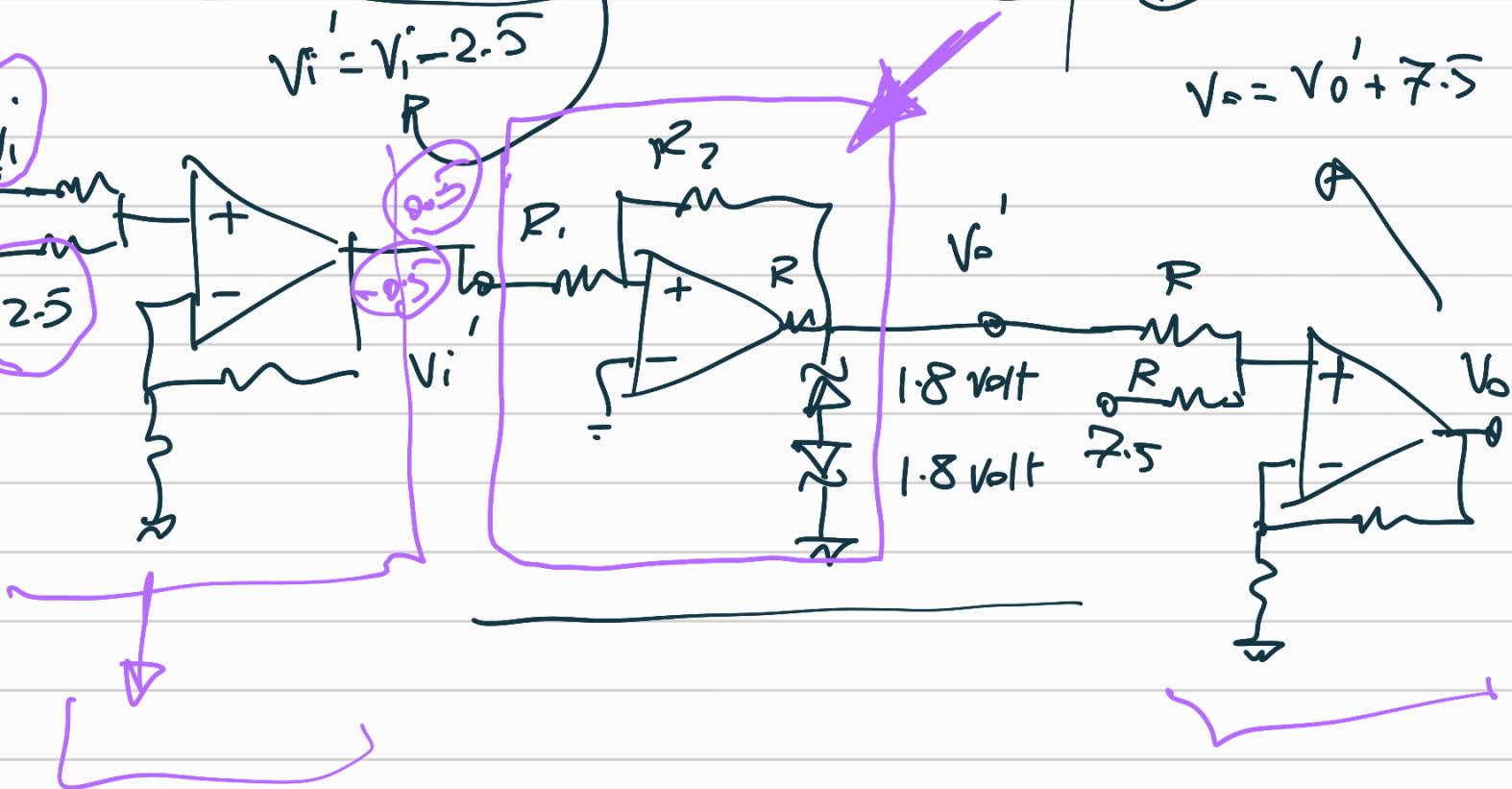
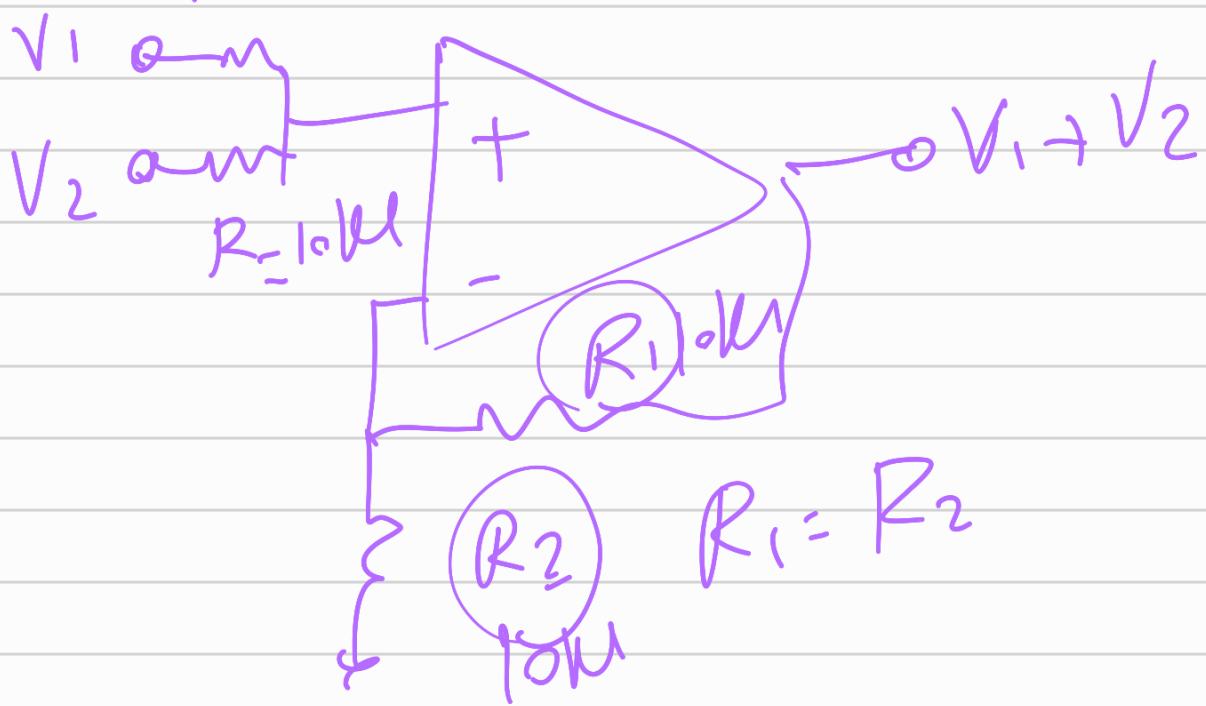


$$V_i' = V_i - 2.5$$

$$V_o = V_0' + 7.5$$



$$R = 10k\Omega$$

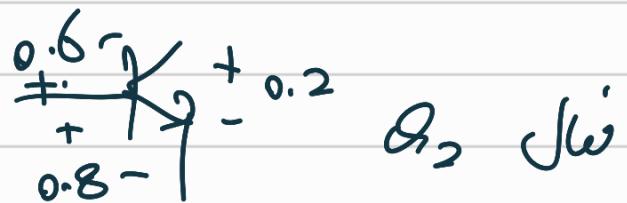
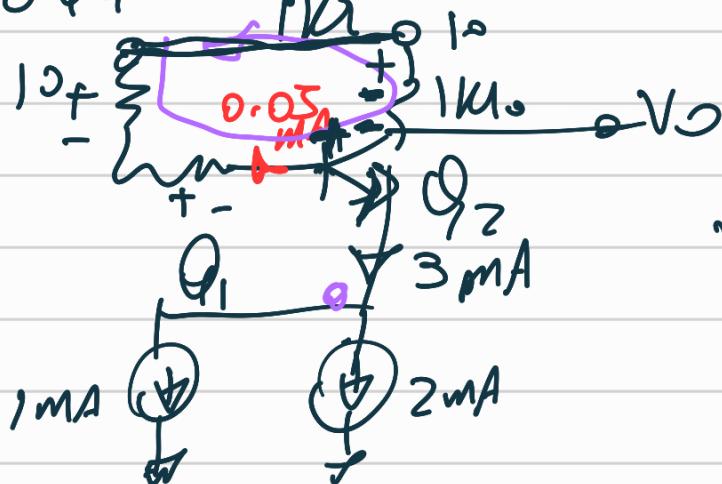


$$V_{B3} = \frac{5}{23k\Omega + 27k\Omega} (-23) = -2.3 \text{ Volt} \quad (1)$$

$$V_{E3} = V_{E4} = -2.3 - 0.7 = -3 \text{ Volt}$$

$$I_{Q3} = \frac{V_{E3} + 5}{2k\Omega} = \frac{2}{2k\Omega} = 1 \text{ mA}$$

$$I_{Q4} = \frac{V_{E4} + 5}{2k\Omega} = 2 \text{ mA}$$



$$V_{E2} = 10 - (1.4 + 0.5) \times 0.03 \text{ mA} = 9.24 \text{ Volt}$$

$$-0.7 = 9.24 \text{ Volt} !!$$

$$V_{CBQ2} = 0.2 \text{ Volt}$$

$$I_{B2} + I_{C2} = I_{E2} = 3 \text{ mA}$$

$$(1.4 + 0.5) I_{B2} + 0.6 = (1.9 \times I_{C2})$$

$$1.9 \times I_{B2} + 0.6 = I_{C2} = 3 - I_{B2}$$

$$2.9 I_{B2} = 2.4 \quad \therefore I_{B2} = 0.82 \text{ mA}$$

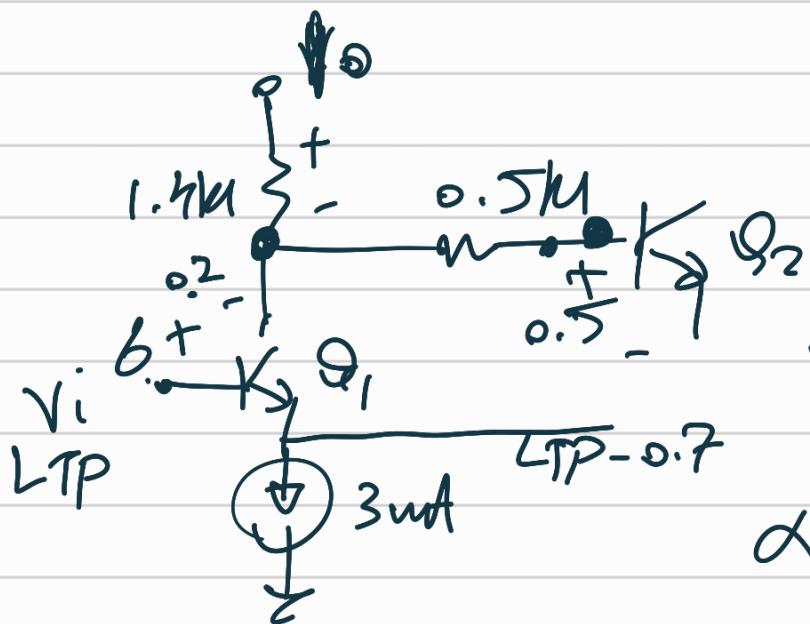
$$I_{C2} = 3 - I_{B2} = 2.17 \text{ mA}$$

$$V_{C2} = V_0 = 10 - 1k\Omega \times 2.17 = 7.83 \text{ Volt} \quad \text{mA}$$

$$V_{E2} = V_{C2} - 0.2 = 7.63 \text{ Volt}$$



$$V_{TP} = 7.63 + 0.5 = 8.13 \text{ Volt}$$



حصيني

$$\alpha = \frac{\beta}{\beta + 1} = \frac{100}{100 + 1} \approx 1$$

$$V_{B2} = 10 - 1.4 \times 3 \text{ mA} \quad \cancel{1}$$

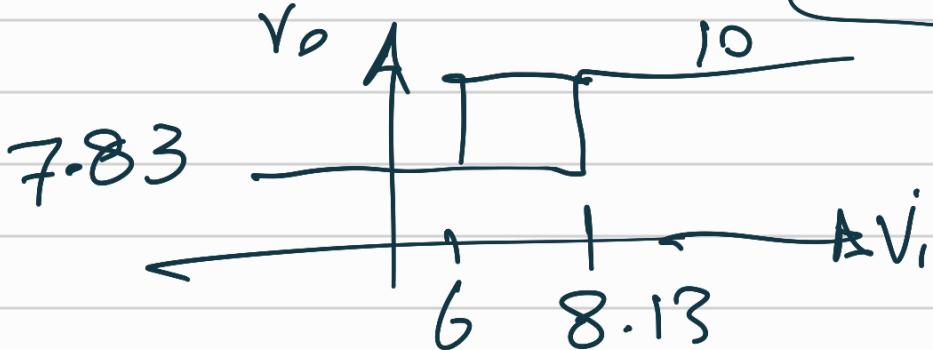
$$V_{B2} = 5.8 \text{ Volt}$$

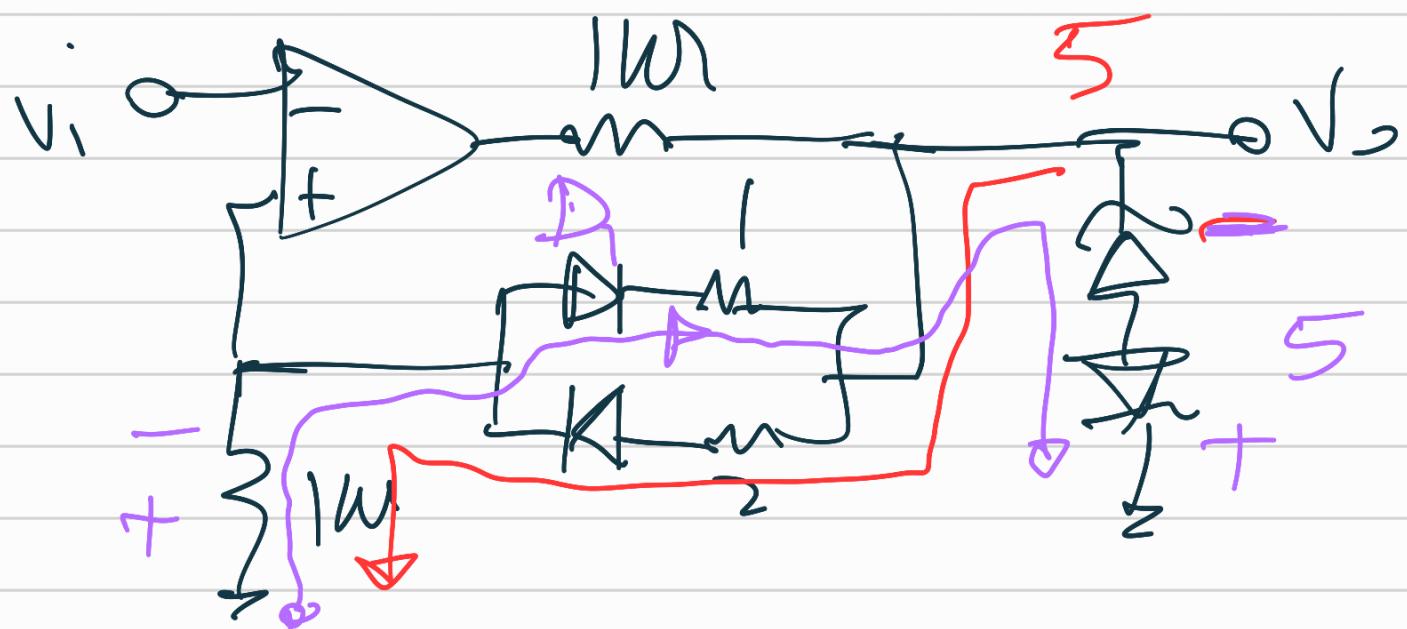
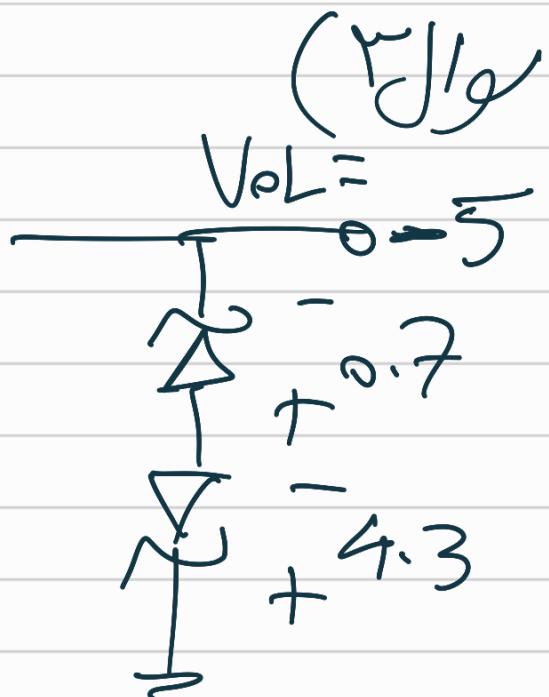
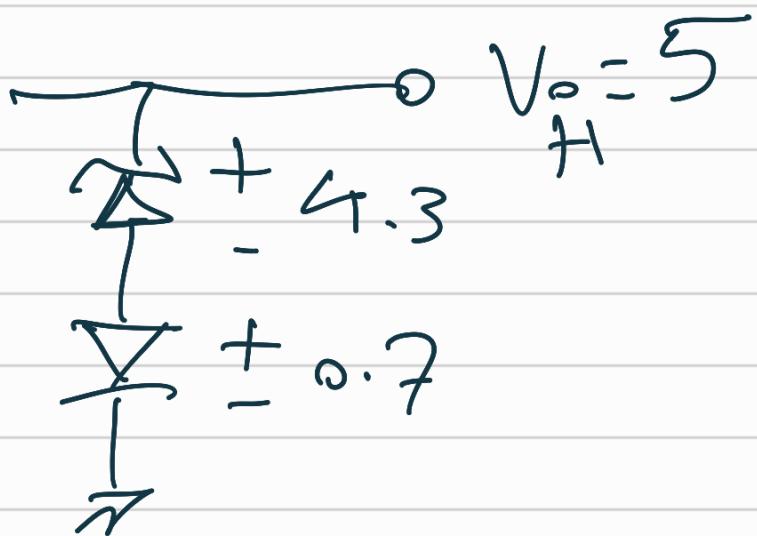
$$5.8 - 0.5 = LTP - 0.7$$

V8

زنون مداری، Q1، Q2

$$LTP = 5.8 + 0.2 = 6 \text{ Volt}$$





if  $V_{oH} = 5$

$$V^+ = \frac{V_{oH} - 0.7}{2+1} \times 1 = \frac{4.3}{3} = 1.4 \text{ Volt}$$

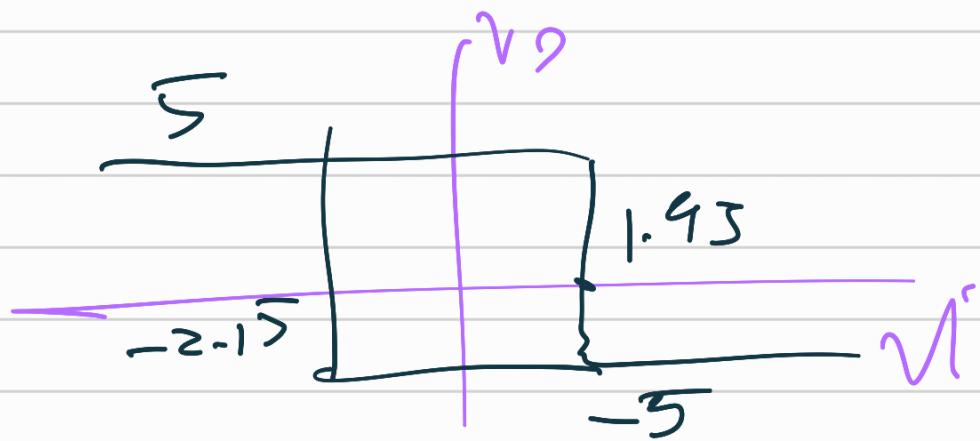
$V_i > V^+$   $\rightarrow V_{oH} \rightarrow V_{oL}$

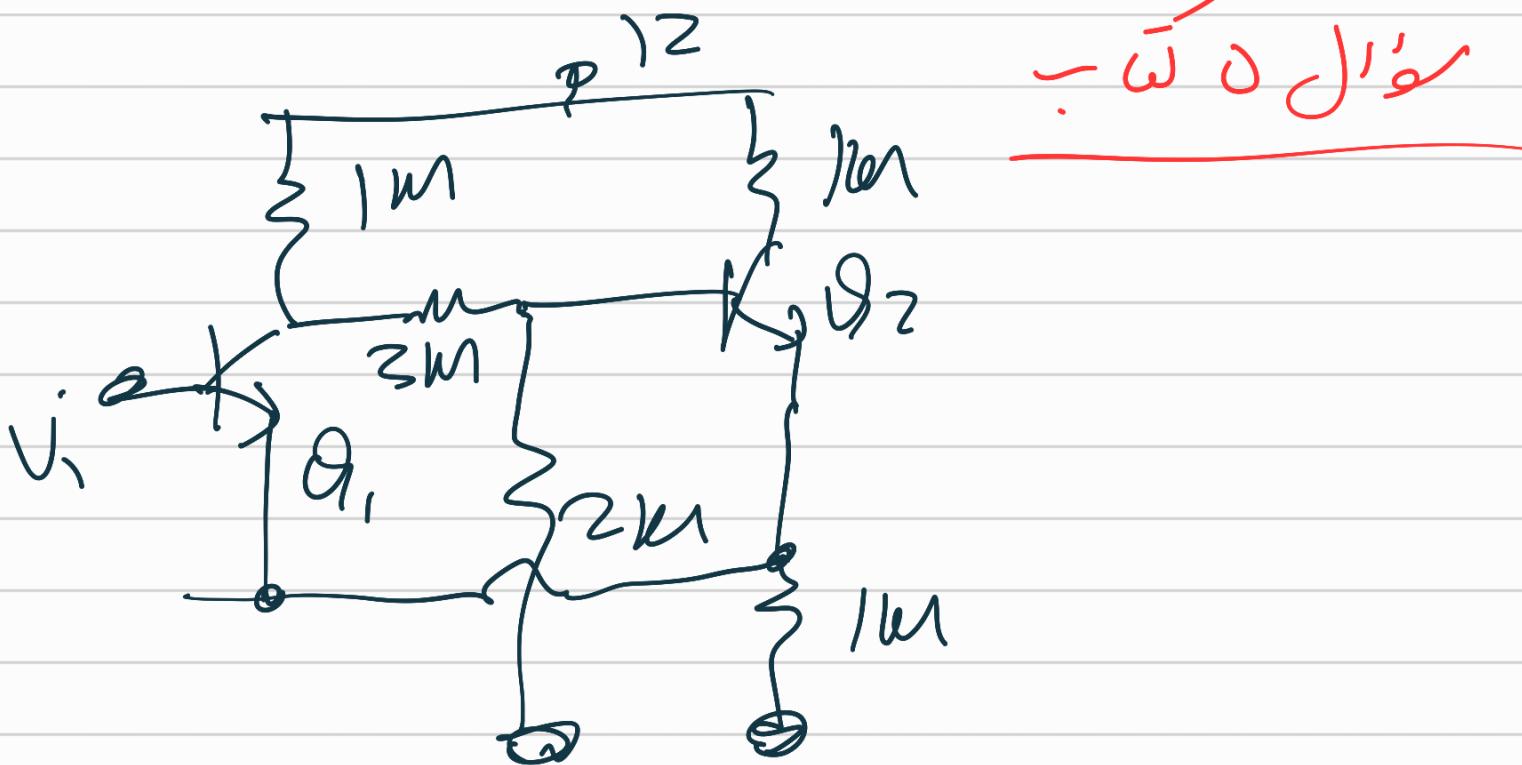
$$+1k\Omega I + 0.7 + 1k\Omega \times I - 5 = 0$$

$$UTP = 1.43 \text{ Volt}$$

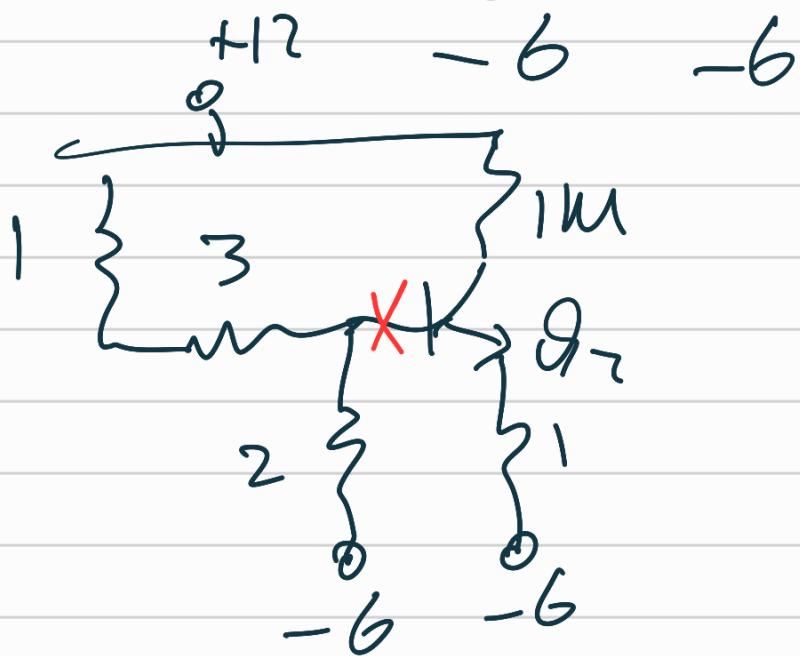
$$V^+ = -4.3 \times 1/\mu\Omega = \frac{4.3}{2} = 2.15 \text{ Volt}$$

$-4.3$  and  $1 + 1$  are circled in red.





- ω₀ ذاكرة



$\rightarrow \text{نقطة } Q_1$

فرصه

$$VB_2 = \frac{12 + 6}{1 + 3 + 2} \times 2 - 6 = 0$$

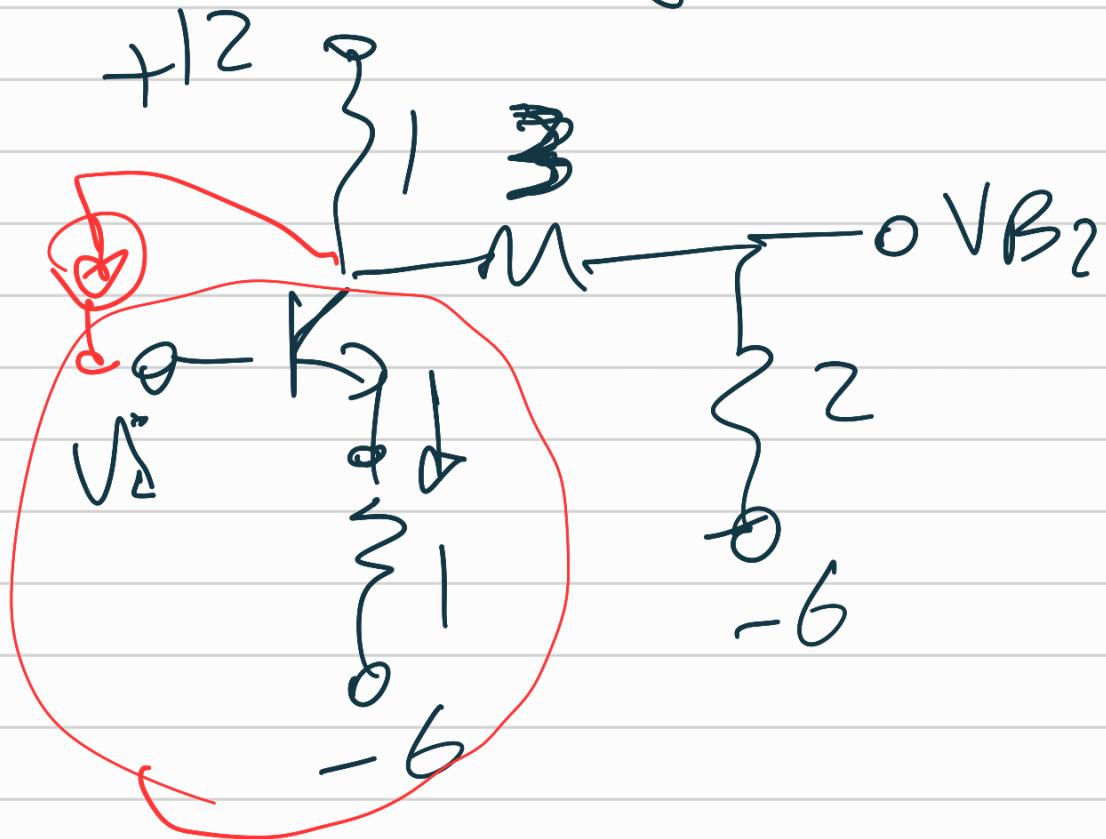
$$VE_2 = VB_2 - 0.7 = -0.7$$

$$IE_2 = \frac{VE_2 + 6}{1k\Omega} = \frac{5.3}{1k\Omega} = 5.3mA$$

$$VC_2 = 12 - 1k\Omega \times 5.3mA = 6.7$$

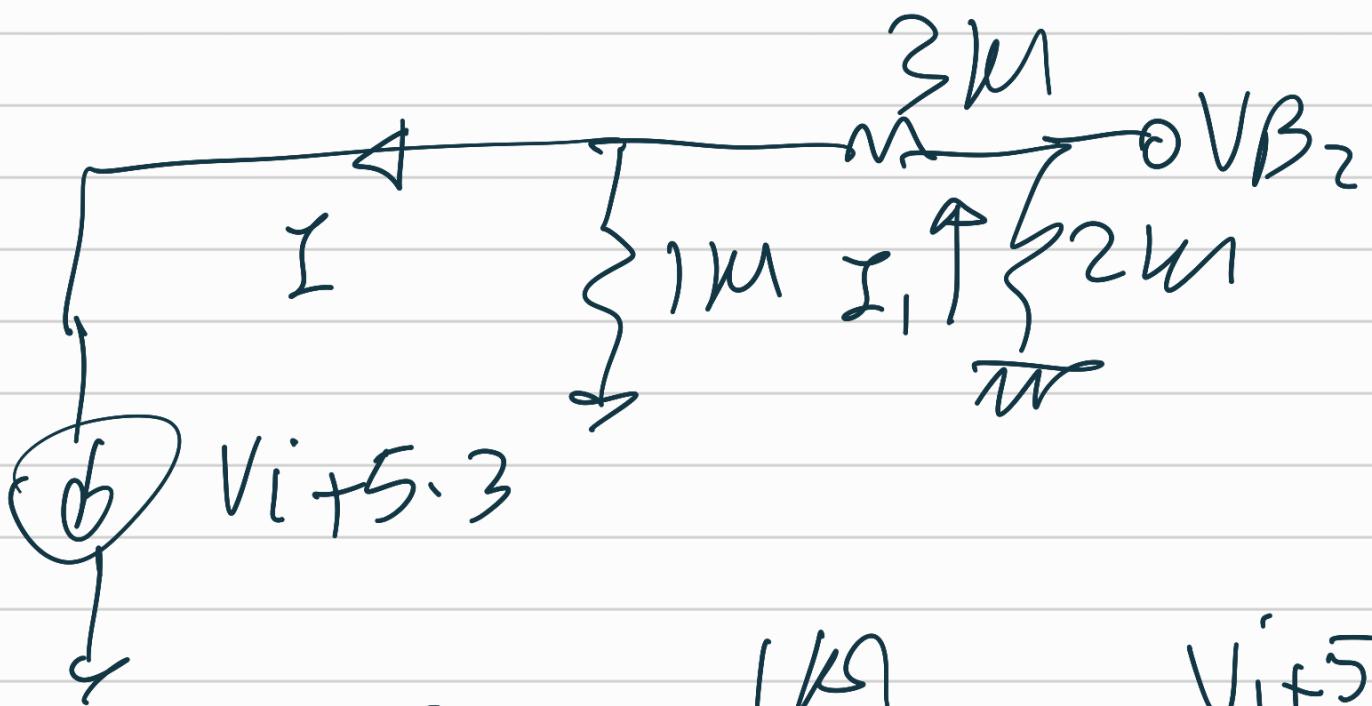
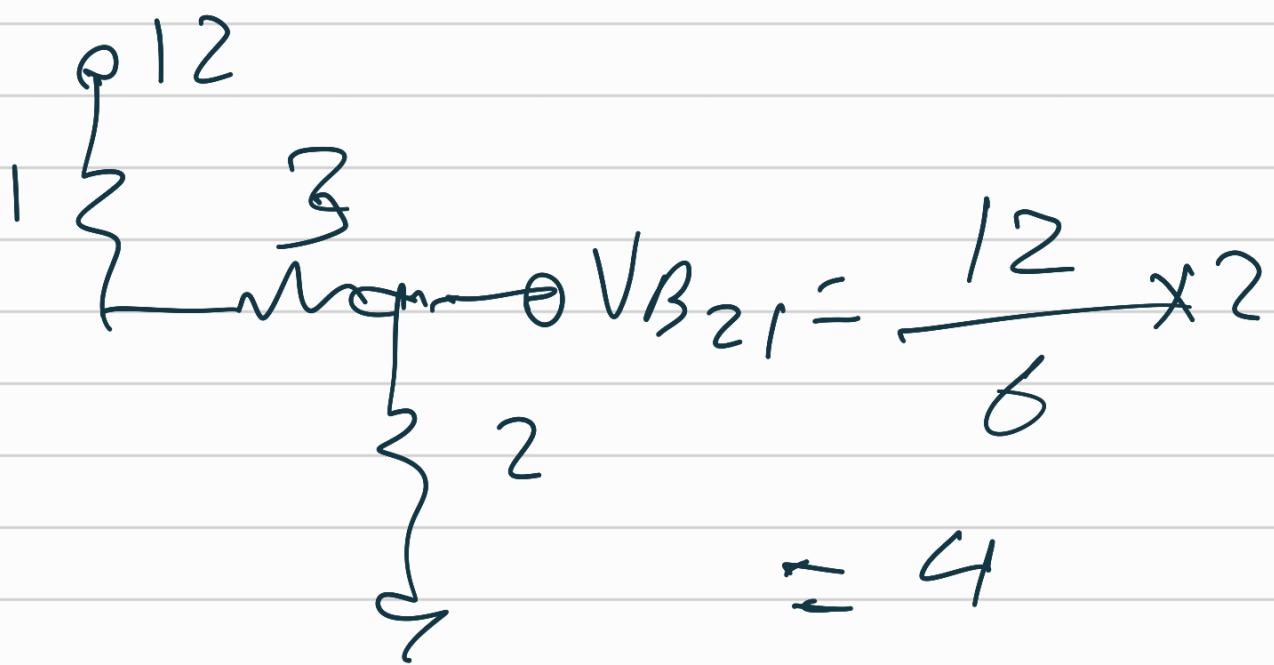
$$U_{TP} = V_E + \omega \cdot \bar{s} = 5.8 \text{ Volt}$$

$\sqrt{\chi}$   
jötüvit



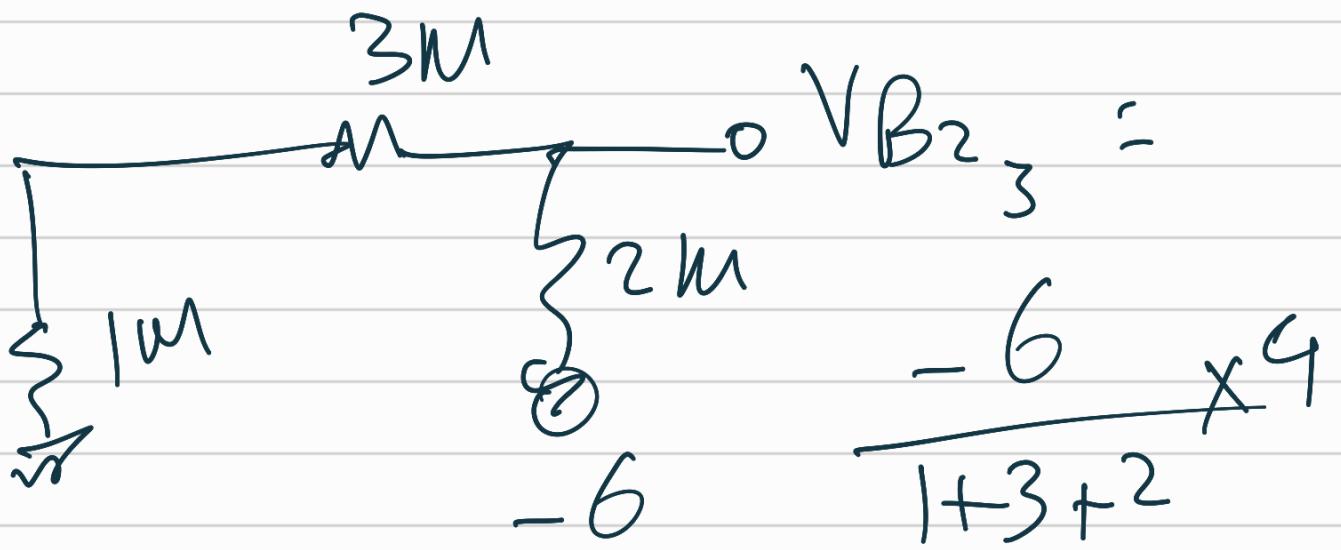
$$I_{E1} = \frac{Vi - 0.7 + 6}{1\text{k}\Omega} = \frac{Vi + 5.3}{1} = Vi + 5.3$$

$$I_C1 = Vi + 5.3$$



$$I_1 = I \times \frac{1\text{ k}\Omega}{1 + 3 + 2} = \frac{Vi + 5.3}{6}$$

$$V_{B2} = - \frac{Vi + 5.3}{6} \times 2\text{ m}\Omega$$



$$= -4 \text{ Volt}$$

$$VB_2 = 4 - 4 - \frac{Vi + 5 \cdot 3}{6} \times 2$$

$$VB_2 - VEZ = 0.5 \vec{i}_w \vec{i}_w^T$$

$Q_2 \rightarrow N$

b  
LTP

$$L = 2 \mu m$$

QVJ'2

$$V_{tp} = -1$$

$$V_{tn} = +1$$

$$k_n' = \mu_n C_{ox} = 40 \mu A/V^2 \quad NMOS$$

$$k_p' = \mu_p C_{ox} = 16 \mu A/V^2 \quad PMOS$$

$$V_{TP} = \frac{V_{DD} + \sqrt{\frac{k_n' w_2}{k_n' w_2 + k_p' w_4} V_{tn}}}{1 + \sqrt{\frac{k_2 w_2}{k_3 w_3}}}$$

$$Q = \frac{5 + \sqrt{\frac{w_2}{w_3}} \times 1}{1 + \sqrt{\frac{w_2}{w_3}}} \approx 1$$

$$Q + Q\sqrt{\frac{w_2}{w_3}} = 5 + \sqrt{\frac{w_2}{w_3}} \quad \therefore \sqrt[3]{\frac{w_2}{w_3}} = 1$$

$$\frac{\omega_2}{\omega_3} = 1/9$$

upE4

$$L_{TP} = \frac{\sqrt{\frac{\omega_4}{\omega_6}} - 1}{1 + \sqrt{\frac{k_7 \omega_4}{k_6 \omega_6}}} = 1$$

$L_{TP} = 1$

$$4 \sqrt{\frac{\omega_4}{\omega_6}} = 1 + \sqrt{\frac{\omega_4}{\omega_6}}$$

$$3 \sqrt{\frac{\omega_4}{\omega_6}} = 1 \Rightarrow \frac{\omega_4}{\omega_6} = 1/9$$

