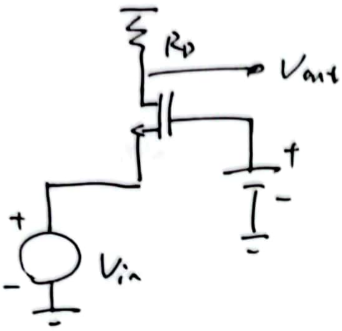
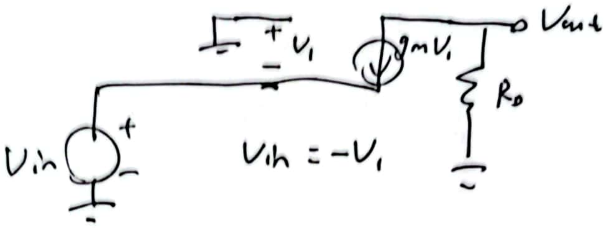
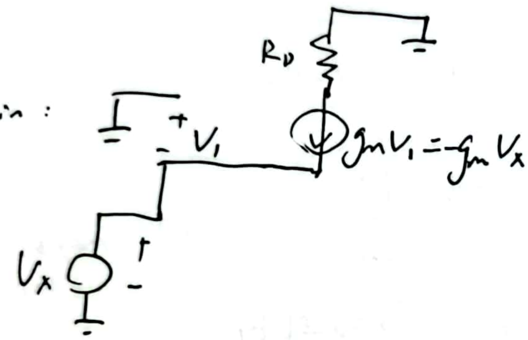
Small-Signal Properties ($\lambda=0$)





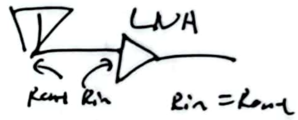
$$\Rightarrow \frac{V_{out}}{R_D} = -g_m V_1 = g_m V_{in} \Rightarrow A_v = g_m R_D$$

R_{in}:



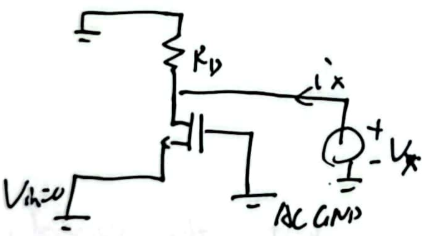
$i_x - g_m V_x = 0 \Rightarrow R_{in} = \frac{1}{g_m}$ 低阻抗

Application:



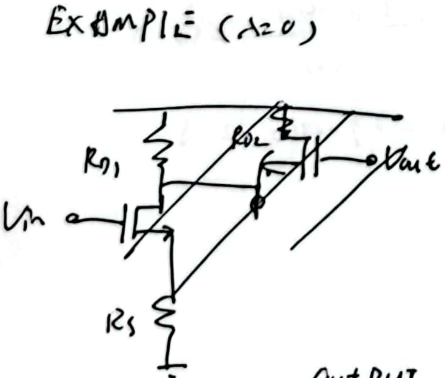
可用于阻抗匹配，如天线
~~天线~~的输入阻抗为50Ω.

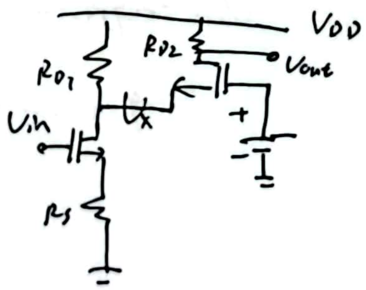
R_{out}:



$R_{out} = R_D$.

EXAMPLE ($\lambda=0$)



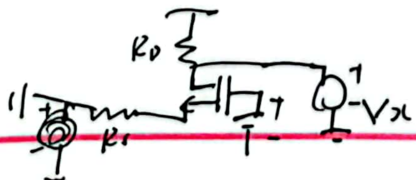


$$-\frac{R \text{ tied bet AC ground and Drain}}{\frac{1}{g_m} + S \text{ and ACG}}$$

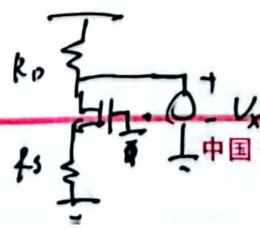
$$\frac{V_{out}}{V_{in}} = \frac{V_x}{V_{in}} \cdot \frac{V_{out}}{V_x}$$

$$= -\frac{R_{D1} \| \frac{1}{g_{m1}}}{\frac{1}{g_{m1}} + R_S} g_{m2} R_{D2}$$

Output Resistance of CG Stage in a special Case $\lambda \neq 0$



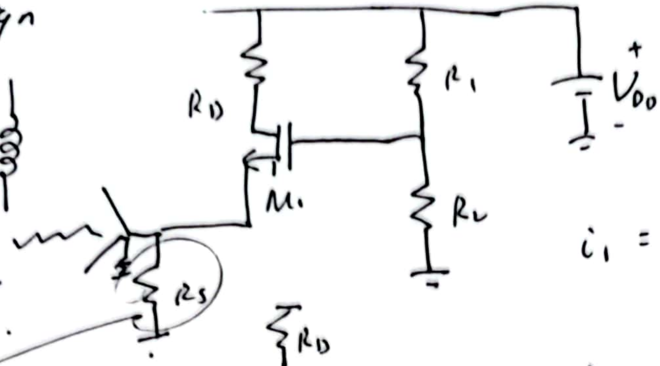
R



$$R_{out} = R_D \| [(1+g_m r_O)R_S + r_O]$$

Bias Design

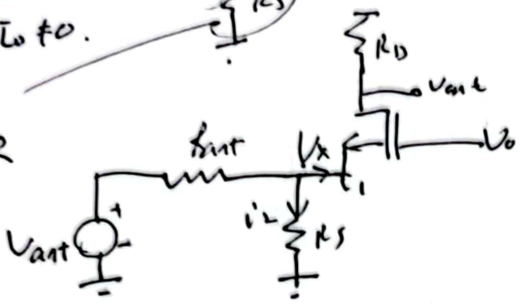
3种可以流过电流的元件，让 $I_D \neq 0$.

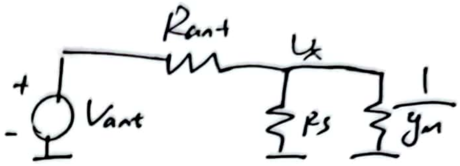


in this case
we choose R

$$i_1 = \frac{R_s}{R_s + \frac{1}{g_m}} i_{ant}$$

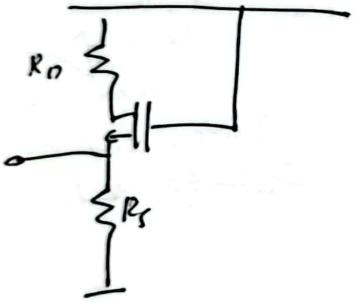
$\therefore R_s \gg \frac{1}{g_m}$ is better





$$\frac{V_{out}}{V_{ant}} = \frac{V_x}{V_{ant}} \cdot \frac{V_{out}}{V_x} = \frac{R_s \parallel \frac{1}{g_m}}{R_{ant} + R_s \parallel \frac{1}{g_m}} \cdot g_m R_D$$

Example



$R_{smax} = \frac{V_{DD} - V_{GS}}{I_D} = 370\Omega$. maybe not satisfy $R_s \gg \frac{1}{g_m}$

To ensure sat. $I_D R_D \le V_{TH}$.

choose $R_D = 500\Omega$

$A_v = g_m R_D = 1.6$.

if Double $\frac{W}{L}$. $A_v \uparrow$, but the speed $\downarrow$

$V_{GS} = 0.95V \Rightarrow R_s = \frac{V_{DD} - V_{GS}}{I_D} = 550\Omega$

$g_m = 4.5mS \Rightarrow g_m R_D = 2.3$