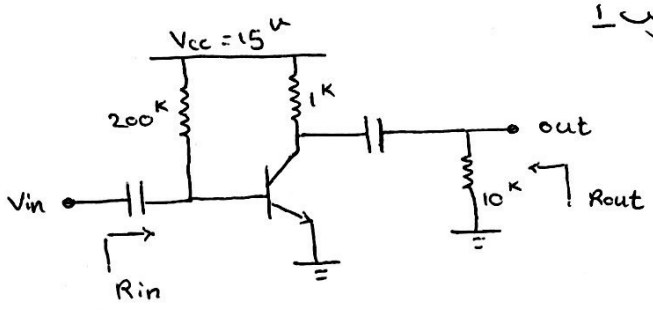
یالطیف

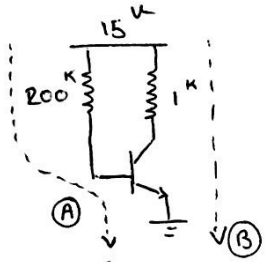
رضا ادیب پور
۹۸۱۱۴۳۰۳
تمرین سری V الکترونیک ۱

#1 determine: { $R_{in}=?$, $R_{out}=?$, $A_v=?$ }

$\beta = 100$



DC Analysis:

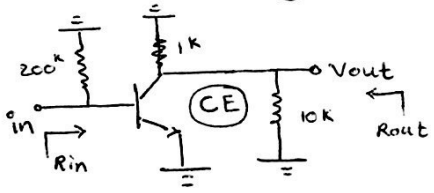


KVL @ A: $-15 + 200\left(\frac{I_C}{100}\right) + 0.7 = 0$

$\Rightarrow I_C \simeq I_E = 7.15\ mA$

KVL @ B: $-15 + 1^K \times 7.15^m + V_{CE} = 0 \Rightarrow V_{CE} = 7.85^V$

S.S Analysis:



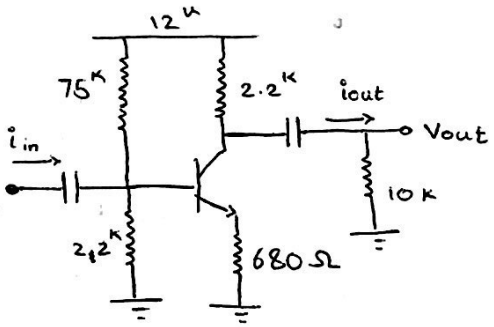
$\begin{cases} g_m = 286\ \frac{mA}{V} \\ r_\pi = \frac{100}{286} \simeq 0.3\ K\Omega \\ r_o = \infty \end{cases}$

$A_v = -g_m(R_c \| R_o) = -286\left(201^K \| \infty\right) = 57486\ \frac{V}{V}$

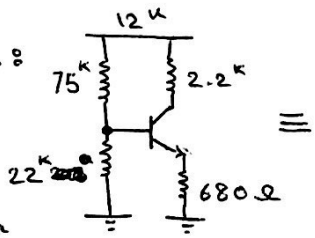
$R_{in} = r_\pi \| 200^K = 0.3^K \| 200^K = 0.3^K$, $R_{out} = 10^K \| r_o \| 1^K = 10^K$

#2 determine: { $A_v = \frac{V_{out}}{V_{in}}$, $A_i = \frac{i_{out}}{i_{in}}$ }

$\beta = 100$



DC Analysis:



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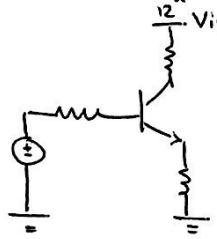
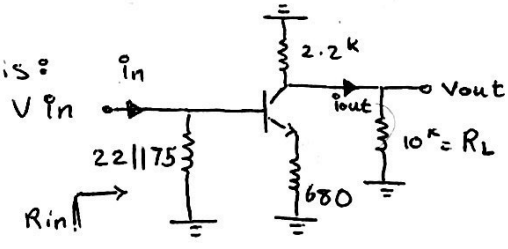


$\begin{cases} V_{TH} = 2.7^V \\ R_{TH} = 17\ K\Omega \end{cases} \xrightarrow{KVL} I_C = I_E = 3\ mA \Rightarrow V_{CE} = 3.36^V \Rightarrow \begin{cases} g_m = 120\ \frac{mA}{V} \\ r_\pi = 0.83\ K\Omega \\ r_o = \infty \end{cases}$

S.S Analysis:



(CE) $\Rightarrow A_v = -g_m(R_c \| r_o) = -120\left(10^K \| 2.2^K\right)$

$= -216\ \frac{V}{V}$

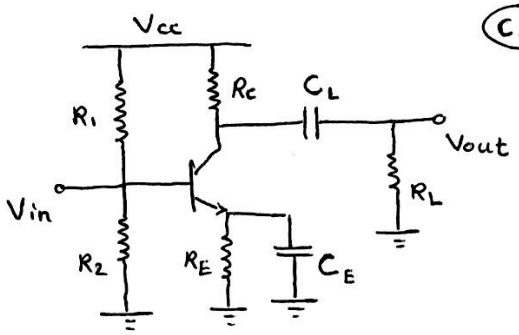
$A_i = A_v \times \frac{R_{in}}{10^K}$

#2 (previous) : $R_{in} = (22 \| 75) \| (r_\pi + (\beta+1) R_E) = 17^K \| 68^K = 13.6\ K\Omega$

$\Rightarrow A_i = \frac{i_{out}}{i_{in}} = A_v \times \frac{R_{in}}{R_L} = -216 \times \frac{13.6^K}{10^K} = \underline{-293.76\ A/A}$

#3

$V_{CE,sat} = 0\ V$
$V_T = 25\ mV$
$R_L = 1\ K\Omega$
$A_v = 48\ V/V$
$V_{cc} = 3^V$
$R_c = ?$



(CE) : $A_v = -g_m (R_c \| r_o)$

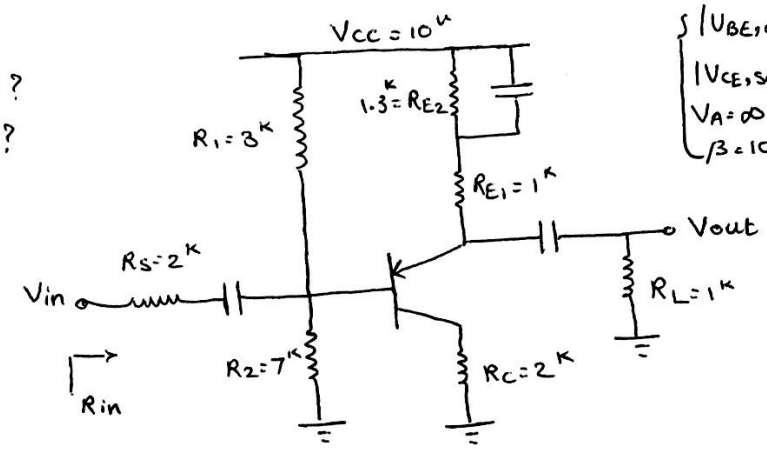
$= \frac{-I_C}{V_T} \left(R_c \| \frac{V_A}{I_C} \right)$

$= \frac{-1}{V_T} (R_c \| V_A)$

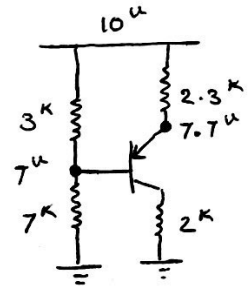
$= \frac{-R_c}{V_T} \Rightarrow \underline{|R_c| = 1.2^K}$

#4 determine : $R_{in} = ?$, $R_{out} = ?$, $A_v = ?$

$|V_{BE,ON}| = 0.7$
$|V_{CE,sat}| = 0.2$
$V_A = \infty$, $V_T = 25\ mV$
$\beta = 100$



DC analysis :

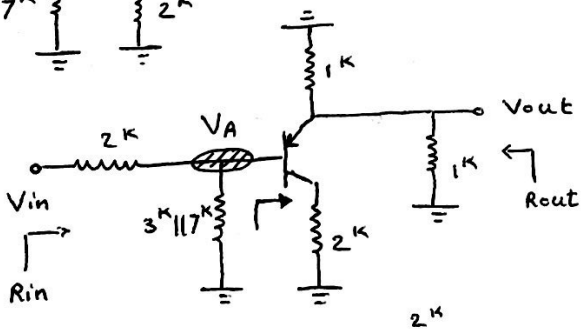


$R_{TH} = 2.1^K$
$\Rightarrow V_{TH} = 7^V$

$\Rightarrow I_C = I_E = \frac{10 - 7.7}{2.3^K} = \underline{1\ mA}$

$V_{CE} = 5.7^V > 0.2 \Rightarrow$ $\begin{cases} g_m = 40\ mA/V \\ r_\pi = 2.5^K \\ r_o = \infty \end{cases}$

S.S analysis :

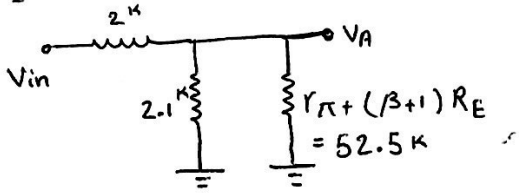


(CC) : $A_v = \frac{V_{out}}{V_A} = \frac{R_E}{R_E + \frac{1}{g_m}}$

$\Rightarrow A_v = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_A} \times \frac{V_A}{V_{in}}$

$\frac{V_{out}}{V_A} = \frac{(1^K \| 1^K)}{(1^K \| 1^K) + \frac{1}{40}} \simeq 1$

$\Rightarrow$



$\frac{V_A}{V_{in}} = \frac{(2.1^K \| 52.5^K)}{(2.1^K \| 52.5^K) + 2^K}$

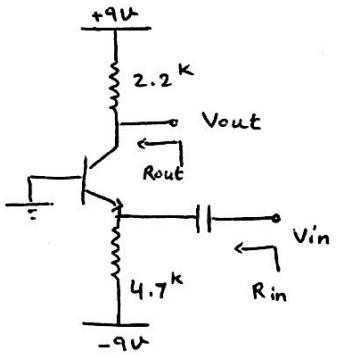
$= 0.5\ V/V$

$\Rightarrow A_v = \frac{V_{out}}{V_{in}} = 1 \times 0.5 = \underline{0.5\ V/V}$

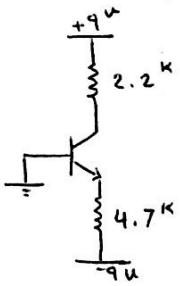
$R_{in} = \left[(r_\pi + (\beta+1) R_E) \| 2.1^K \right] + 2^K \simeq \underline{4.1\ K\Omega}$, $R_{out} = 0.5^K \| \frac{1}{g_m} \| 1^K = \underline{25\ \Omega}$

#5 calculate : { $A_v = ?$, $R_{in} = ?$, $R_{out} = ?$

$\beta = 100$

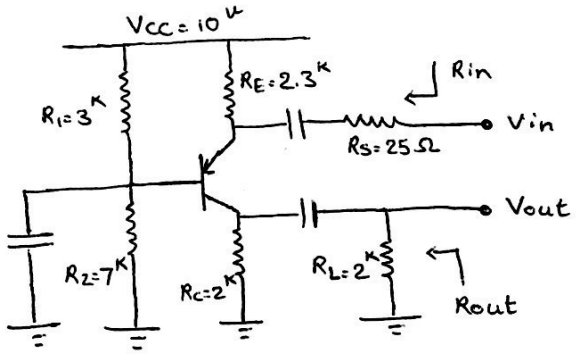


DC analysis :

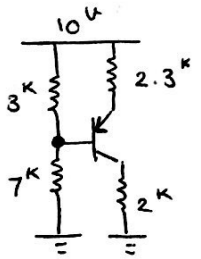


#6 determine : { $A_v = ?$, $R_{in} = ?$, $R_{out} = ?$

{ $V_A = \infty$, $\beta = 100$, $V_T = 25\ mV$



DC analysis :



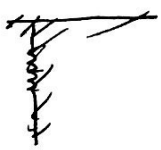
$V_{TH} = 7^V$

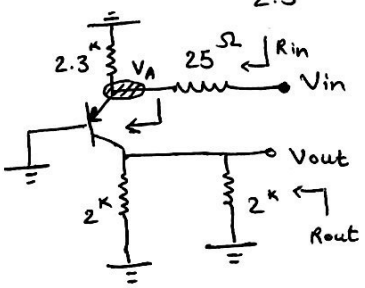
$R_{TH} = 7^K \| 3^K = 2.1^K$

$I_C = I_E = \frac{10 - 7.7}{2.3^K} = 1^{mA}$

$\Rightarrow$ { $g_m = 40\ \frac{mA}{V}$, $r_\pi = 2.5^K$, $r_o = \infty$

S.S analysis :



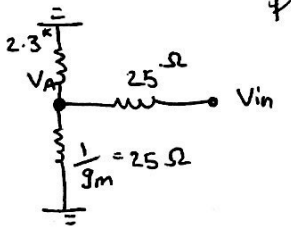


$A_v = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_A} \times \frac{V_A}{V_{in}}$

(CB) : $A_v = \frac{V_{out}}{V_A} = g_m (R_C \| r_o)$

$= 40\ \frac{mA}{V} \times (2^K \| 2^K) = 40\ V/V$

$\Rightarrow$



$\Rightarrow \frac{V_A}{V_{in}} = \frac{(25 \| 2.3^K)}{(25 \| 2.3^K) + 25\Omega} = 0.5 \Rightarrow \frac{V_{out}}{V_{in}} = 40 \times \frac{1}{2} = 20\ V/V$

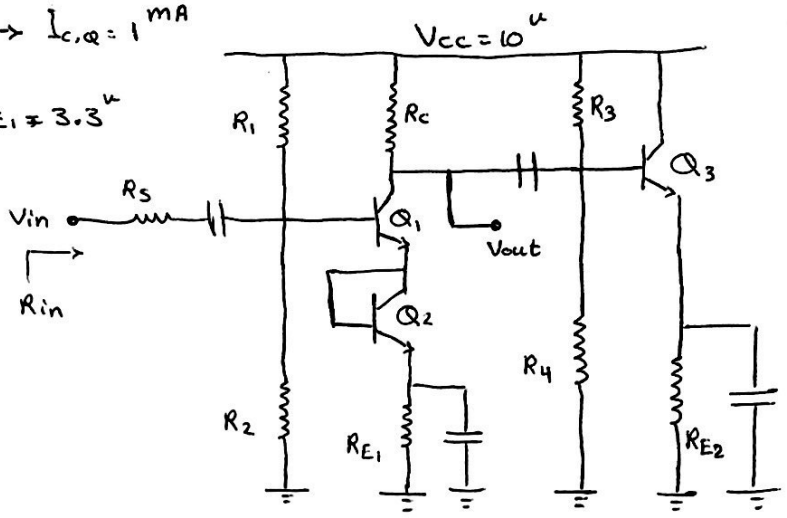
$\Rightarrow R_{in} = \left(2.3^K \| \frac{1}{g_m}\right) + 25\Omega = 50\Omega$, $R_{out} \overset{r_o = \infty}{=\!=} 2K \| 2^K = 1^K$

#7

a) if Q_1 in F.A Region $\longrightarrow I_{C,Q} = 1^{mA}$

b) Determine R_C $\longleftrightarrow V_{CE_1} = 3.3^{\mu}$

c) Vout = ?



$R_S = 1^K$

$R_1 = 7.6^K$, $R_2 = 2.4^K$

$R_3 = R_4 = 20^K$

$R_{E_1} = 1K$, $R_{E_2} = 17.2^K$

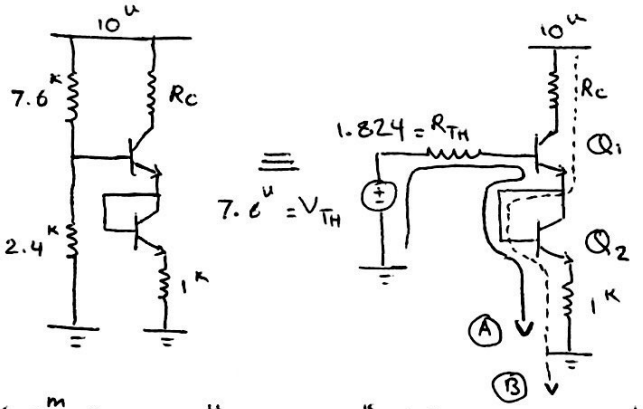
$V_{BE,ON} = 0.7$, $V_{CE,sat} = 0.2$

$\beta = 100$, $V_A = \infty$

$V_T = 25\,mV$

$V_{in} = 10^{-3} \sin(10^3 t)$

DC analysis :



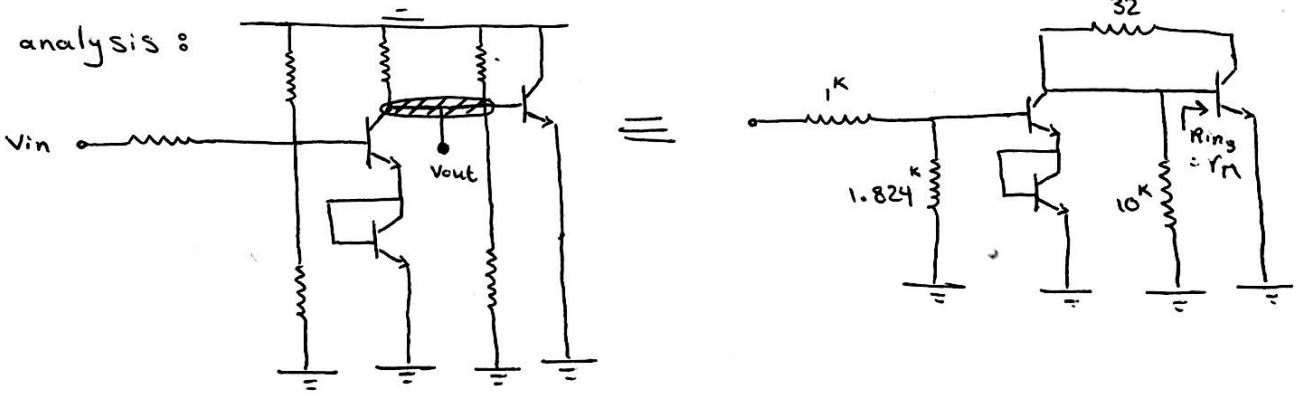
KVL in (A) : $-7.6 + 1.824\, I_{B_1} + 0.7 + 0.7 + 1^K \times I_{E_2} = 0$

$\because I_{B_1} = I_{B_2} = 0 \longrightarrow I_{C_1} = 6.2^{mA}$

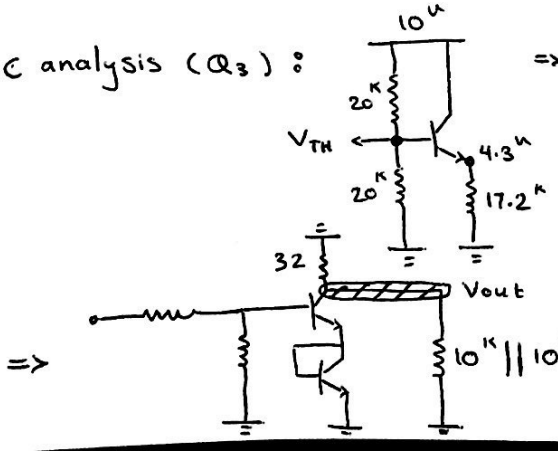
$\rightarrow I_{C_1} = I_{C_2}$

KVL @ B : $-10 + 6.2^m \times R_C + \underbrace{3.3^{\mu}}_{V_{CE_1}} + 0.7 + 1^K \times 6.2\,m = 0 \Rightarrow |R_C| = 0.03^K = 32\,\Omega$

S.S analysis :



DC analysis (Q_3) :



$\Rightarrow \begin{cases} V_{TH} = 5^{\mu} \\ R_{TH} = 10^K \\ I_{CQ_3} = 0.25^{mA} \end{cases} \Rightarrow \begin{cases} g_m = 10\ \frac{mA}{V} \\ r_\pi = 10\,K \\ r_o = \infty \end{cases}$

ترانزیستور Q_3 بایس مقاومت به مقدار r_π مدل می‌شود

$\Rightarrow$ $V_{out} = \left[\underbrace{(10^K \| 10^K)}_{5^K} \| 32^{\Omega} \times 6.2^{mA} \right] = 198.4^{mV}$