 2.46\ v$$

$$LTP = \frac{\sqrt{\frac{K_4}{K_6}}\,(V_{DD} + V_t)}{1 + \sqrt{\frac{K_4}{K_6}}} = 0.53\ v$$

.30

$$LTP = \frac{R_2}{R_1 + R_2} V_{REF} + \frac{R_1}{R_1 + R_2} V_{oL}$$

$$UTP = \frac{R_2}{R_1 + R_2} V_{REF} + \frac{R_1}{R_1 + R_2} V_{oH}$$



$$V^+ = \frac{R_2}{R_1+R_2} V_{REF} + \frac{R_1}{R_1+R_2} V_o \longleftarrow \text{جمع آثار}$$

if $V^+ > V^-$

$$\frac{R_2}{R_1+R_2} V_{REF} + \frac{R_1}{R_1+R_2} V_{oH} > V_i \longrightarrow UTL$$

if $V^+ < V^-$

$$\frac{R_2}{R_1+R_2} V_{REF} + \frac{R_1}{R_1+R_2} V_{oL} < V_i \longrightarrow LTP$$