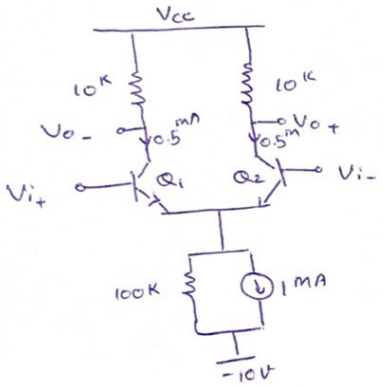
یا علی

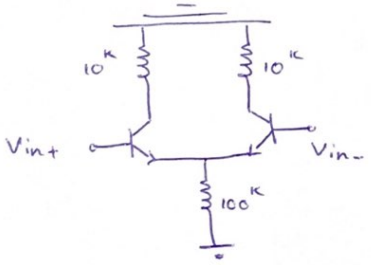
رضا دیندار
۹۸۱۴۳۰۴
تمرین سری ۶ الف 2

#1

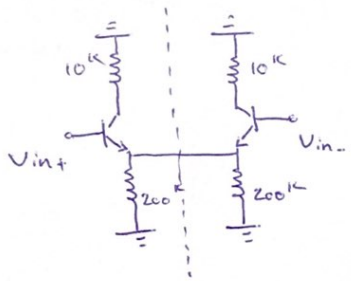


$\begin{cases} V_A = \infty \rightarrow r_o = \infty \\ V_T = 25\ mV \\ \beta = 100 \\ V_{i+} = 0.5\ V_{id} \\ V_{i-} = -0.5\ V_{id} \\ V_{id} = 10 \sin 10t\ mV \end{cases}$

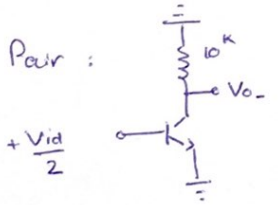
AC Analysis :



$\Rightarrow$



Diffrential Pair :



$\Rightarrow A_{v,d} = \dfrac{V_{o-}}{\frac{V_{id}}{2}} = -g_m R_o = -(40 \times 0.5) \times 10^K = -200$

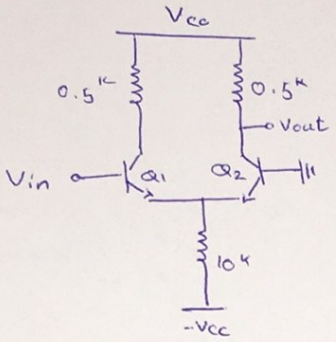
$\Rightarrow A_{v,d} = \dfrac{V_{o-}}{V_{id}} = -100\ \frac{V}{V} \Rightarrow V_{o-} = -100\ V_{id}$

$= -100\,(10^m) = -1\ V$

$V_{o+} = 100\ V_{id} = 1000^{mV} = 1^V$

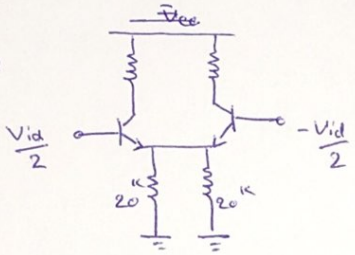
$\Rightarrow V_{o,d} = V_{o+} - V_{o-} = 1^V + 1^V = 2^V$

#2

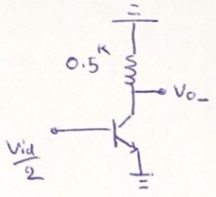


$$\begin{cases} I_{C_1} = I_{C_2} = 1\,mA \\ \beta = 100 \\ V_A = \infty \\ V_T = 25\,mV \end{cases}$$

AC Analysis :



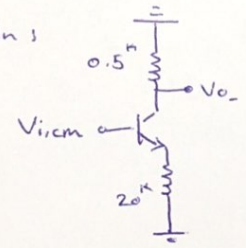
Diffrential gain :



$$A_v = \frac{V_{o-}}{\frac{V_{id}}{2}} = -g_m R_c = -(40 \times 1) \times 0.5^K = -20$$

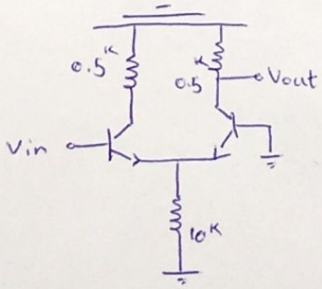
$$\Rightarrow A_{v,d} = \frac{V_{o-}}{V_{id}} = -10 \frac{V}{V} \qquad \Rightarrow A_{v,d}\Big|_{diff-out} = \frac{V_{o+} - V_{o-}}{V_{id}} = 20$$

Common mode gain :

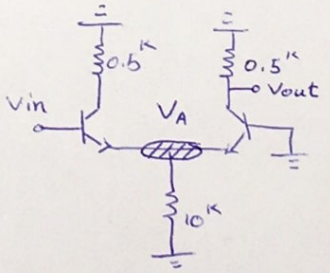


$$A_{v,cm} = \frac{V_{o-}}{V_{i,cm}} = \frac{-0.5}{\frac{1}{40} + 20^K} = -0.025$$

Direct Analysis :



$\Rightarrow$

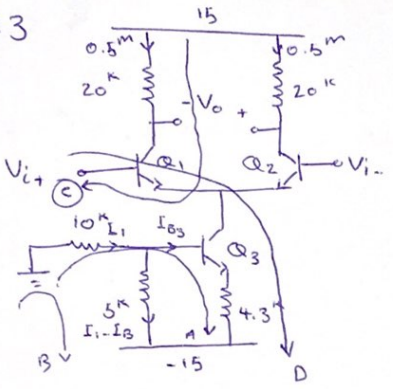


$$\frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_A} \times \frac{V_A}{V_{in}}$$

$$\frac{V_A}{V_{in}} = \frac{R_E}{R_E + \frac{1}{g_{m_1}}} = \frac{10^K}{10^K + \frac{1}{40}} = 0.99 \quad , \quad \frac{V_{out}}{V_{in}} = +g_m (R_c \| r_o) = 40\,(0.5) = 20$$

$$\Rightarrow A_v = \frac{V_{out}}{V_A} \times \frac{V_A}{V_{in}} = 20 \times 0.99 \simeq 19.950 \frac{V}{V}$$

#3



$$\begin{cases} V_{BE} = 0.6 \\ V_{CE,sat} = 0\,V \\ V_A = 10\,V \\ \beta = 100 \end{cases}$$

a) KVL in (A): $10^K I_1 + 0.6 + 4.3\, I_{C_3} - 15 = 0 \xrightarrow{I_{C_3} = 100 I_{B_3}} 10\, I_1 + 430\, I_B = 14.4$ | (I)

KVL @ B: $10^K I_1 + 5^K (I_1 - I_B) - 15 = 0 \Rightarrow 15\, I_1 - 5\, I_B = 15$ | (II)

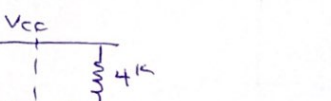
(I), (II) $\longrightarrow$ $\begin{cases} I_1 = 1.00\ mA \\ I_B = 0.01 \rightarrow I_{C_3} = 1\ mA \end{cases}$

KVL @ C: $-15 + 20^K (0.5) + V_{CE} - 0.6 + V_{idc} = 0 \Rightarrow V_{idc} = 15 - 10 - V_{CE}$

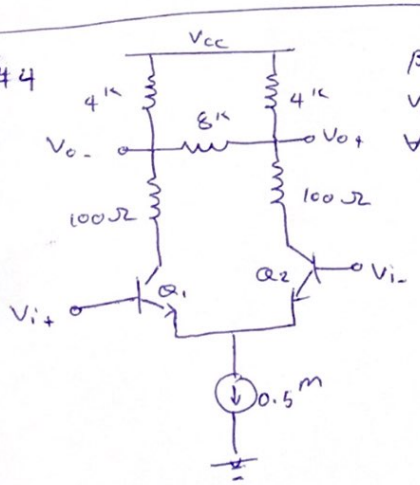
$V_{idc} = 5 - V_{CE} \Rightarrow Max\{V_{idc}\} = 5$

KVL @ D: $-V_{idc} + 0.6 + V_{CE_3} + 4.3^K (I_{B1}^M) - 15 = 0 \Rightarrow V_{idc} = -15 + 4.3 + 0.6 + V_{CE_3}$

$V_{idc} = -10.1 + V_{CE_3} \Rightarrow Min\{V_{idc}\} = -10.1$



#4



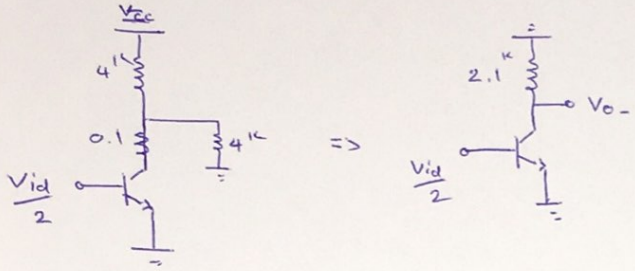
$\beta = 100$

$V_A = \infty \rightarrow r_o = \infty$

$V_T = 25\ mV$

$\Rightarrow$

Diffrential half circuit:

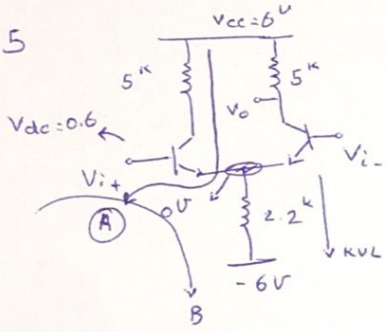


$\frac{V_{o-}}{\frac{V_{id}}{2}} = -g_m R_c = -(40 \times 0.25) \times 2.1^{K} = -21$

$\frac{V_{o-}}{V_{id}} = -\frac{21}{2} = \underline{-10.5}$, $\frac{V_{o+}}{V_{id}} = +10.5$

$\Rightarrow A_d = \frac{V_{od}}{V_{id}} = \frac{V_{o+} - V_{o-}}{V_{i+} - V_{i-}} = 10.5 - (-10.5) = 21 \frac{V}{V}$

#5



$\begin{cases} V_{BE} = 0.6 \\ V_{CE} = 0.2 \end{cases}$ ICMR = ?

KVL : $I_{EE} = \frac{0-(-6)}{2.2^{K}} = \underline{2.72^{mA}}$

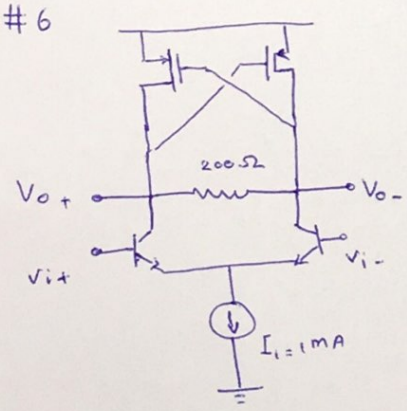
KVL @ A : $-6 + 5^{K}\left(\frac{2.72}{2}\right) + V_{CE} - 0.6 + V_{idc} = 0$

$\Rightarrow V_{idc} = 6 - 6.81 - V_{CE} + 0.6 \Rightarrow V_{idc} = -0.21 - V_{CE}$

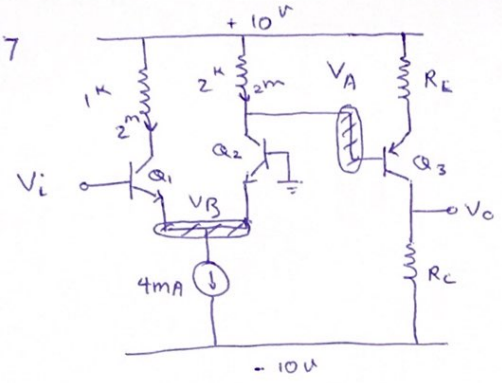
$\Rightarrow \text{Min}\{V_{idc}\} = \underline{-0.41}$

KVL @ B : $-V_{idc} + 0.6 + 2.2^{K}(2.72^{m}) - 6 = 0 \Rightarrow V_{idc_{max}} = \underline{0.584}$

#6



#7



$$A_v = \frac{V_o}{V_i} = \frac{V_o}{V_A} \times \frac{V_A}{V_B} \times \frac{V_B}{V_i}$$

$$\frac{V_o}{V_A} = \frac{R_E}{R_E + \frac{1}{g_{m3}}}$$

$$\frac{V_A}{V_B} =$$

$$\frac{V_B}{V_i} = \frac{R_E}{R_E + \frac{1}{g_m}} \rightarrow \infty = ??$$