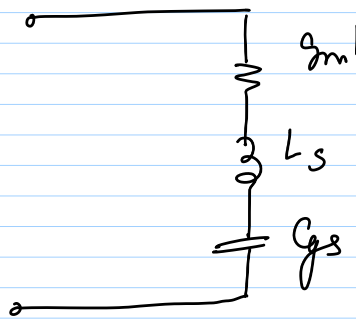
6-9-13

Lec 16

b) $Z_s = sL_s$

$$Z_{in} = sL_s + \frac{1}{sC_{gs}} + \frac{g_m L_s}{C_{gs}}$$



$g_m L_s / C_{gs} = \omega_T L_s$

→ eq. resistance w/o using a physical resistor (low noise)

* Low noise (no physical resistor)
* small S_{11} ⇒ $\omega_T L_s = 50\,\Omega$
* Make L_s & C_{gs} resonate @ desired freq. f_0

Constraints:

Gain,
C_{gs}
I_{bias}

Set f_0, I_{bias}, $\omega_T L_s$ independently

– add another degree of freedom

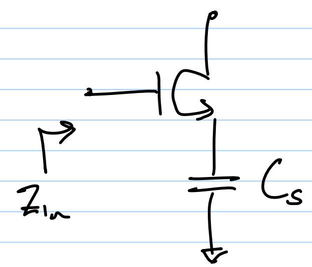
(1) add cap C_x in $\parallel^l$ to C_{gs}

$$\omega_T{}' = \frac{g_m}{C_{gs} + C_x}$$ ✗ changes $Re(Z_{in})$

(2) add L_g in series with the gate

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

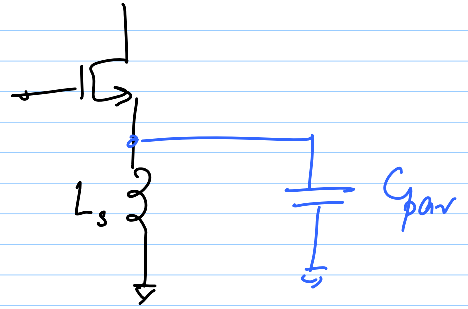
III C_s @ source op C.S.



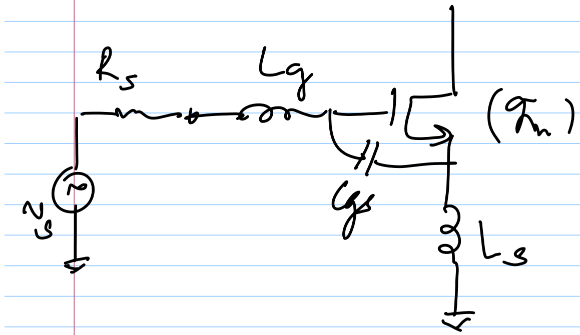
$$Z_{in} = \frac{1}{sC_s} + \frac{1}{sC_{gs}} + \frac{g_m}{s^2 C_{gs} C_s}$$

→ –ve resistance

→ freq. dependent



← can cause problems @ other freq.



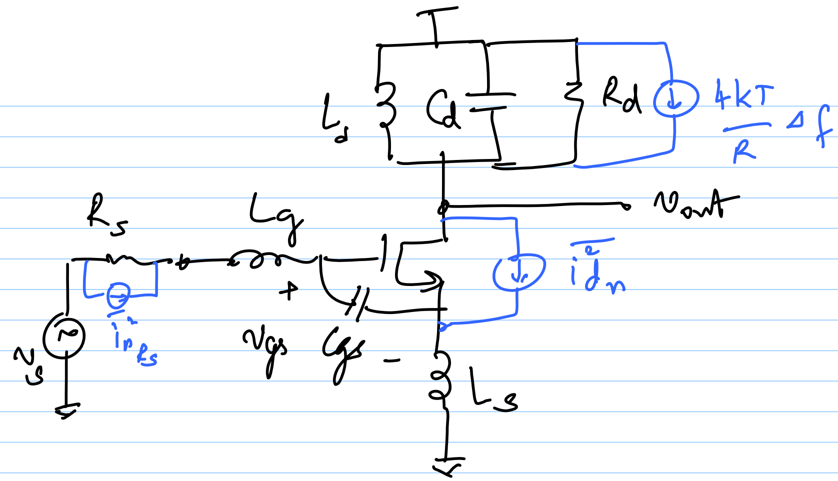
S_{11}

gain, NF, power, linearity, BW

* Narrowband LNA
  → BW dep. on Q of input ckt (dep. on Q_{in})

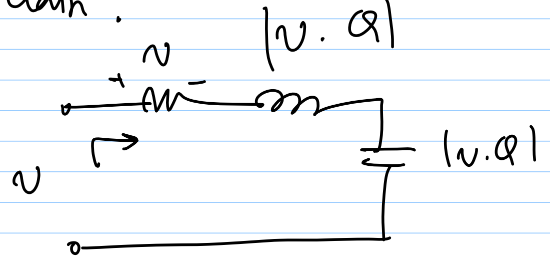
$$\boxed{Q_{in} = \frac{\omega(L_g + L_s)}{2R_s}}$$

* $\uparrow BW \Rightarrow \downarrow Q_{in} \Rightarrow \downarrow (L_g + L_s)$
  $\Rightarrow \uparrow C_{gs}$ (keep ω_0 constant) $\Rightarrow \omega_T \downarrow$
  $\Rightarrow R_{in} \downarrow$ ~~$\Rightarrow \uparrow L_s$ ....~~
  $\Rightarrow \uparrow g_m \Rightarrow \uparrow I_{bias}$



* $L_d - C_d \Rightarrow$ swings are better
  – OOB filtering better
  – BW limitations (RC)

* Gain :



$v_{gs} = Q_{in} \cdot v_s$

$i_d = g_m \cdot Q_{in} \cdot v_s$

$v_{out} = g_m \cdot R_d \cdot Q_{in} \cdot v_s$

gain $= \frac{v_o}{v_s} = g_m \cdot R_d \cdot Q_{in}$

a) more gain than normal C.S.A.
dep. on Q_{in}

b) NF better than normal C.S.A.
dep. on Q_{in}

c) Linearity worse than normal CSA