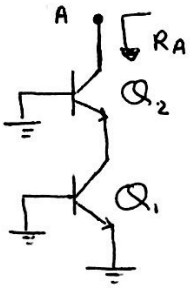
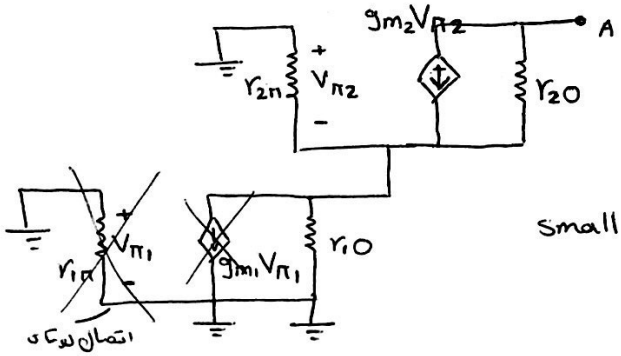
یا لطیف

رضا آذین‌پور
۹۸۱۴۳۰۳
تمرین سری ۶، آنالوگ ۱

#1

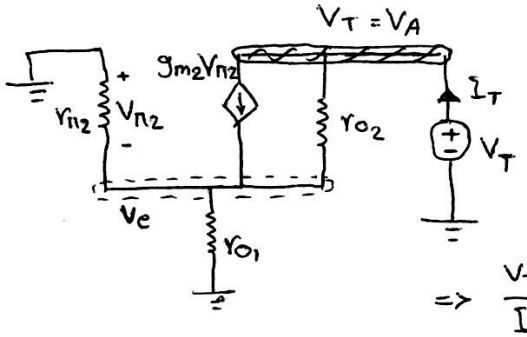


S.S



small signal model

$\Rightarrow$



KCL in V_T: $-I_T + \frac{V_T - V_e}{r_{O2}} + g_{m2}V_{\pi2} = 0$

$V_e = -V_{\pi2}$ $\rightarrow$ $-I_T + \frac{V_T + V_{\pi2}}{r_{O2}} + g_{m2}V_{\pi2} = 0$

$V_{\pi2} = I_T \times r_{\pi2}$ $\rightarrow$ $-I_T + \frac{V_T}{r_O} + \frac{r_{\pi2} I_T}{r_O} + g_{m2} I_T r_{\pi2} = 0$

$\Rightarrow \frac{V_T}{I_T} = R_a = -r_O \left(g_{m2} r_{\pi2} + \frac{r_{\pi2}}{r_O} - 1 \right)$

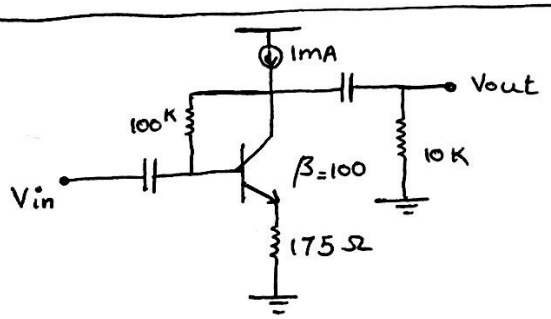
$I_{C,Q_1} = I_{C,Q_2} = 1\,mA$
$V_A = 50\,V$
$V_T = 25\,mV$
$\beta = 200$

$r_O = \frac{V_A}{I_{C,Q}} = \frac{50}{1\,mA} = 50\,K\Omega$

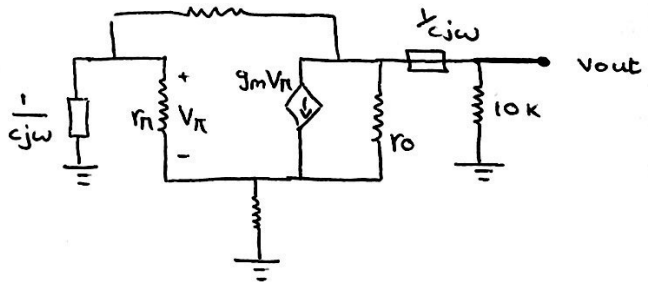
$r_{\pi2} = \frac{\beta}{g_m} = \frac{200}{40} = 5K\Omega$, $g_m = \frac{I_{CQ}}{V_T} = \frac{1\,mA}{0.025} = 40\,\frac{mA}{V}$

$\Rightarrow R_a = -50^K \left(40^m \times 5^K + \frac{5^K}{50^K} - 1 \right) = 9955\,K\Omega$

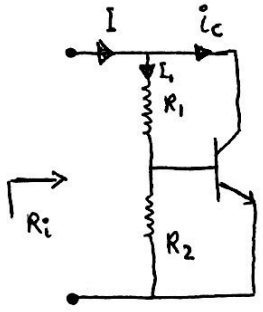
#2



S.S



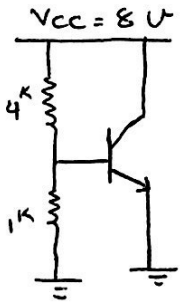
#3



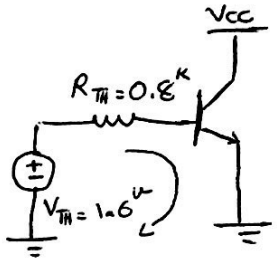
$\begin{cases} R_1 = 4\,K \\ R_2 = 1\,K \\ I = 2mA \end{cases}$

$\Rightarrow V_{cc} = I \times R_1 = 2^{mA} \times 4^{K} = 8^{V}$

$\equiv$



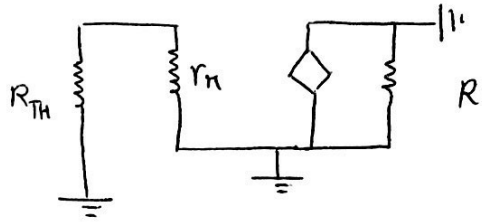
$\equiv$



KVL: $-1.6 + 0.8^{K} \times I_B + 0.7 = 0$

$\Rightarrow I_B = 1.125\ mA$

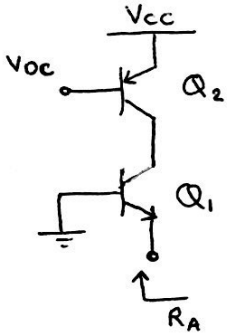
$\Rightarrow I_C = I_E \cong I_B \longrightarrow$



$R_{eq} = r_\pi \,||\, r_{TH}$

#4

a)



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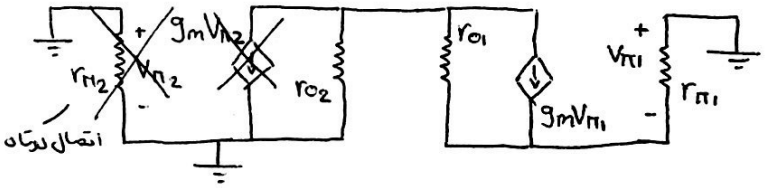
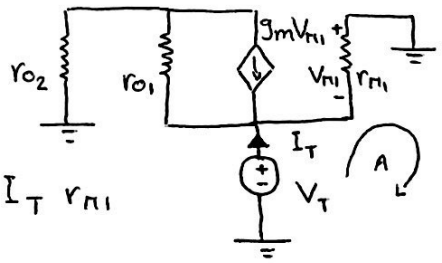


$\Rightarrow$

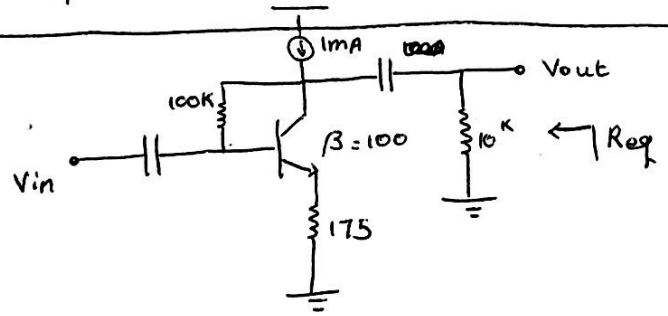


KVL @ A: $-V_T - V_{\pi 1} = 0$

$\Rightarrow V_T = -V_{\pi 1} \xrightarrow{V_{\pi 1} = -I_T \times r_{\pi 1}} V_T = I_T\, r_{\pi 1}$

$\Rightarrow \dfrac{V_T}{I_T} = R_a = r_{\pi 1}$

#5



$\equiv$ S.S