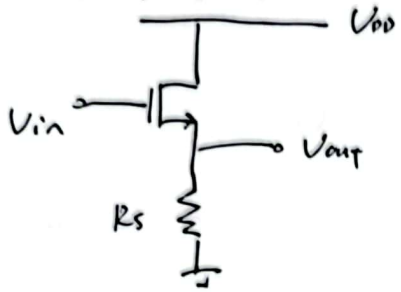
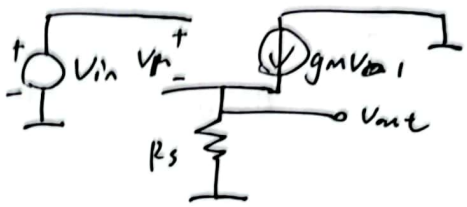
Source Follower



$\lambda = 0$ $\Longrightarrow$

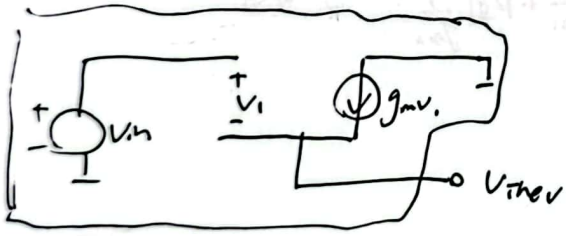


$$V_{in} = V_1 + V_{out}$$

$$\therefore A_V = \frac{\text{Resistance tied between S\&Gnd}}{\frac{1}{g_m} + R \text{ tied bet S\&GND}} \frac{V_{out}}{R_s} = g_m V_1 = g_m (V_{in} - V_{out}) \Rightarrow A_V = \frac{R_s}{\frac{1}{g_m} + R_s}$$

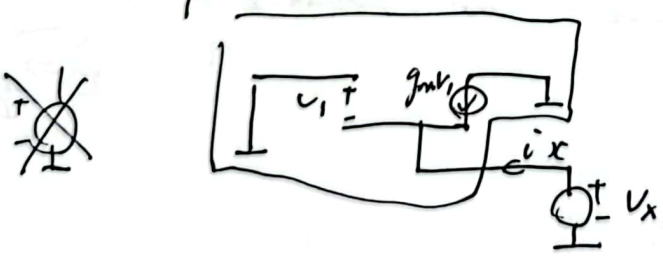
Alternative Analysis

Thevenin Equivalent

① 

$g_m V_1 = 0 \Rightarrow V_1 = 0 \Rightarrow V_{in} = V_{thev}$

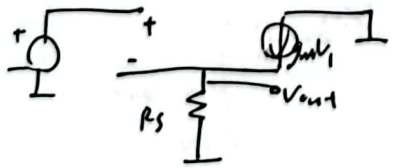
② kill the indepent source to calculate the input impedence

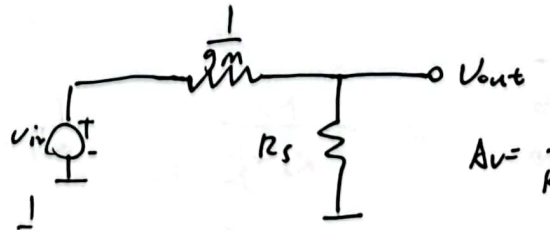


$i_x = -g_m V_1$

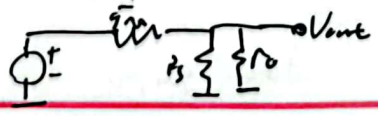
$V_1 = -V_x$

$\therefore R_x = \frac{V_x}{i_x} = \frac{-V_1}{-g_m V_1} = \frac{1}{g_m}$

$\therefore$ 

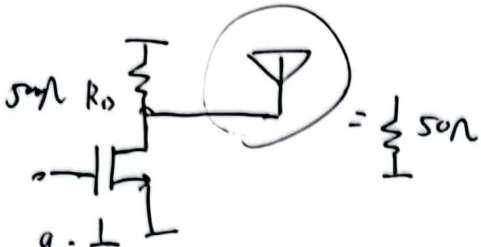
$\Rightarrow$ 

$$A_V = \frac{R_s}{R_s + \frac{1}{g_m}}$$

若 $\lambda \neq 0$, $r_o > 0$. 

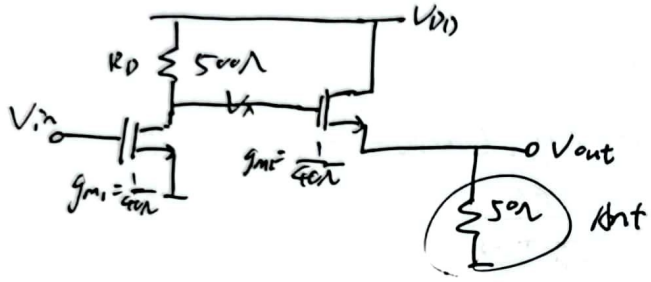
$$A_V = \frac{R_s \| r_o}{R_s \| r_o + \frac{1}{g_m}} \qquad R_{out} = \frac{1}{g_m} \| R_s \| r_o$$

Application of Source Follower



$A_V = -\frac{R_D}{\frac{1}{g_m}} = -12.5$ ⟹ add ant $A_V = -\frac{1}{40\Omega}(50\Omega \| 500\Omega) = -1.14$

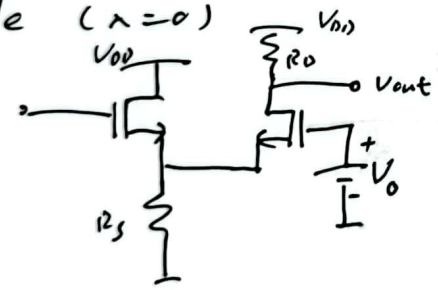
A_V ↓ . we can add a SF to reduce the decrease



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

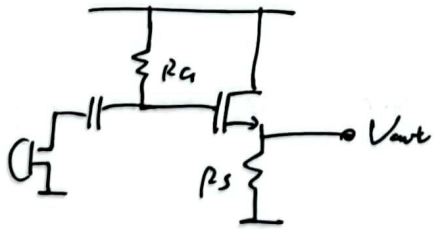
$= -12.5 \times \frac{R_S}{\frac{1}{g_{m2}} + R_S} = -6.9$

Example ($\lambda = 0$)

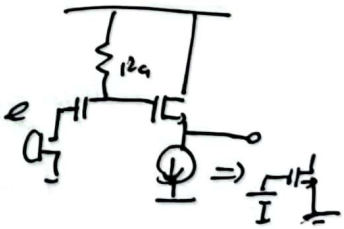


$A_V = \frac{R_S \| \frac{1}{g_{m2}}}{\frac{1}{g_{m1}} + R_S \| \frac{1}{g_{m2}}} \cdot g_{m2} R_D$

Bias Design

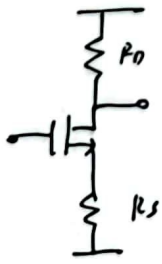


or , advance



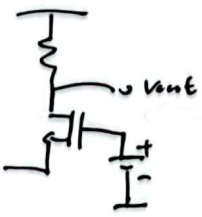
Summary $\lambda = 0$

CG



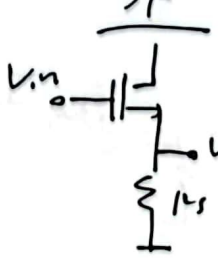
$A_V = -\frac{R_D}{R_S + \frac{1}{g_m}}$

CG



$A_V = g_m R_D$

SF



$A_V = \frac{R_S}{R_S + \frac{1}{g_m}}$