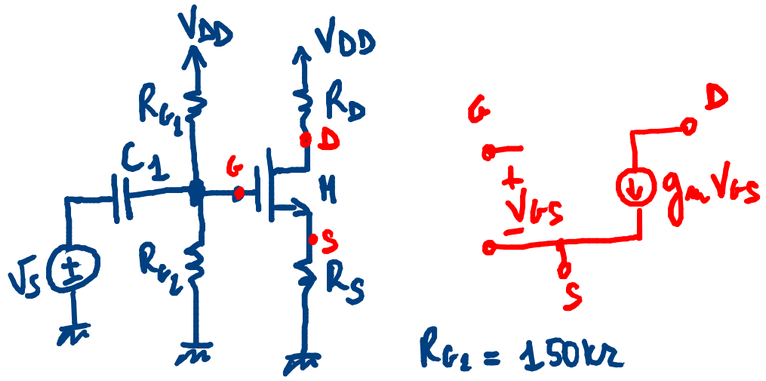


$R_{G1} = 150k\Omega$

$R_{G2} = 50k\Omega$

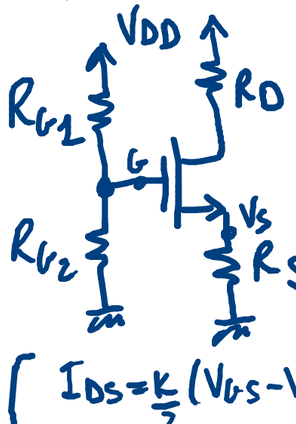
$R_D = 4k\Omega$

$R_S = 1k\Omega$

$V_{DD} = 12V$

$k = \mu_n C_{ox} \frac{W}{L} = 2 mA/V^2$

$k = \mu_n C_{ox} \frac{W}{L} = 2 mA/V^2$



$V_T = 1V$

$V_G = \frac{R_{G2}}{R_{G1}+R_{G2}} V_{DD} = 3V$

Ip. sat.: $I_{DS} = \frac{k}{2}(V_{GS} - V_T)^2$

$$\begin{cases} I_{DS} = \frac{k}{2}(V_{GS} - V_T)^2 \\ V_G = V_{GS} + R_S I_{DS} \end{cases}$$

$\frac{R_S}{2} k V_{GS}^2 - R_S k V_{GS} V_T + V_{GS} + \frac{R_S}{2} k V_T^2 = 0$

$V_{GS}^2 - V_{GS} \cdot 2 = 0 \Rightarrow V_{GS} = \begin{cases} -1V & NO \\ 2V & OK \end{cases}$

$\boxed{V_{GS} \geq V_T}$

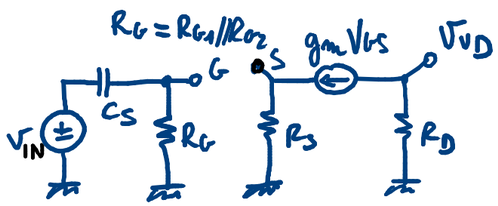
$I_{DS} = 1 mA$

$V_{DS} = V_D - V_S = \underbrace{V_{DD} - R_D I_{DS}}_{V_D} - \underbrace{R_S I_{DS}}_{V_S} =$

$= 7V$

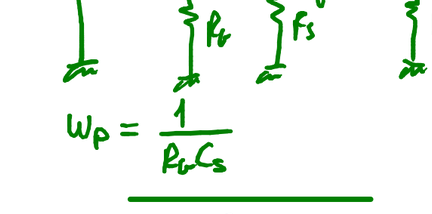
$V_{DS} = 7V \geq V_{GS} - V_T = 1V$ OK Sat

$g_m = \frac{\delta I_{DS}}{\delta V_{GS}} = k(V_{GS} - V_T) = 2 mS$



$$A_D = \frac{V_{OUT}}{V_{IN}} = \frac{A_{D\infty} S}{(S+\omega_P)} \qquad \omega_P = \frac{1}{C_S R_{VCS}}$$

$\lim_{S \to +\infty} A_D(S) = A_{D\infty}$



$V_G = V_{IN} \qquad V_{OUT} = -R_D g_m V_{GS}$

$V_{GS} = V_G - V_S$

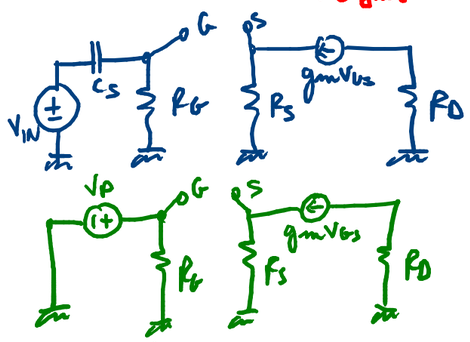
$V_S = R_S g_m V_{GS}$

$V_{GS} = V_G - R_S g_m V_{GS}$

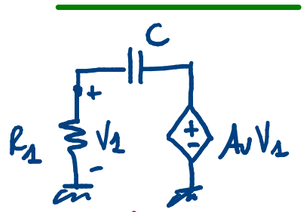
$$V_{GS} = \frac{V_G}{1+R_S g_m} = \frac{V_{IN}}{1+R_S g_m}$$

$$V_{OUT} = \frac{-R_D g_m V_{IN}}{1+R_S g_m}$$

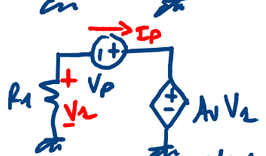
$$A_{D\infty} = \frac{V_{OUT}}{V_{IN}} = \frac{-R_D g_m}{1+R_S g_m} \overset{R_S g_m \gg 1}{\approx} -\frac{R_D}{R_S}$$



$$\omega_P = \frac{1}{R_G C_S}$$



R_{VC} ?

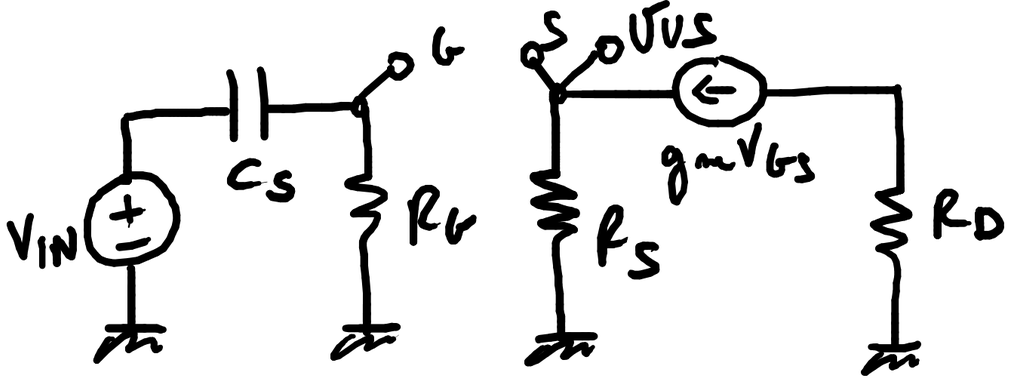


$V_P = R_1 I_P + A_V V_1$

$V_1 = -R_1 I_P$

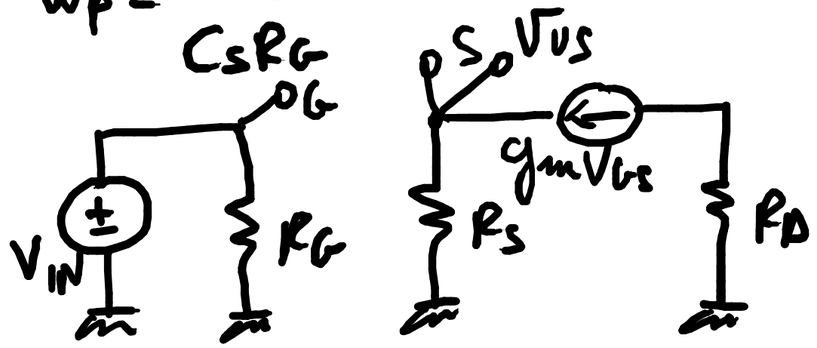
$V_P = R_1 I_P - A_V R_1 I_P$

$V_P / I_P = R_1 (1 - A_V)$



$$A_{VS}(s) = \frac{A_{VS\infty}\, s}{(s + W_P)}$$

$$W_P = \frac{1}{C_S R_G}$$

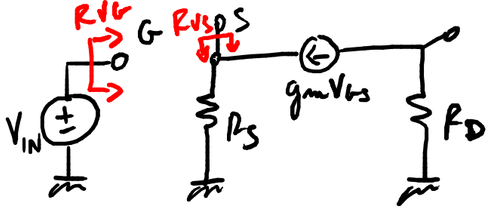


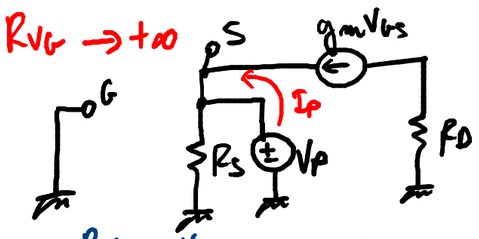
$$A_{VS\infty} = \frac{V_{US}}{V_{IN}}$$

$$V_{US} = R_S g_m V_{GS}$$

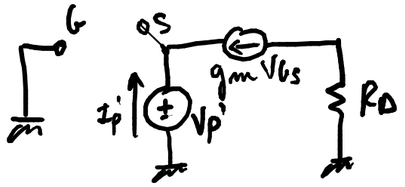
$$V_{GS} = \frac{V_G}{1 + R_S g_m} \Rightarrow V_{US} = \frac{R_S g_m}{1 + g_m R_S} V_{IN}$$

$$A_{VS\infty} = \frac{R_S g_m}{1 + R_S g_m} \overset{R_S g_m \gg 1}{\underline{\approx}} 1$$





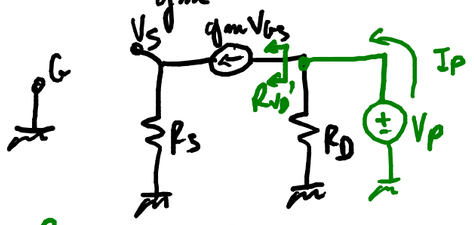
$$R_{VS} = \frac{V_P}{I_P} = R_S \,//\, R_{VS}'$$



$$R_{VS}' = \frac{V_P'}{I_P'} \Rightarrow I_P' = -g_m V_{GS}$$

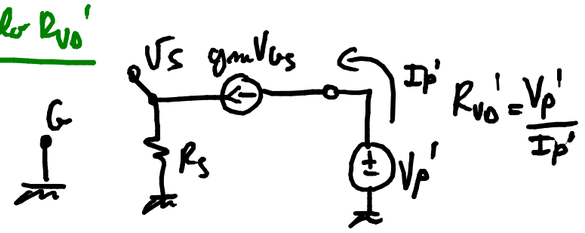
$$V_{GS} = -V_P' \Rightarrow I_P' = g_m V_P'$$

$$R_{VS}' = \frac{1}{g_m} \Rightarrow R_{VS} = R_S \,//\, \frac{1}{g_m}$$



$$R_{VD} = \frac{V_P}{I_P} = R_D \,//\, R_{VD}'$$

Calcolo R_{VD}'



$$I_P' = g_m V_{GS}$$

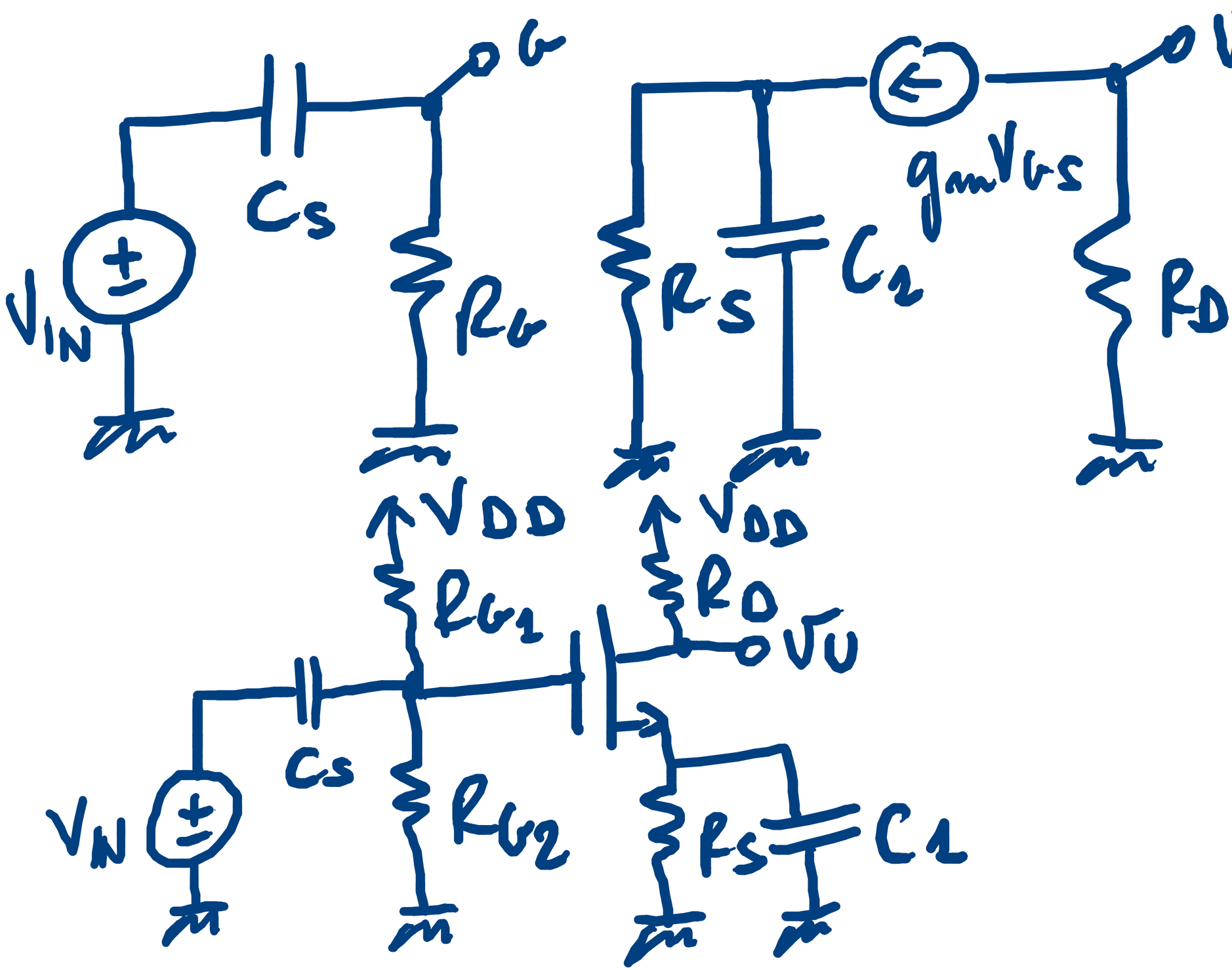
$$V_{GS} = V_G - V_S \qquad V_S = R_S g_m V_{GS}$$

$$V_G = 0V$$

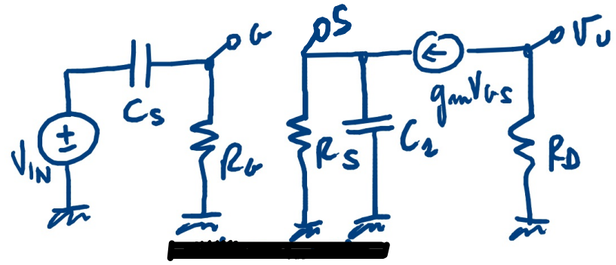
$$V_{GS} = -R_S g_m V_{GS} \Rightarrow V_{GS} = 0V$$

$$I_P' = 0A \Rightarrow R_{VD}' \to +\infty$$

$$\boxed{R_{VD} = R_D}$$

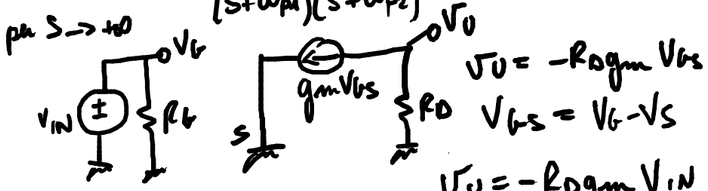


$$A_{V_{DD}} = -\frac{g_m R_D}{1 + g_m R_S}$$



$$A_V(s) = \frac{A_{V0}\, s\,(s+\omega_0)}{(s+\omega_{P1})(s+\omega_{P2})}$$

per $s \to +0$



$V_U = -R_D g_m V_{GS}$

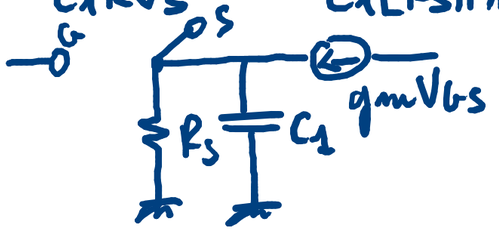
$V_{GS} = V_G - V_S$

$V_U = -R_D g_m V_{IN}$

$$A_{V0} = -R_D g_m$$

$$\omega_{P1} = \frac{1}{C_S R_{VCS}} = \frac{1}{C_S R_G}$$

$$\omega_{P2} = \frac{1}{C_1 R_{VS}} = \frac{1}{C_1[R_S \| 1/g_m]}$$



$$V_{GS} = V_G - V_S = V_G - Z_S\, g_m V_{GS}$$

$$Z_S = R_S \| \frac{1}{C_1 s}$$

$$V_{GS} = V_G - Z_S(S_0)\, g_m V_{GS}$$

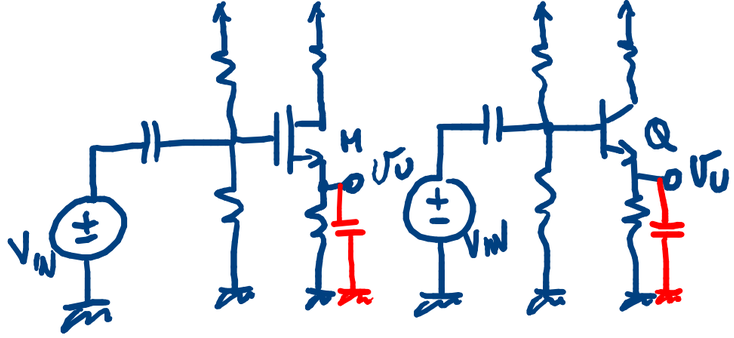
Se $Z_S(s_0) \to +\infty$

$$V_{GS} \simeq -Z_S(s_0)\, g_m V_{GS}$$

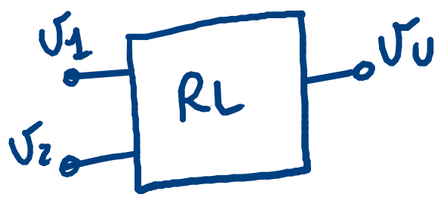
$V_{GS} = 0\,V \Rightarrow V_U = ? = -R_D g_m V_{GS}$

$V_U = 0\,V$

$$S_0 = -\frac{1}{R_S C_1} \Rightarrow \omega_0 = \frac{1}{R_S C_1}$$



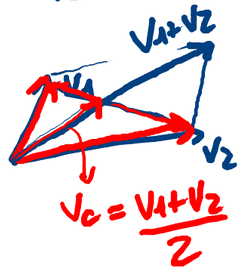
$$h_{fe} = \frac{\Delta I_C}{\Delta I_B}$$



$$V_U = A_1 V_1 + A_2 V_2$$

$$\begin{cases} V_d = V_1 - V_2 \\ V_c = \frac{V_1 + V_2}{2} \end{cases} \Rightarrow V_1 = V_d + V_2 \qquad V_c = \frac{V_d + V_2 + V_2}{2}$$

$$V_c = \frac{V_d}{2} + V_2 \Rightarrow \begin{cases} V_2 = V_c - \frac{V_d}{2} \\ V_1 = V_c + \frac{V_d}{2} \end{cases}$$



$$V_U = A_1\left(V_c + \frac{V_d}{2}\right) + A_2\left(V_c - \frac{V_d}{2}\right) =$$

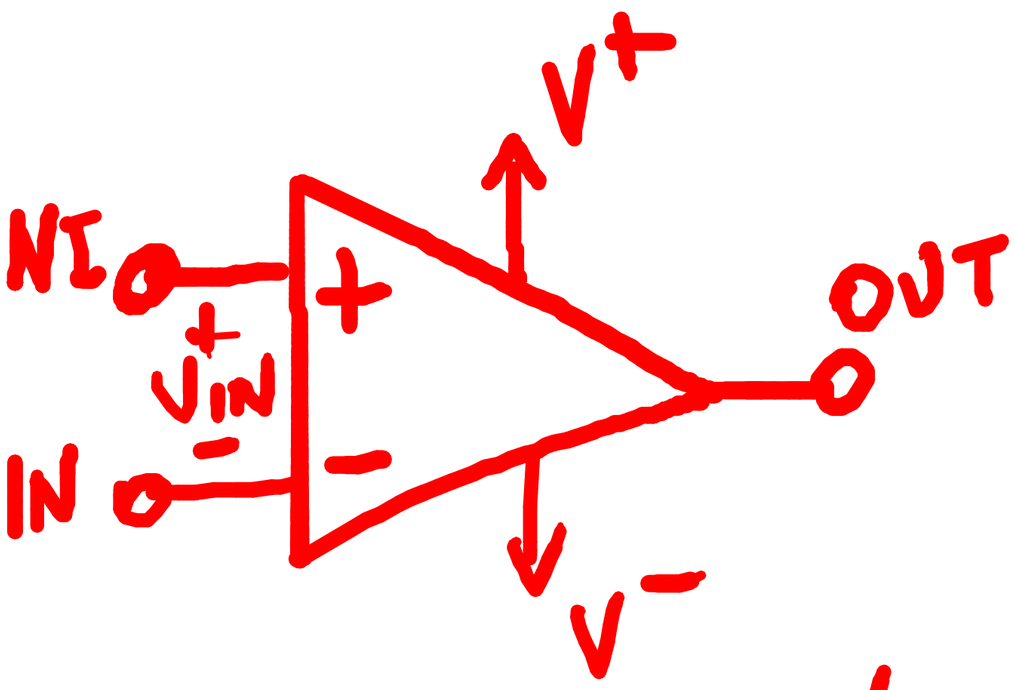
$$= \left[\frac{A_1 - A_2}{2}\right] V_d + (A_1 + A_2) V_c$$

A_d A_c

$$V_U = A_d V_d + A_c V_c$$

$$CHRR = \frac{A_d}{A_c} \gg 1$$

COMMON MODE REJECTION RATIO



$$V_U = A_{VOL} \phi V_{IN}$$