11/2/20

Lec 12

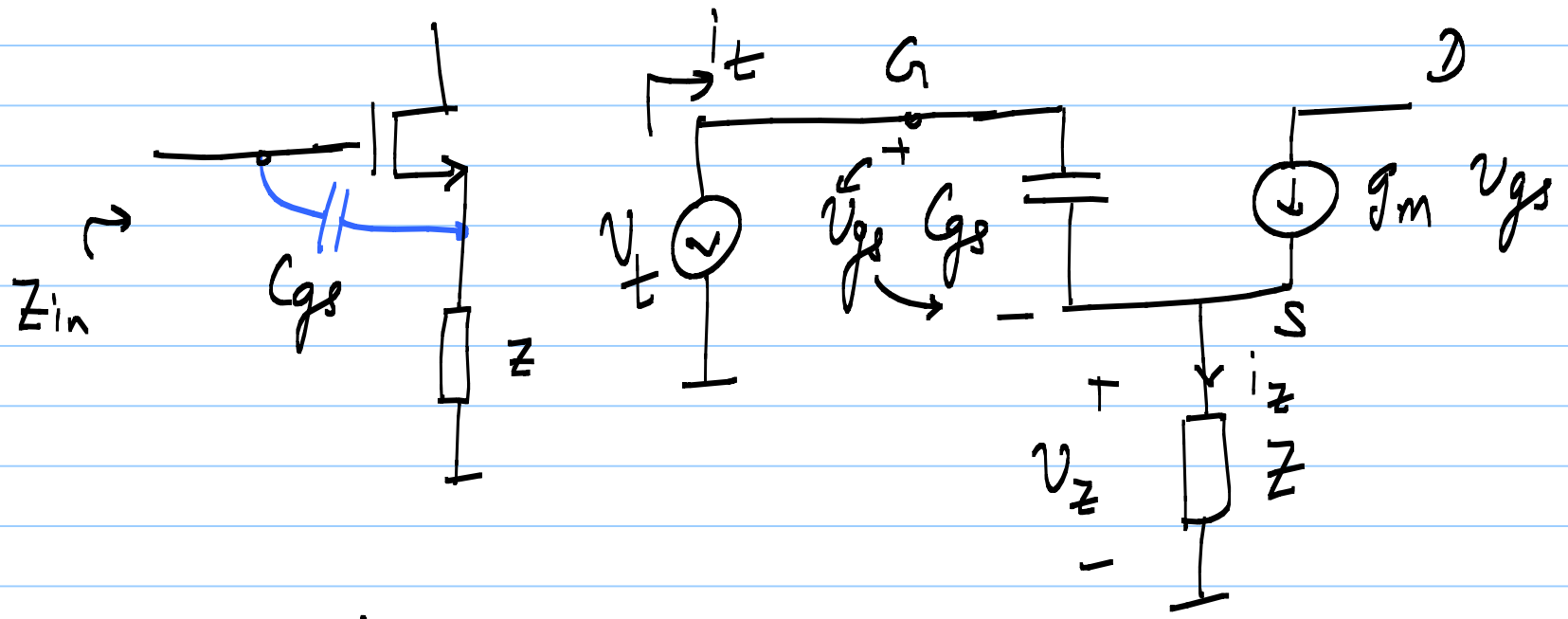
Wide band CG LNA

* achieve $g_m = 1/R_s$ with small C_{gs},

small W_1, L_1

large I_{bias} ←

large V_{DSAT} } limited swings



$$Z_{in} = \frac{v_t}{i_t} = ?$$

$$v_{gs} = \frac{i_t \cdot 1}{sC_{gs}} \quad ; \quad i_z = i_t + g_m v_{gs}$$

$$= i_t + \frac{g_m}{sC_{gs}} \cdot i_t$$

$$v_z = i_z \cdot Z = i_t \cdot Z \left(1 + \frac{g_m}{sC_{gs}}\right)$$

$$v_t = v_{gs} + v_z$$

$$v_t = \frac{i_t}{sC_{gs}} + i_t \cdot Z \left[1 + \frac{g_m}{sC_{gs}} \right]$$

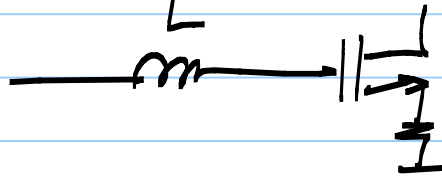
$$Z_{in} = \frac{v_t}{i_t} = \underbrace{\frac{1}{sC_{gs}}}_{\text{capacitive}} + Z + \underbrace{\frac{g_m}{sC_{gs}} \cdot Z}$$

Z

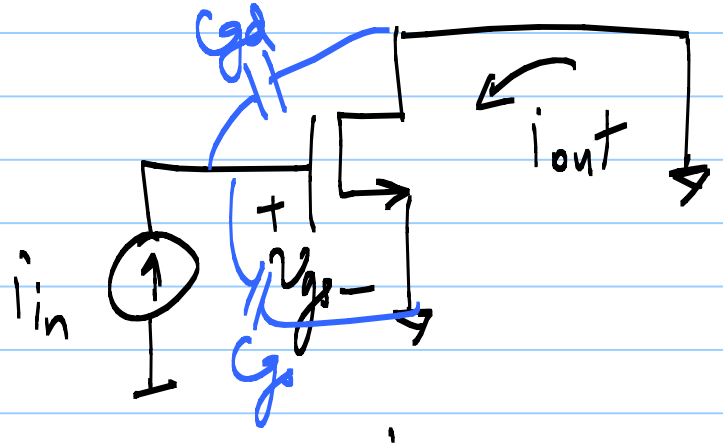
$$\frac{g_m}{C_{gs}} \simeq \omega_T = 2\pi f_T$$

1) $Z = R \Rightarrow Z_{in} = \frac{1}{jwC_{gs}} + R + \frac{g_m R}{jwC_{gs}}$

add L in series with input



HW: noise figure



$$\left|\frac{i_{out}}{i_{in}}\right| = 1 \quad @\ \omega_T \quad @\ f_T$$

transition freq.

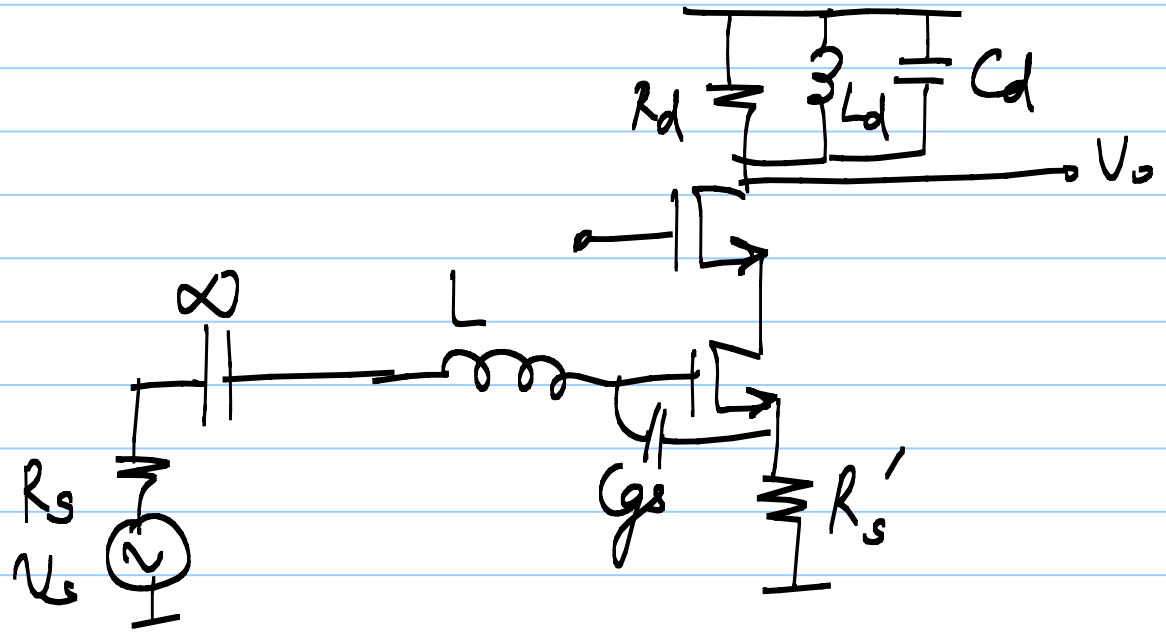
$$v_{gs} = \frac{i_{in}}{sC_{gs}}$$

$$i_{out} = g_m v_{gs} = \frac{g_m}{sC_{gs}} \cdot i_{in}$$

$$@\quad \omega = \omega_T = \frac{g_m}{C_{gs}}, \left|\frac{i_{out}}{i_{in}}\right| = 1$$

$$\omega_T = \frac{g_m}{C_{gs} + C_{gd}}$$

HW: NF of following circuit



2) $Z = \text{Capacitance} = \dfrac{1}{jwC_s}$

$$Z_{in} = \underbrace{\frac{1}{jwC_{gs}} + \frac{1}{jwC_s}}_{\text{capacitive}} + \underbrace{\frac{g_m}{jwC_{gs}} \cdot \frac{1}{jwC_s}}_{\frac{-g_m}{w^2 C_{gs} C_s}}$$

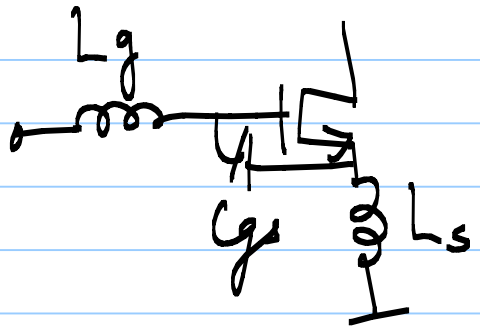
3) $Z =$  L_s

$$Z_{in} = \underbrace{\frac{1}{jwC_{gs}} + jwL_s}_{\text{noiseless input match}} + \underbrace{\frac{g_m}{jwC_{gs}} \cdot jwL_s}_{\leftarrow \frac{g_m}{C_{gs}} \cdot L_s = \omega_T L_s}$$

* set $\omega_T L_s = 50\,\Omega$ $\Big\}$ does not guarantee that $\frac{1}{j\omega C_{gs}} = -j\omega L_s$

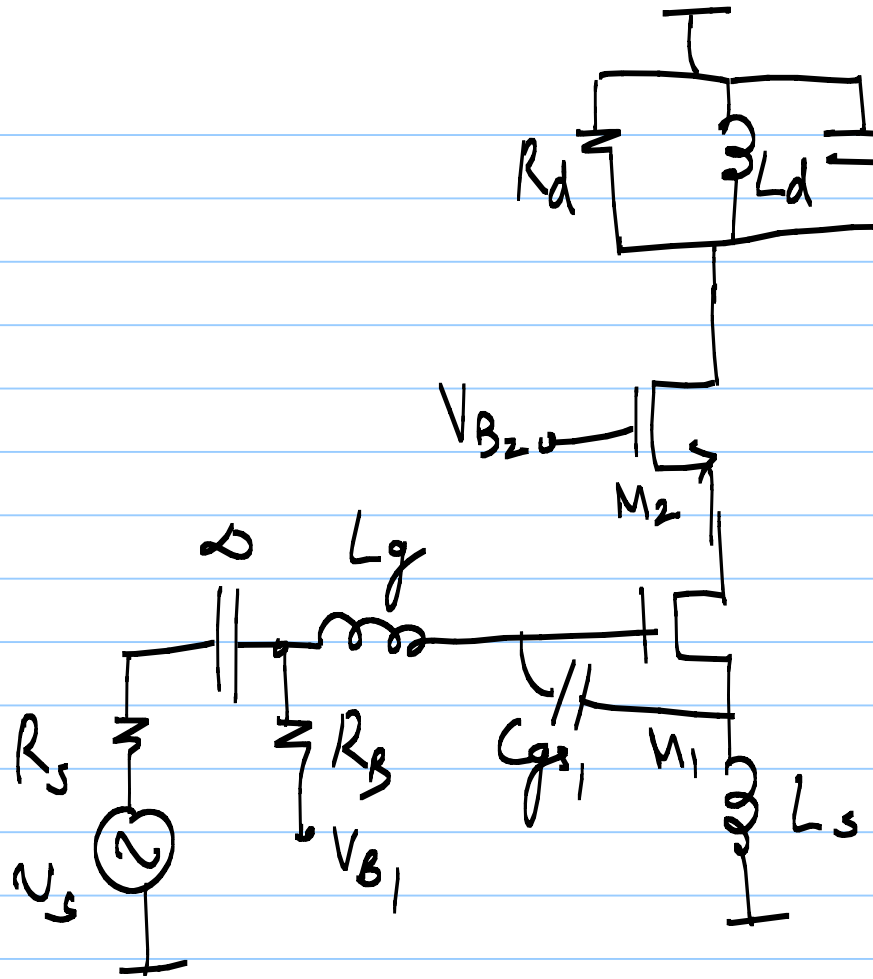
$\frac{g_m}{C_{gs}}$

If $\frac{1}{j\omega C_{gs}} > -j\omega L_s \Rightarrow$ use a second ind. L_g to resonate @ desired freq.



* $f_0 = \frac{1}{2\pi\sqrt{C_{gs}(L_s+L_g)}}$

↳ sets L_g



$$f_0 = \frac{1}{2\pi\sqrt{L_d C_d}}$$

Commm Sourc LNA

CS LNA