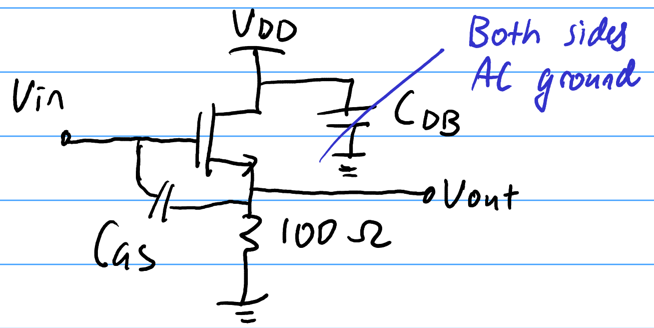
11.57 NMOS source follower must drive $100\ \Omega$ with $A_v = 0.8$. Given $I_D = 1$ mA, $\mu_n C_{ox} = 100\ \mu A/V^2$, $C_{ox} = 12\ fF/\mu m^2$, $L = 0.18\ \mu m$, $\lambda = 0$, $C_{GD} \approx 0$, $C_{SB} \approx 0$, $C_{GS} = \frac{2}{3} W L C_{ox}$. Find input capacitance.



Bias network not shown.

First find the required g_m. Recall that the gain of a source follower is

$$A_v = \frac{R_S}{1/g_m + R_S} \Rightarrow \frac{1}{g_m} = \frac{R_S}{A_v} - R_S$$

$$\frac{1}{g_m} = \frac{100}{0.8} - 100 = 25\ \Omega.$$

$$g_m = 40\ mS.$$

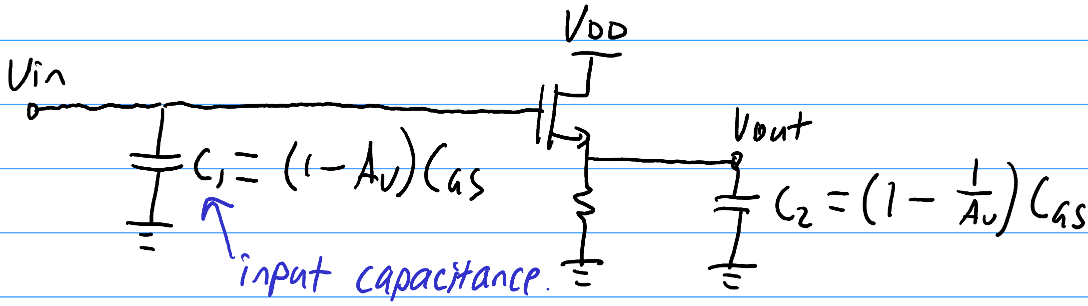
Since g_m and I_D are fixed, we can solve for $\frac{W}{L}$.

$$g_m = \sqrt{2 \mu_n C_{ox} \frac{W}{L} I_D}$$

$$(0.04)^2 = 2 \times 100 \times 10^{-6} \times W \times \frac{1}{0.18 \times 10^{-6}} \times 0.001$$

$$W = 1.44\ mm.$$ ← Big value, for a real design increase I_D to reduce $\frac{W}{L}$.

Use Miller approx. to convert C_{GS}.



$$C_{gs} = \frac{2}{3} W L C_{ox}$$
$$= \frac{2}{3} \times 1.44 \times 10^{-3} \times 0.18 \times 10^{-6} \times 12 \times \frac{10^{-15}}{(10^{-6})^2}$$
$$= 2.07 \text{ pF.}$$

$$\therefore C_1 = (1 - 0.8) C_{gs}$$
$$= 415 \text{ fF.}$$

Notice higher I_D would reduce W & therefore reduce the input capacitance.