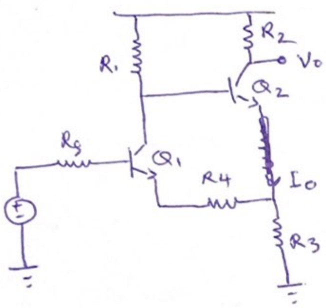
یا لطیف

رضا آدینه‌پور

۹۸۱۴۳۰۳

تمرین سری ۴ الک 2

#1



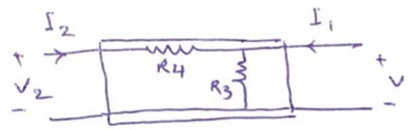
if Vo → open circuit → $I_o \neq 0$

input – output

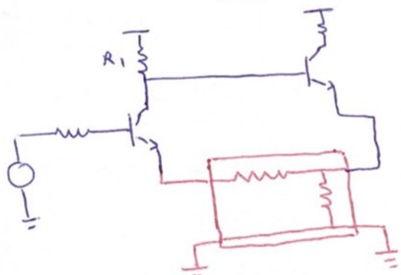
series – shunt

$\bar{V}$ – $\bar{V}$

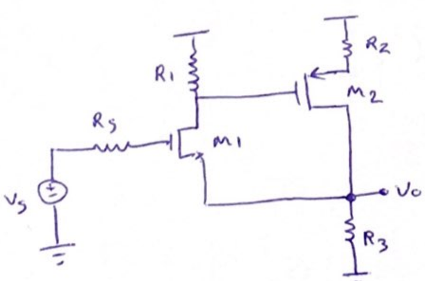
feedback network:



main Amp:



b)



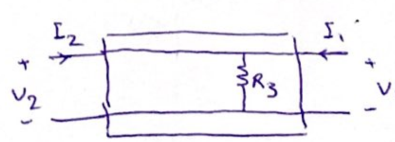
if Vo → short circuit → Vo = 0

input — output

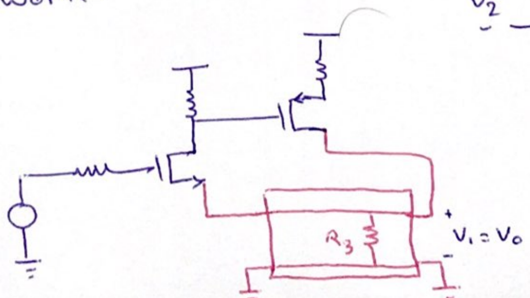
series — shunt

$\bar{V}$ — $\bar{V}$

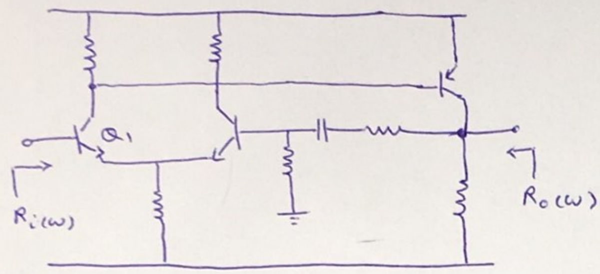
feedback network:



main Amp:

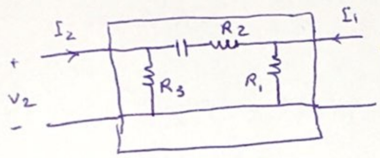


#23



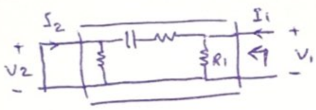
input — output
series — shunt
(V) — (V)

feedback network:



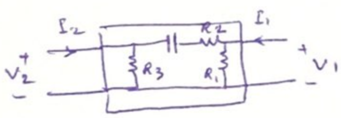
$$\begin{cases} V_1 = \alpha_{11} I_1 + \alpha_{12} V_2 \\ I_2 = \alpha_{21} I_1 + \alpha_{22} V_2 \end{cases}$$

$\alpha_{11} = \frac{V_1}{I_1}\Big|_{V_2=0} \Rightarrow$



$$\begin{cases} \text{if } \omega = 0 \rightarrow C: -\circ\ \circ- \Rightarrow \alpha_{11} = R_1 \\ \text{if } \omega = \infty \rightarrow C: -\bullet- \Rightarrow \alpha_{11} = 0 \end{cases}$$

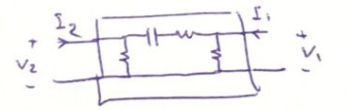
$\alpha_{21} = \frac{I_2}{I_1}\Big|_{V_2=0} \Rightarrow$



$\Rightarrow$

$$\begin{cases} \text{if } \omega = 0 \rightarrow C: -\circ\ \circ- \Rightarrow \alpha_{21} = 0 \\ \text{if } \omega = \infty \rightarrow C: -\bullet- \Rightarrow \alpha_{21} = \frac{G_2}{G_1+G_2} \end{cases}$$

$\alpha_{22} = \frac{I_2}{V_2}\Big|_{I_1=0} \Rightarrow$



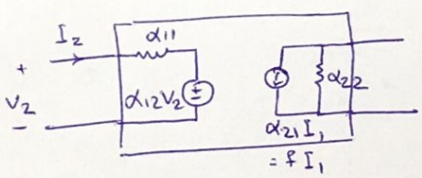
$\Rightarrow$

$$\begin{cases} \text{if } \omega = 0 \Rightarrow C: -\circ\ \circ- \Rightarrow \alpha_{22} = \frac{1}{R_3} \\ \text{if } \omega = \infty \Rightarrow C: -\bullet- \Rightarrow \alpha_{22} = \frac{1}{R_3 \| (R_1+R_2)} \end{cases}$$

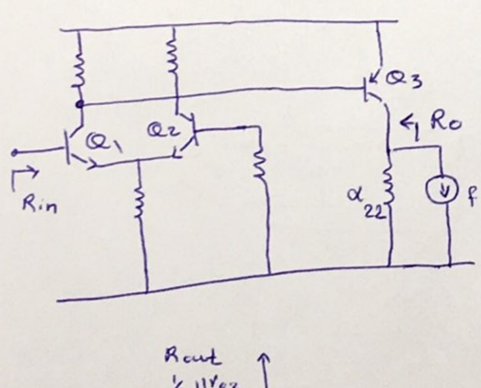
$$R_o = \frac{R_o|_{f=0}}{1+af}$$

$$R_{in} = R_{in}|_{f=0} \times (1+af)$$

$\Rightarrow$



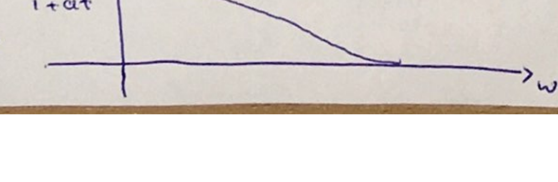
$\Rightarrow$



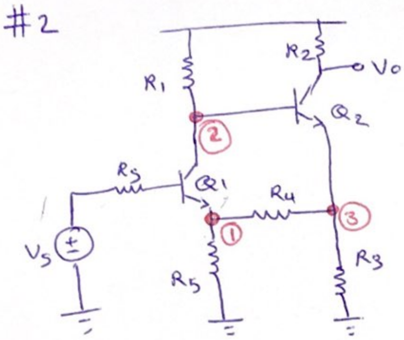
$$R_o|_{f=0} = \alpha_{22} \| r_{o3} \quad \begin{cases} \omega = 0 \rightarrow \frac{1}{R_3} \| r_{o3} \\ \omega = \infty \rightarrow \frac{1}{R_3 \| (R_1+R_2)} \| r_{o3} \end{cases}$$

$$\Rightarrow R_{out} = \frac{R_o|_{f=0}}{1+af} \rightarrow \begin{cases} \omega = 0 \quad \frac{(\frac{1}{R_3} \| r_{o3})}{1+af} \\ \omega = \infty = \frac{\frac{1}{\frac{1}{R_3} \| (R_1+R_2)} \| r_{o3}}{1+af} \end{cases}$$

$\Rightarrow$



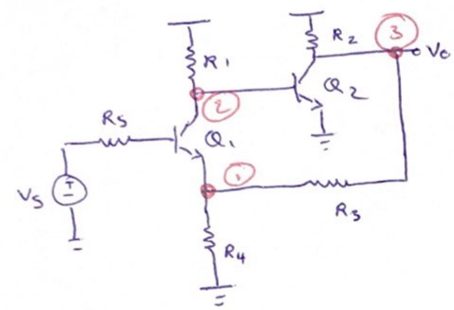
#2



if ① $\uparrow$ (+) => ② $\uparrow$ (+) => ③ $\uparrow$ (+)

=> ① $\uparrow$ (+) -> Positive feedback

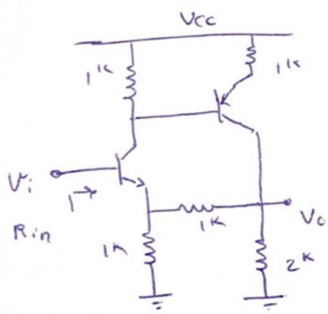
b)



if ① $\uparrow$ (+) => ② $\uparrow$ (+) => ③ $\downarrow$ (-)

=> ① $\uparrow$ (+) => negative feedback

#4

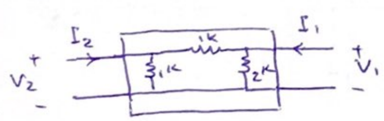


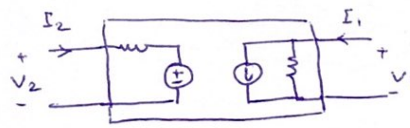
$\begin{cases} r_\pi = 1^K \\ \beta = 50 \end{cases}$

=> input — output

series — shunt

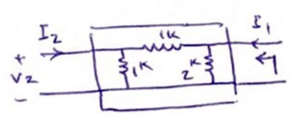
(V) — (V)

=> 



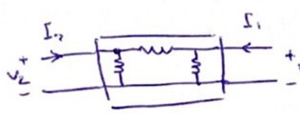
$$\begin{cases} I_1 = \alpha_{11} V_1 + \alpha_{12} I_2 \\ V_2 = \alpha_{21} V_1 + \alpha_{22} I_2 \end{cases}$$

$\alpha_{11} = \left.\dfrac{I_1}{V_1}\right|_{I_2=0}$:



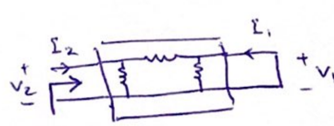
=> $\alpha_{11} = \dfrac{1}{2^K \| 2^K} = \dfrac{1}{1^K}$

$\alpha_{21} = f = \left.\dfrac{V_2}{V_1}\right|_{I_2=0}$:

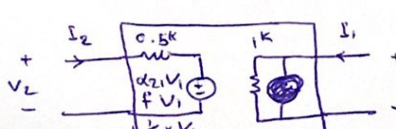


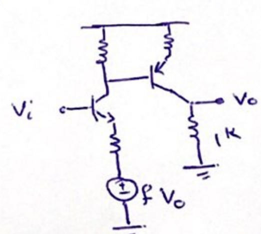
=> $\alpha_{21} = f = \dfrac{1^K}{1^K + 1^K + 2^K} = \dfrac{1}{4}$

$\alpha_{22} = \left.\dfrac{V_2}{I_2}\right|_{V_1=0}$:

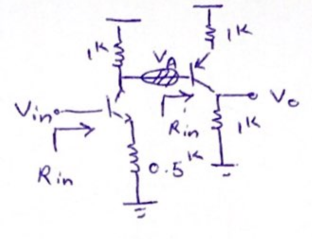


=> $\alpha_{22} = 1^K \| 1^K = 0.5^K$

=> 

=> 

$R_{in}|_{f=0}$:



$$R_{in}|_{f=0} = r_{\pi_1} + (\beta+1) R_{E_1}$$

$$= \underbrace{r_{\pi_1}}_{1^K} + 50\,(0.5^K) = 26^K$$

$\Rightarrow$ ~~R/f~~ $\quad a = \frac{V_o}{V_{in}}\Big|_{f=0} \Rightarrow \frac{V_o}{V_{in}} = \frac{V_o}{V_A} \times \frac{V_A}{V_{in}} = -g_{m_2} R_{c_2} \times \left(-g_{m_1} \times R_{c_1}\right)$

$= (-g_{m_2} \times 1^K) \times (-g_{m_1} \times 1^K \| R_{in}') = \left[-g_{m_2} \times 1^K\right] \times \left[-g_{m_1}\left(1^K \| (r_{\pi_2} + \beta R_{E_2})\right)\right]$

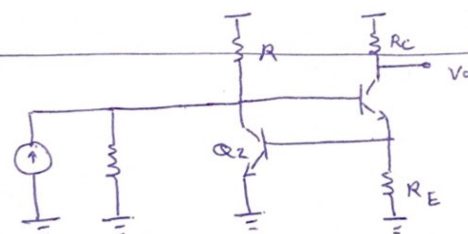
$\xrightarrow{g_{m_1} = g_{m_2} = 50^{mmho}} (-50 \times 1^K) \cdot (-50\,(1^K \| 51^K)) = 100 \Rightarrow A_v = \frac{V_o}{V_{in}} = \frac{a}{1+af} = \frac{100}{1 + \frac{1}{4}(100)}$

$A_v = 3.8$

$R_{in} = R_i|_{f=0} \times (1+af) = 26^K\,(1+25) = \boxed{676^K}$

$R_{out} = \frac{R_o|_{f=0}}{1+af} = \frac{1^K \| r_{o2}(1 + g_{m_2}(R_{E_2} \| r_{\pi_2}))}{1+25} = \frac{1^K \| 1040^K}{1+25} = \frac{1^K}{26} = \boxed{0.03^K}$

#5

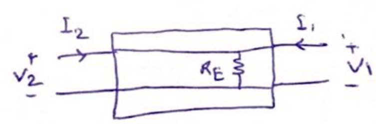


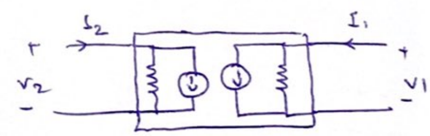
input – output

shunt ~~series~~ – shunt

I – V

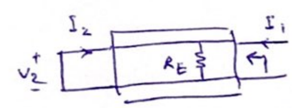
feed back network:





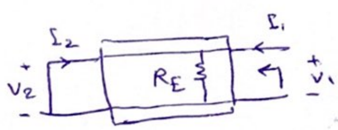
$$\begin{cases} I_1 = Y_{11} V_1 + Y_{12} V_2 \\ I_2 = Y_{21} V_1 + Y_{22} V_2 \end{cases}$$

$Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$:



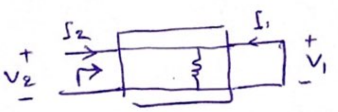
$Y_{11} = 0$

$Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$:



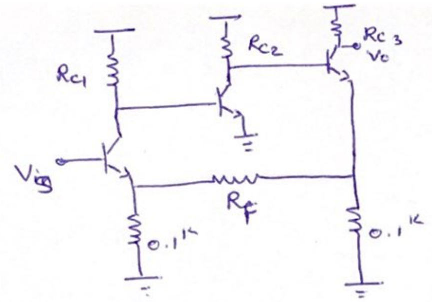
$Y_{21} = 0$

$Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$



$Y_{22} = 0$???

#6



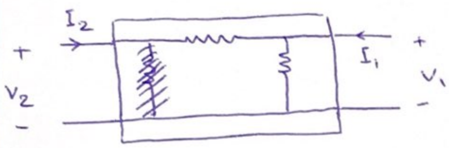
$\frac{i_o}{V_s} = 0.1$

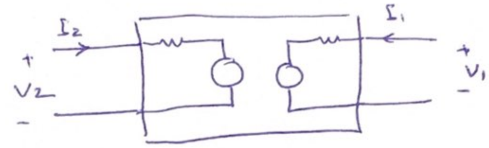
$a \gg 1 \Rightarrow A_v \approx \frac{1}{f}$

input - output

series - series

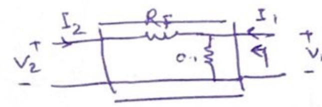
V - I





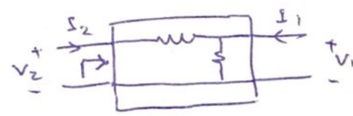
$\begin{cases} V_1 = Z_{11} I_1 + Z_{12} I_2 \\ V_2 = Z_{21} I_1 + Z_{22} I_2 \end{cases}$

$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$:



$\Rightarrow Z_{11} = 0.1^K$

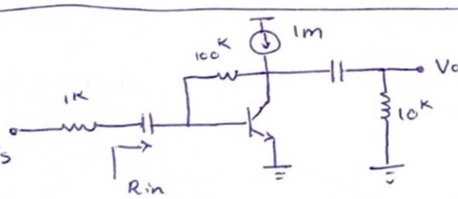
$Z_{21} = f = \frac{V_2}{I_1}\Big|_{I_2=0}$:



$Z_{21} = -(R_F + 0.1^K)$

$-(R_f + 0.1^K) = 0.1 \Rightarrow R_f = -0.2$

#7

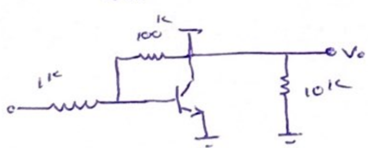


$\begin{cases} V_T = 25\,mV \\ \beta = 100 \end{cases}$ $\left(\frac{V_o}{V_s} = ?\right)$

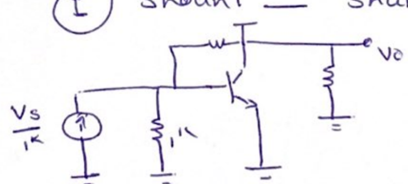
input — output

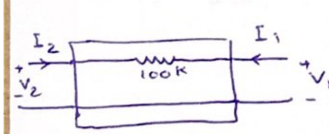
I shount — shunt V

ac :



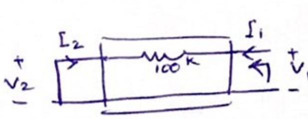
$\equiv$





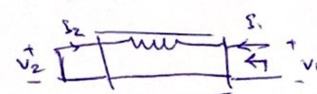
$\begin{cases} I_1 = Y_{11} V_1 + Y_{12} V_2 \\ I_2 = Y_{21} V_1 + Y_{22} V_2 \end{cases}$

$Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$



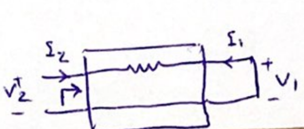
$= \frac{1}{100^K}$

$Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$:



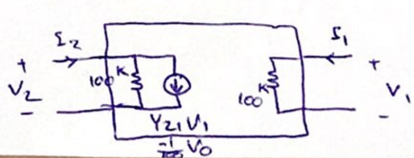
$= \frac{-1}{100^K}$

$Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$

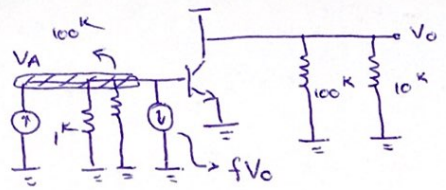


$= \frac{1}{100^K}$

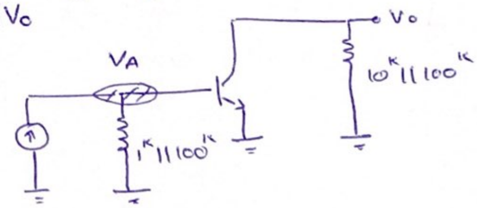
$\Rightarrow$



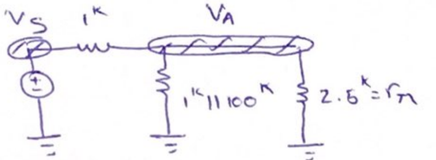
$\Rightarrow$



$a = \left.\dfrac{V_o}{V_A}\right|_{f=0}$:



$\dfrac{V_o}{V_A} = -g_m R_C = -40\,(10^K \| 100^K) \simeq -9$



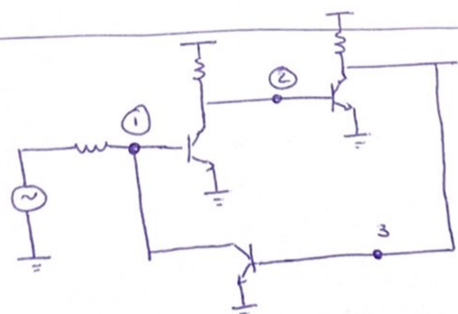
$\dfrac{V_A}{V_S} = \dfrac{2.5^K \| 1^K \| 100^K}{(2.5^K \| 100^K \| 1^K) + 1^K} = \dfrac{0.7^K}{1.7} = \cancel{0.04} \Rightarrow$

$\Rightarrow a = \left.\dfrac{V_o}{V_S}\right|_{f=0} = 0.4(-9) = -3.6 \Rightarrow A = \dfrac{V_o}{V_S} = \dfrac{a}{1+af} = \dfrac{\cancel{0.4}\,-3.6}{1+0.4\left(-\frac{1}{100}\right)} = \dfrac{-3.6}{1.004} = -3.5$

$R_{in} = \dfrac{R_i|_{f=0}}{1+af} = \dfrac{1^K \| 100^K \| 2.5^K}{1+0.036} = 0.6 \Rightarrow \cancel{\underbrace{R_S + R_{in}}_{1^K \| 100^K \| 2.5^K = 0.7} = 0.6^K \Rightarrow R_{in} =}$

$R_{in} = 100^K \| 2.5^K = 2.43^K$

#9



if ① ↑ (+) → ② ↓ (−) ⇒ ③ ↑ (+)

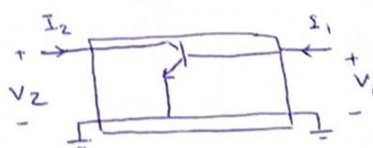
⇒ ① ↓ (−) ⇒ negative feedback

input — output

series — shunt

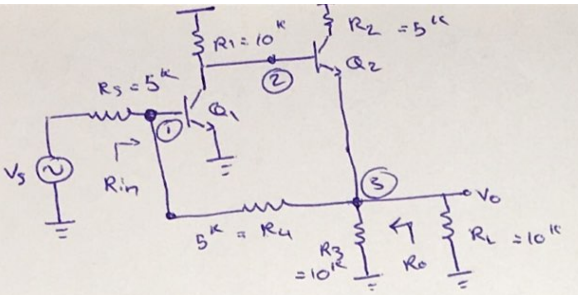
Ⓥ — Ⓥ

feedback network ?



$\Rightarrow$

8



$\beta = 100$

$g_m = 40$ mmho

$V_A = \infty$

$V_{cc} = 10v$

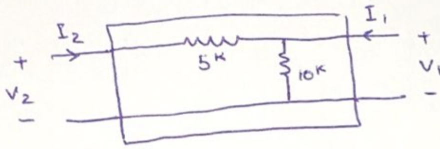
if ① ↑ (+) ⟶ ② ↓ (−) ⟶ ③ ↓ (−) ⟶ ① ↓ (−)

input — output

series — shunt

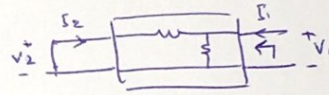
V — V

feedback network:



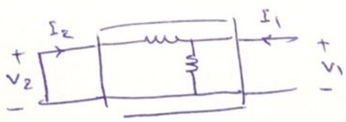
$$\begin{cases} V_1 = \alpha_{11} I_1 + \alpha_{12} V_2 \\ I_2 = \alpha_{21} I_1 + \alpha_{22} V_2 \end{cases}$$

$\alpha_{11} = \frac{V_1}{I_1}\Big|_{V_2 = 0}$:



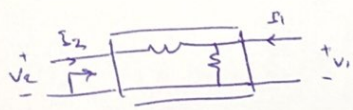
$\alpha_{11} = 5^k \| 10^k = 3.3^k$

$\alpha_{21} = \frac{I_2}{I_1}\Big|_{V_2 = 0} = f$



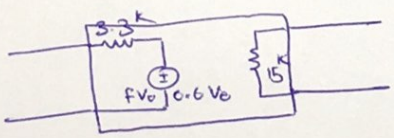
$\alpha_{21} = \dfrac{\frac{1}{5^k}}{\frac{1}{5^k} + \frac{1}{10^k}} = -0.6$

$\alpha_{22} = \frac{I_2}{V_2}\Big|_{I_1 = 0}$

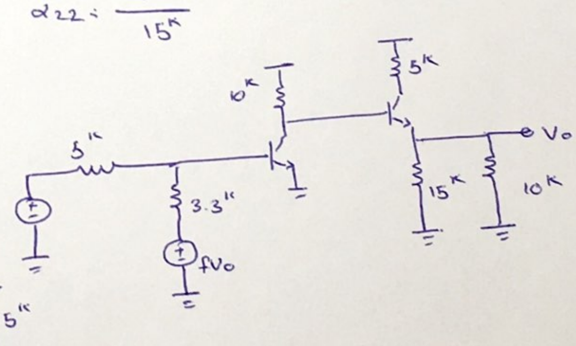


$\alpha_{22} = \frac{1}{15^k}$

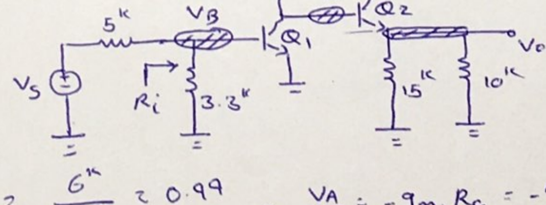
$\Rightarrow$



$\Rightarrow$



$a = \frac{V_o}{V_i}\Big|_{f=0}$ $\Rightarrow$



$\frac{V_o}{V_s} = \frac{V_o}{V_A} \times \frac{V_A}{V_B} \times \frac{V_B}{V_s}$

$\frac{V_o}{V_A} = \dfrac{10^k \| 15^k}{(10^k \| 15^k) + \frac{1}{40}} = \frac{6^k}{6.025} = 0.99$, $\frac{V_A}{V_B} = -g_m . R_c = -40\left(10^k \| (2.5 + 100(10^k \| 15^k))\right) = -400$

$\Rightarrow \frac{V_B}{V_s} = \dfrac{3.3^k \| 2.5}{5^k + (3.3^k \| 2.5^k)} = \frac{1.42}{6.42} = 0.22$ $\Rightarrow \frac{V_o}{V_s} = 0.99 . (-400) \times 0.22 = -88 = a$

$\frac{V_{out}}{V_s} = \frac{a}{1 + af} = \frac{-88}{1 + 52.8} = -1.63$

$R_i = R_i\big|_{f=0}$: $R_i = 2.5^k \| 3.3^k \approx 1.42^k \Rightarrow R_{in} = R_i\big|_{f=0} \times (1+af)$

$\Rightarrow R_{in} = 1.42\,(1+52.8) = 76.39$

$R_{out} = \dfrac{R_o\big|_{f=0}}{1+af} \Rightarrow R_o\big|_{f=0} = 10^k \| 15^k \| \dfrac{2.5^k + (10^k \| \infty)}{100} = 0.124^k$

$\Rightarrow R_{out} = \dfrac{0.124^k}{1+52.8} \approx 0.0023^k$