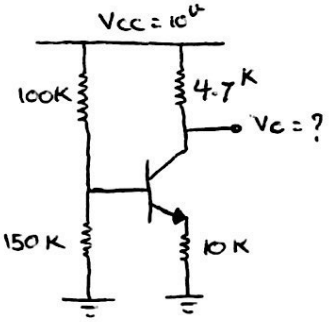
یا علی

رضا ادیب پور
۹۸۱۴۳۰۳
تمرین سری ۵ الکترونیک ۱

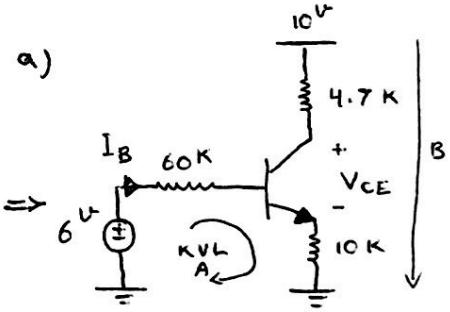
#1 $\begin{cases} |V_{BE,ON}| = 0.7\ V \\ \beta = 100 \end{cases}$



$\Rightarrow V_{TH} = \frac{150^K}{100+150} \times 10^V = 6^V$

$R_{TH} = 100^K \,||\, 150^K = 60\,K\Omega$

a)



$4.7 \gg \frac{60^K}{100+1}$ ⟶ KVL @ A: $-6 + 60^K \times I_B + V_{BE,ON} + 10^K \times I_E$

$\Rightarrow I_E = 0.53\ mA \simeq I_C$

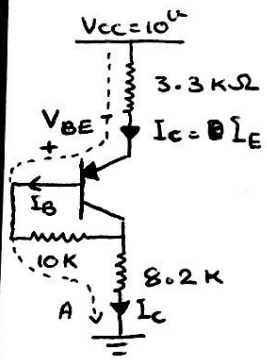
KVL @ B: $-10 + 4.7^K \times 0.53^m + V_{CE} + 10^K \times 0.53^m = 0 \Rightarrow V_{CE} = 2.2^V$ $\Rightarrow V_C = V_{CE} + 10^K \times I_E$

$\Rightarrow V_C = 2.2 + 10^K \times 0.53^m = 7.5^V$

b) KVL @ A: $-6 + 60^K \times I_B + 0.7 + 10^K \times I_E = 0 \xrightarrow{I_B = \frac{I_E}{\beta+1}} I_E\left(\frac{60^K}{101} + 10^K\right) = 5.3$

$\Rightarrow I_E = \frac{5.3}{10.6^K} = 0.5\ mA$, $I_B = \frac{0.5^m}{101} = 0.005\ mA$, $I_C = I_E - I_B = 0.495\ mA$

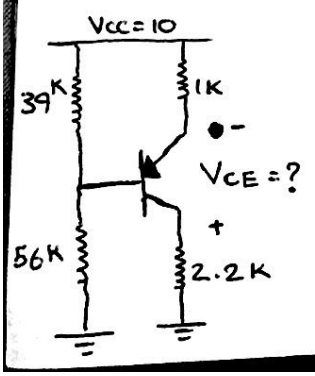
KVL @ B: $-10 + 4.7^K \times I_C + V_{CE} + 10^K \times I_E = 0 \Rightarrow V_{CE} = 2.6735^V \Rightarrow V_C = 7.6735^V$

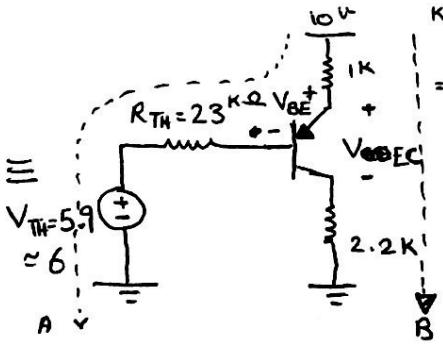


$3.3^K + 8.2^K \gg \frac{10^K}{100}$ $\Rightarrow$ KVL @ A: $-10 + 3.3^K \times I_E - 0.7 + 10^K \times I_B + 8.2^K \times I_C$

$\Rightarrow I_E \simeq I_C \Rightarrow -10 + 3.3^K \times I_C - 0.7 + 10^K \left(\frac{I_C}{100+1}\right) + 8.2^K \times I_C = 0$

$\Rightarrow I_C = \frac{10.7}{11.5} = 0.9 \simeq I_E$





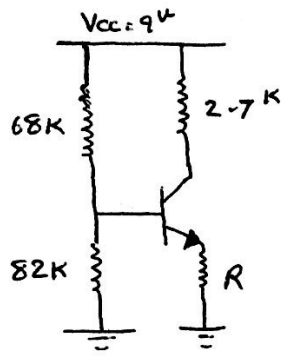
KVL @ A: $-10 + 1^K \times I_E - 0.7 + 23^K \times I_B + 6 = 0$

$\Rightarrow I_E = 4.7\ mA \simeq I_C$

KVL @ B: $-10 + 1^K \times 4.7^m + V_{EC} + 2.2 \times 4.7$

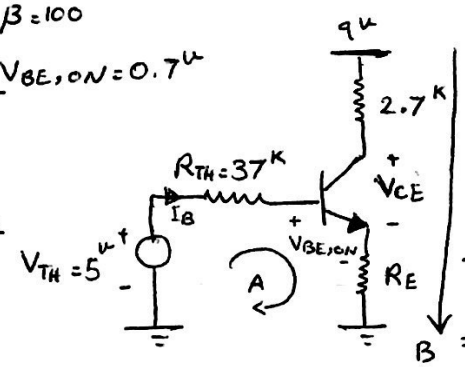
$\Rightarrow V_{EC} = -5.304 \Rightarrow V_{CE} = 5.04$

#2



$\beta = 100$

$V_{BE,ON} = 0.7\ V$



KVL @ A: $-5 + 37^{K} \times I_B + 0.7 + R_E I_E = 0$

$\Rightarrow$ [illegible]

$-5 + 37^{K}\left(\frac{I_E}{101}\right) + 0.7 + R_E I_E = 0$

$\Rightarrow 0.367 I_E + R_E I_E = 4.3 \quad (I)$

$\Rightarrow I_E (0.37 + R_E) = 4.3$

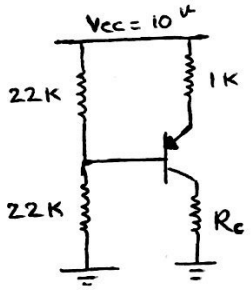
KVL @ B: $-9 + 2.7^{K} \times I_C + V_{CE} + R_E I_E = 0 \quad (II)$

(I) in (II) $\Rightarrow$ $I_C \simeq I_E$

$-9 + 2.7\left(\frac{4.3}{0.37+R_E}\right) + V_{CE} + R_E\left(\frac{4.3}{0.37+R_E}\right) = 0 \Rightarrow V_{CE} = 9 - \frac{11.61}{0.37+R_E} - \frac{4.3 R_E}{0.37+R_E}$

$V_{CE} > 0.2 \longrightarrow R_E < \frac{8.36}{13} \simeq 0.6\ K\Omega$

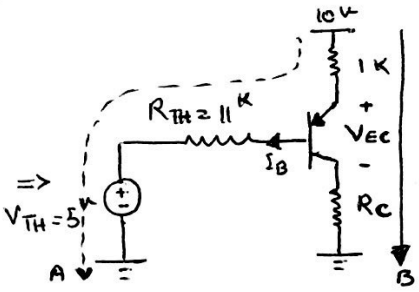
#3



$\beta \to \infty$

$V_{BEB,ON} = 0.7\ V$

$0 < R < 50\ K\Omega$



KVL @ A:

$-10 + 1^{K} \times I_E + 0.7 + 11^{K} \times I_B + 5 = 0$

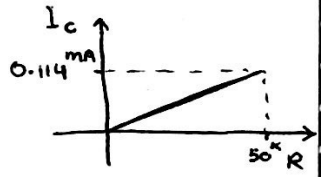
$\Rightarrow I_E = 4.3\ mA$

KVL @ B: $-10 + 1^{K}(4.3^{m}) + V_{EC} + R_c \times I_c = 0 \Rightarrow V_{EC} = 5.7 - I_c R_c \xrightarrow{V_{EC} > 0.2}$

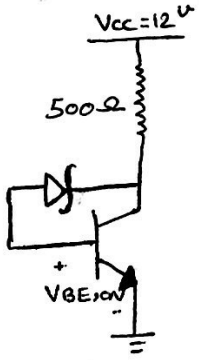
$\Rightarrow 5.7 > I_c R_c \xrightarrow{R_c = 0,\ R_c = 50^{K}}$

if $R_c = 0 \longrightarrow I_c = 0$

if $R_c = 50^{K} \longrightarrow I_c < 0.114\ mA$



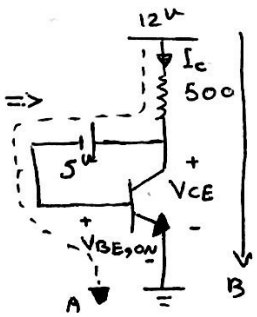
#4



$\beta = 100$

$V_{BE,ON} = 0.7\ V$

$V_Z = 5\ V$



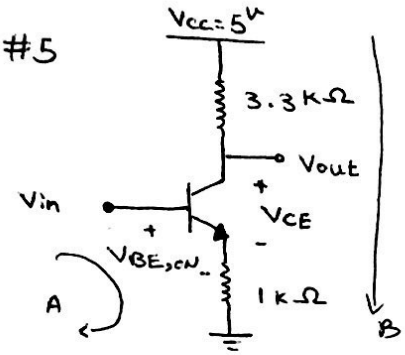
KVL @ A: $-12 + 500 I_c + 5 + 0.7 = 0$

$\Rightarrow I_{c_Q} = 12.6\ mA$

KVL @ B: $-12 + 0.5^{K} \times 12.6^{m} + V_{CE} = 0$

$\Rightarrow V_{CE_Q} = 5.7\ V$

#5



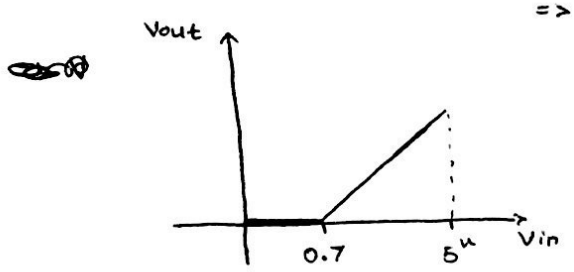
if $0 < V_{in} < 0.7 \longrightarrow V_{BE}$: off $\longrightarrow V_{out} = 0$

if $V_{in} > 0.7 \longrightarrow V_{BE}$: ON $\longrightarrow V_{out} = V_{CE} + 1^K \times I_E$

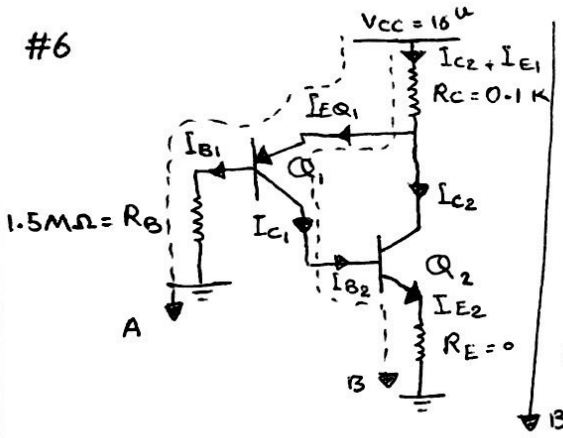
KVL @ A: $-V_{in} + 0.7 + 1^K \times I_E = 0 \Rightarrow I_E = \dfrac{V_{in} - 0.7}{1^K}$ (I)

$\Rightarrow$ KVL @ B: $-5 + 3.3^K \times I_E + V_{CE} + 1^K \times I_E = 0$

$\Rightarrow V_{out} = 5 - 3.3^K \times I_E$ (II) $\xrightarrow{\text{(I) in (II)}} V_{out} = 7.31 - 3.3 V_{in}$



#6



$\begin{cases} \beta_1 = 160 \\ \beta_2 = 200 \\ |V_{CE,sat}| = 0.2^V \\ |V_{BE,ON}| = 0.7^V \end{cases}$ $\qquad I_{B_2} = I_{C_1}$

KVL @ A & $-16 + 0.1^K (I_{C_2} + I_{E_1}) - 0.7 + 1.5^M I_{B_1} = 0$

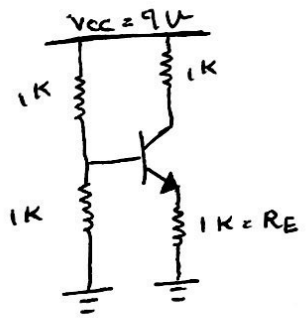
$I_{E_1} = I_{C_1} = I_{B_2} = 0 \Rightarrow 0.1^K (I_{C_2}) = 16.7 \Rightarrow I_{C_2} = 167\,mA$

KVL @ A: $-16 + 0.1^K \times I_{C_2} + V_{CE_2} = 0 \Rightarrow V_{CE_2} = -0.7 \longrightarrow$ Bias Point $= (167^{mA}, -0.7^V)$

KVL @ B: $-16 + 0.1^K \times I_{C_2} + V_{EC_1} + V_{BE_2} = 0 \Rightarrow V_{EC_1} = -1.4 \longrightarrow$ Bias Point $= (0, -1.4^V)$

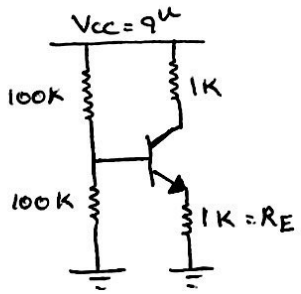
#7

①



$R_{TH①} = \dfrac{1}{2} = 0.5\,K\Omega$

②



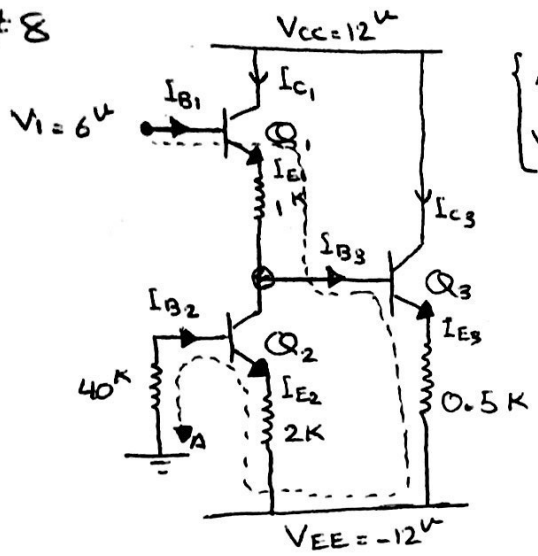
$R_{TH②} = \dfrac{100}{200} = 50\,K\Omega$

$R_E \gg \dfrac{R_{TH}}{\beta+1} \longrightarrow I_B = 0$

$\begin{cases} ①: 1^K \gg \dfrac{0.5^K}{100} = 0.005^K \checkmark \\ ②: 1^K \gg \dfrac{50^K}{100} = 0.5^K \times \end{cases}$

in the first circuits, the Base current can be ignored, Because: $R_E \gg \dfrac{R_{TH}}{\beta+1}$

#8



$\begin{cases} \beta = 100 \\ V_{BE,ON} = 0.6\ V \end{cases}$

$I_{C2} = I_{E1} - I_{B3} \Rightarrow I_{C2} \simeq I_{E2} \simeq I_{E1} \simeq I_{C1}$

KVL@A: $-6 + 0.6 + 1^{K} \times I_{E1} + 0.6 + 0.5^{K} \times I_{E3} - 12 + 2^{K}(-I_{E2}) - 0.6 + 40^{K}(I_{B2}) = 0$

$\Rightarrow \underline{I_{E1} = -34.8\ mA}$

KVL: $-12 + V_{CE3} + 0.5^{K} \times$