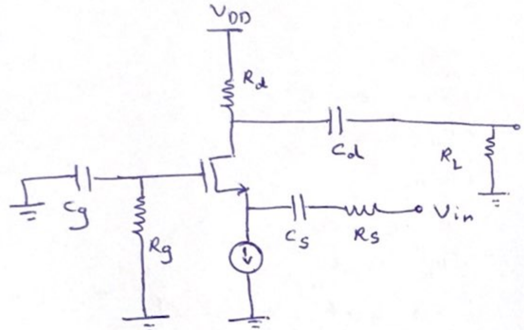
یا لطیف

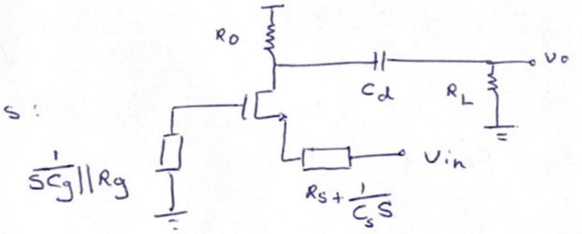
رضا ادینه پور
۹۸۱۴۳۰۳
تمرین سری ۱ الک ۳

#1



$r_o = \infty$
$g_m = 10$ mmho
$R_d = R_L = 5^K$
$R_g = 2^K$
$R_S = 100 = 0.1^K$
$C_d = 2\mu F$
$C_g = 1\mu F$
$C_s = 5\mu F$

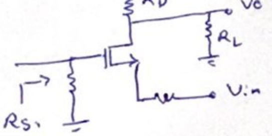
=> AC Analysis:



$$A_v = + g_m (R_D \| r_o) = g_m \left(R_D \| (C_d + R_L) \right) \Rightarrow \frac{V_o}{V_i} = A_v = g_m \cdot \left[R_D \| \frac{1}{C_d S} + R_L \right]$$

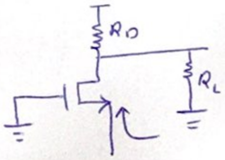
$$\omega_L = \sum_{i=1}^{n} \frac{1}{C_i R_{is}} = \frac{1}{\tau_1} + \frac{1}{\tau_2} + \frac{1}{\tau_3} = \frac{1}{R_{S_1} C_g} + \frac{1}{R_{S_2} C_S} + \frac{1}{R_{S_3} C_d}$$

R_{S_1} :



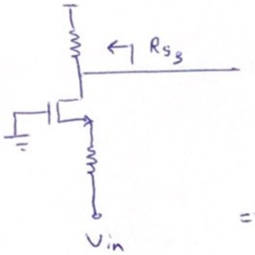
$$\boxed{R_{S_1} = R_g = 2^K}$$

R_{S_2} :



$$R_{S_2} = 0.1^K + \frac{1}{g_m} = \underline{0.2^K}$$

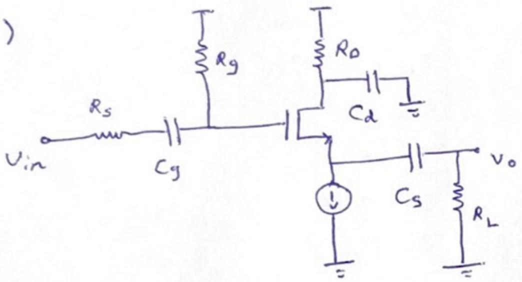
R_{S_3} :



$$R_{S_3} : R_D \parallel \overset{=\infty}{\hat{r_o}} (1+g_m R_S) = \boxed{R_D = 5^k}$$

$$\Rightarrow f_L = \frac{\omega_L}{2\pi} = \frac{1}{2\pi} \cdot \left[\frac{1}{2^k \times 1^\mu} + \frac{1}{0.2^k \times 5^\mu} + \frac{1}{5^k \times 2^\mu} \right] = \boxed{254 \text{ HZ}}$$

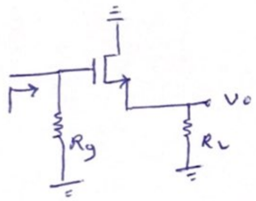
b)



$$\begin{cases} r_o = \infty \\ g_m = 10 \text{ mmho} \\ R_d = 200\ \Omega \\ R_g = 2^k \\ R_s = 500\ \Omega \\ R_L = 100\ \Omega \\ C_d = 2\ \mu F, \quad C_g = 2\ \mu F, \quad C_s = 2\ \mu F \end{cases}$$

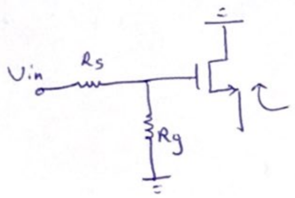
$$f_L = \frac{1}{2\pi} \sum_{i=1}^{n} \frac{1}{\tau_i} = \frac{1}{2\pi} \cdot \left[\frac{1}{R_{S_1} C_g} + \frac{1}{R_{S_2} C_S} + \frac{1}{R_{S_3} C_d} \right]$$

R_{S_1} :



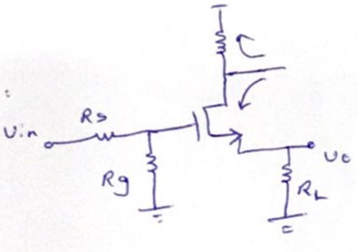
$$R_{S_1} = R_S + R_g = \boxed{2.5^k}$$

R_{S_2} :



$$R_{S_2} = R_L \parallel \frac{1}{g_m} = 100\,\Omega \parallel 100^\Omega = 50^\Omega = \cancel{0.005}\ \boxed{0.05^k}$$

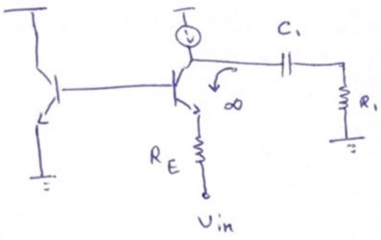
R_{S_3} :



$$R_{S_3} = R_D \parallel \infty = 0.2^k$$

$$\Rightarrow f_L = \frac{1}{2\pi} \cdot \left[\frac{1}{2.5^k \cdot 2^\mu} + \frac{1}{0.05^k \cdot 2^\mu} + \frac{1}{0.2^k \times 2^\mu} \right] \simeq 2.02^{\text{KHZ}}$$

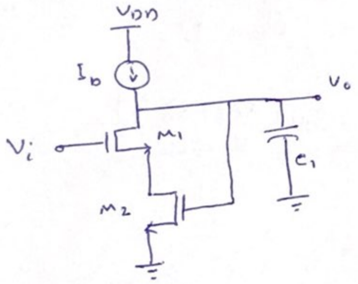
c)



$I_c = 1^{mA}$
$C_1 = 5\ \mu F$
$R_E = 50\ \Omega$
$R_1 = 100\ \Omega$

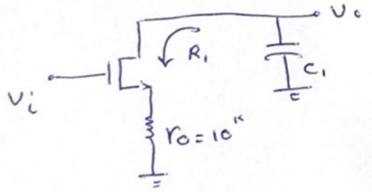
$$R_t = R_1 \cancel{8} = 0.1^k \Rightarrow f_L = \frac{1}{2\pi}\left(\frac{1}{0.1^k \times 5^\mu}\right) = \boxed{318^{\ HZ}}$$

d)



$I_b = 1^{mA} \longrightarrow g_m = \frac{2I_D}{V_{ov}} = \frac{2}{0.2} = 10^{mmho}$
$C_1 = 2\ \mu F$
$V_{ov} = 0.2^v$
$\lambda = 0.1 \Rightarrow r_o = \frac{1}{\lambda I_D} = \frac{1}{0.1} = \boxed{10^k}$

=>

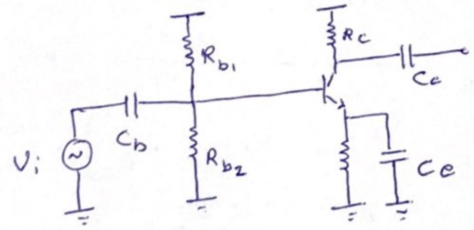


$$R_1 = r_o(1 + g_m r_o) = 10^k \cdot \left[1 + 10^m \times 10^k\right] = \boxed{1000^k}$$

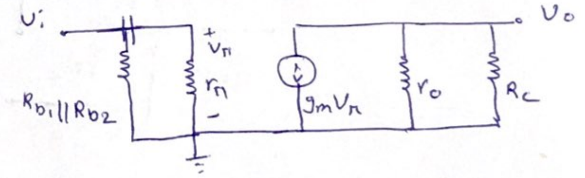
$$\Rightarrow f_2 = \frac{1}{2\pi}\left[\frac{1}{1000^k \times 5^\mu}\right] = 30^{\ mHZ}$$

#2

a)



=>

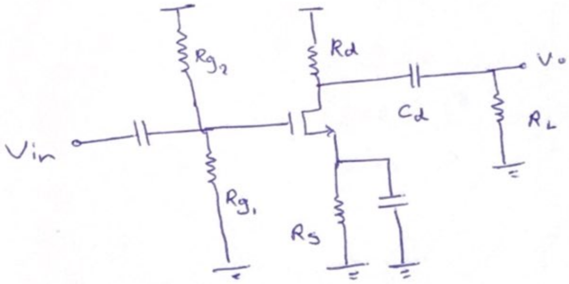


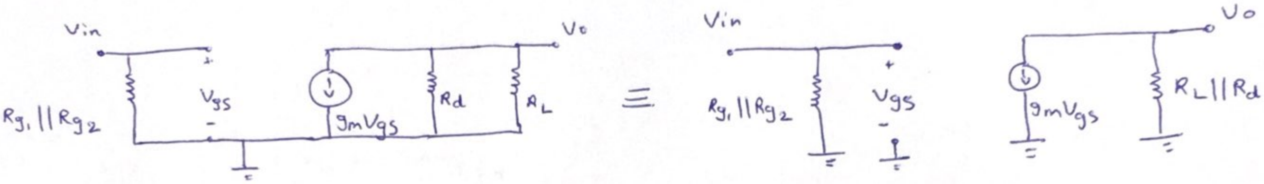
در مدل ac
خازن‌ها
اتصال کوتاه
می‌شوند :

$$V_o = -g_m V_\pi (R_c || r_o)$$

$$\xrightarrow{V_\pi = V_{in}} \frac{V_o}{V_{in}} = -g_m (r_o || R_c)$$

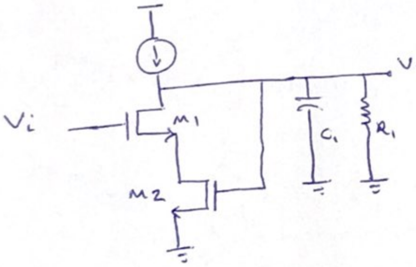
b)

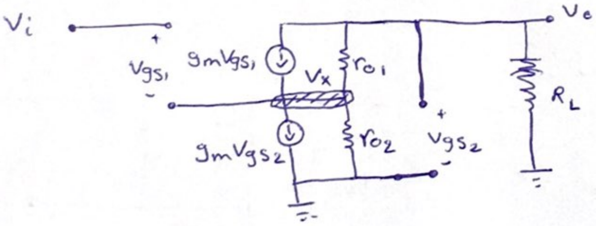




$$V_o = -g_m V_{gs} (R_L || R_d) \xrightarrow{V_{gs} = V_{in}} \frac{V_o}{V_{in}} = \underline{\boxed{A_{v_o} = -g_m (R_L || R_d)}}$$

c)





kcl in V_x: $-g_m V_{gs_1} + g_m V_{gs_2} + \frac{V_x - V_o}{r_{o_1}} + \frac{V_x - 0}{r_{o_2}} = 0$

$$\xrightarrow{V_{gs_2} = V_o} V_x \left[\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}} \right] = \frac{V_o}{r_{o_1}} + g_m V_{gs_1} - g_m V_o$$

$$\Rightarrow V_x = \frac{V_o \left(\frac{1}{r_{o_1}} - g_m \right) + g_m V_{gs_1}}{\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}}}$$

kcl in V_o:

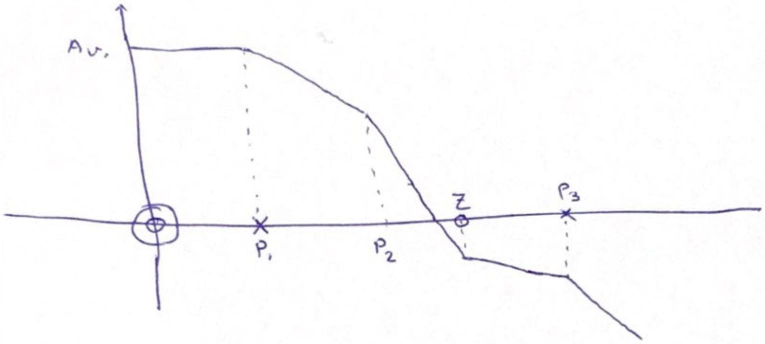
$$\frac{V_o}{R_L} + \frac{V_o - V_x}{r_{o_1}} + g_m V_{gs_1} = 0$$

$$\xrightarrow{V_{gs_1} = V_i} \frac{V_o}{R_L} + \frac{V_o}{r_{o_1}} - \frac{1}{r_{o_1}} \left(\frac{V_o \left(\frac{1}{r_{o_1}} - g_m \right) + g_m V_i}{\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}}} \right) + g_m V_i = 0$$

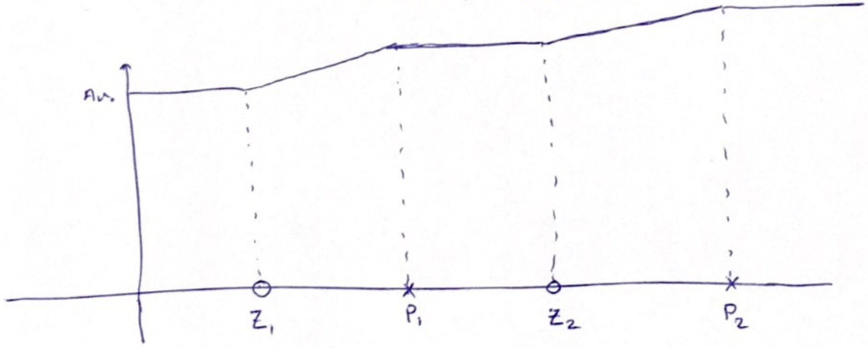
$$\Rightarrow \frac{V_o}{V_i} = A_{v_o} = \frac{\frac{g_m}{\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}}} - g_m}{\frac{1}{R_L} + \frac{1}{r_o} - \frac{\frac{1}{r_{o_1}^2}}{\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}}} + \frac{\frac{g_m}{r_{o_1}}}{\frac{1}{r_{o_1}} + \frac{1}{r_{o_2}}}}$$

#3

a) $A_v(s) = A_{v_0} \cdot \dfrac{s^2(s+Z)}{(s+P_1)(s+P_2)(s+P_3)}$ $(P_1 < P_2 < Z < P_3)$



b) $A_v(s) = A_{v_0} \cdot \dfrac{(s+Z_1)\cdot(s+Z_2)}{(s+P_1)\cdot(s+P_2)}$ $(Z_1 < P_1 < Z_2 < P_2)$



c) $A_v(s) = A_{v_0} \cdot \dfrac{s(s+50)(s+100)}{(s+25)(s+75)(s+150)}$