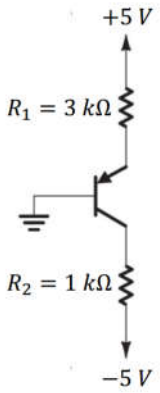
Problem 1



a) Assuming BJT is in ACTIVE MODE $\Rightarrow I_C = \beta I_B$, $I_E = (\beta + 1)I_B$ and $V_{EB} = V_{D0} = 0.7V$
BE KVL, $5 = I_E \times 3k + V_{EB}$

$$\Rightarrow I_E = 1.4333m\ A,\ \ I_C = \frac{\beta}{\beta + 1} I_E = 1.419\ mA$$

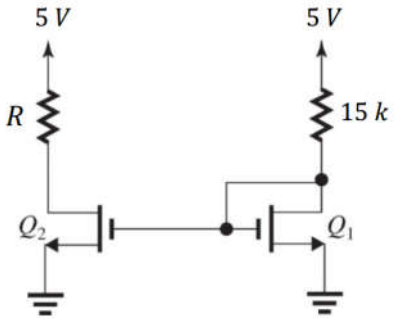
$\Rightarrow V_E = 5 - 3k \times I_E = 0.7\ V,\ \ V_C = -5 + 1k \times I_C =$ -3.58 V

$V_{EC} =$ 4.28 V $> V_{D0} \Rightarrow Correct\ Assumption$

b) Transistor stays in ACTIVE MODE until $V_{EC} = V_{D0} = 0.7 \Rightarrow V_C = 0V$. Then,

$$R_2 = \frac{V_C + 5}{I_C} = \frac{5}{1.419m} = 3.523\ k\Omega$$

Problem 2



important For Q1, $V_{GD1} = 0 < V_t \Rightarrow$ Q1 is at SATURATION

$$\frac{5 - V_{D1}}{15k} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}V_{OV1}^2$$

$$\Rightarrow \frac{5 - V_{GS1}}{15k} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}V_{OV1}^2$$

$$\Rightarrow \frac{5 - V_{OV1} - V_t}{15k} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}V_{OV1}^2$$

$$30\,V_{OV1}^2 + V_{OV1} - 4 = 0$$

$$\Rightarrow V_{OV1} = 0.34886\,V, \sout{-0.3822}$$

$$\Rightarrow V_{GS1} = V_{G1} = V_{G2} = V_{GS2} = V_{OV1} + V_t = 1.34886\,V$$

Here,

important $V_{GS1} = V_{GS2} \Rightarrow I_{D1} = I_{D2}$ *and* $V_{OV1} = V_{OV2}$

Now, Q2 is at the edge of SATURATION $\Rightarrow V_{GS2} - V_t = V_{OV2} = V_{DS2}$

Then,

$$I_{D2} = \frac{5 - V_{DS2}}{R} \Rightarrow \frac{1}{2}\mu_n C_{ox}\frac{W}{L}V_{OV1}^2 = \frac{5 - V_{OV1}}{R}$$

$$\Rightarrow R = 19.1\,K\Omega$$