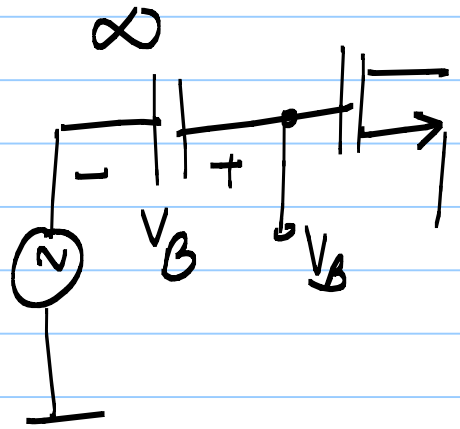
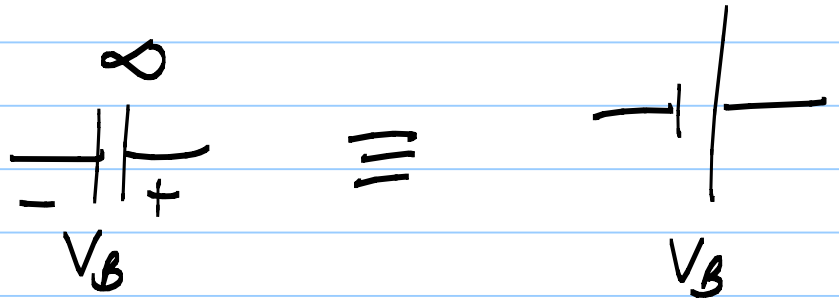
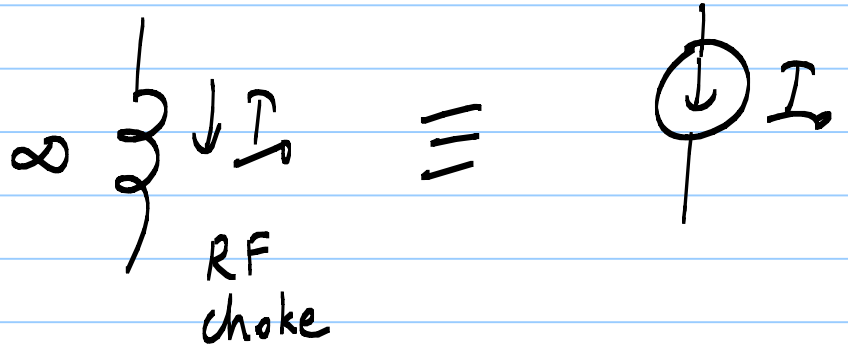
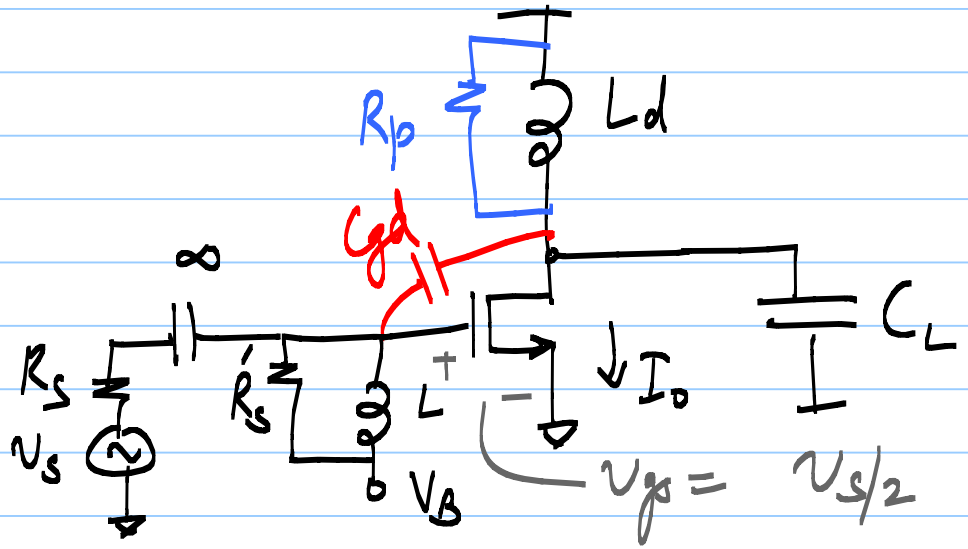
5/2/20

Lec 10









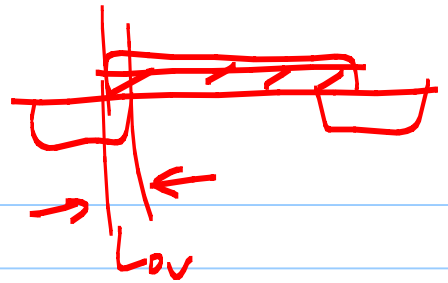
$C_{gs} = W \cdot L \cdot C_{ox}$

$g_m = \mu_n C_{ox} \left(\frac{W}{L}\right)(V_{GS} - V_T)$

$L = k L_{min} \Rightarrow C_{gs} \propto k^2$

$k > 1$

$$\text{gain} = \frac{g_m}{2}(r_{ds} \| R_p)$$

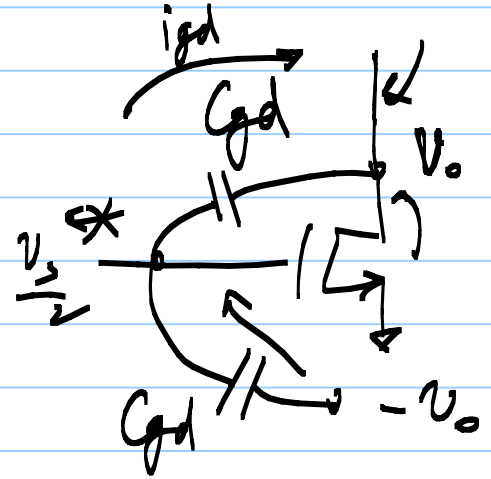


C_{gd} → feedback path that can cause instability

Solutions :

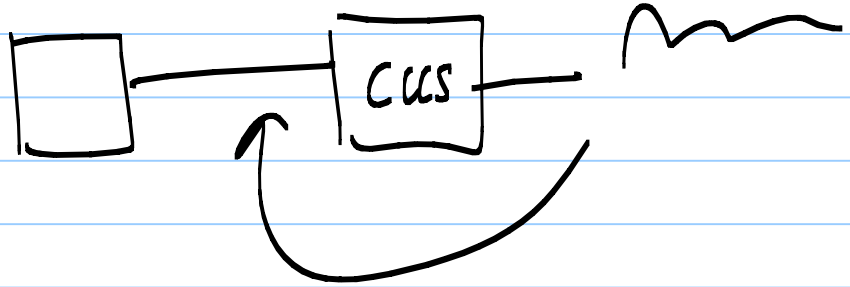
1) L_{gd} to resonate out C_{gd}?
   - ↳ DC short bet. G & D
   - ↳ L_{gd} can be very large

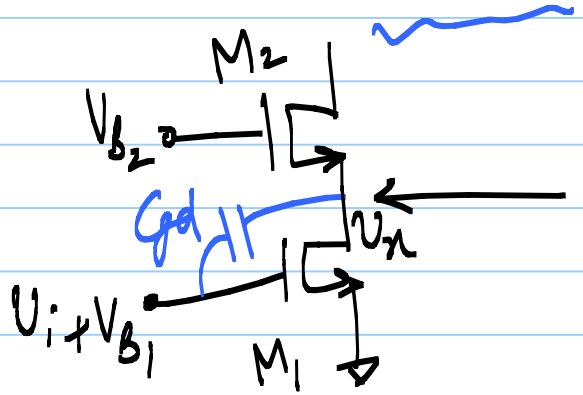
2) $-C_{gd}$ for incremental signal → gyrator based circuits?
   → Miller effect



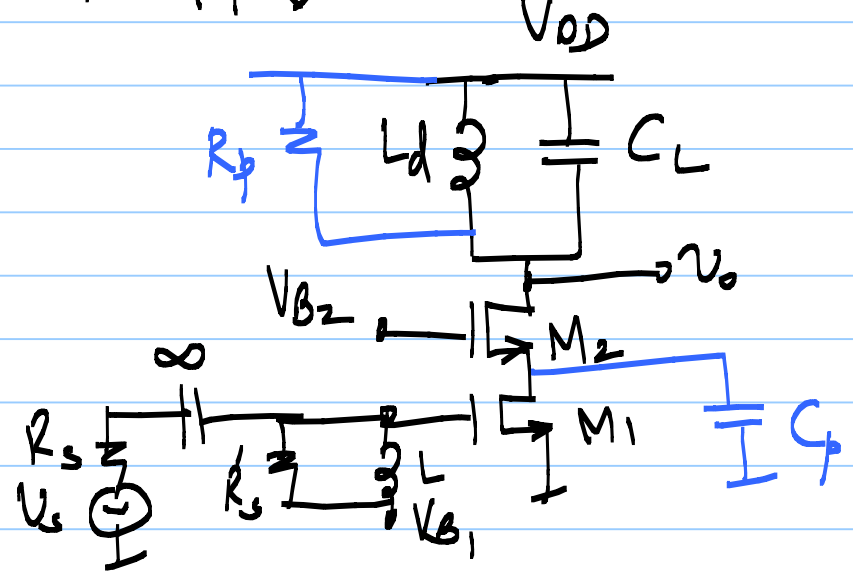
"capacitive neutralization"

3) Cascode





$v_x = -\frac{g_{m1}}{g_{m2}} \cdot v_i$ ← Unilateral amplifier

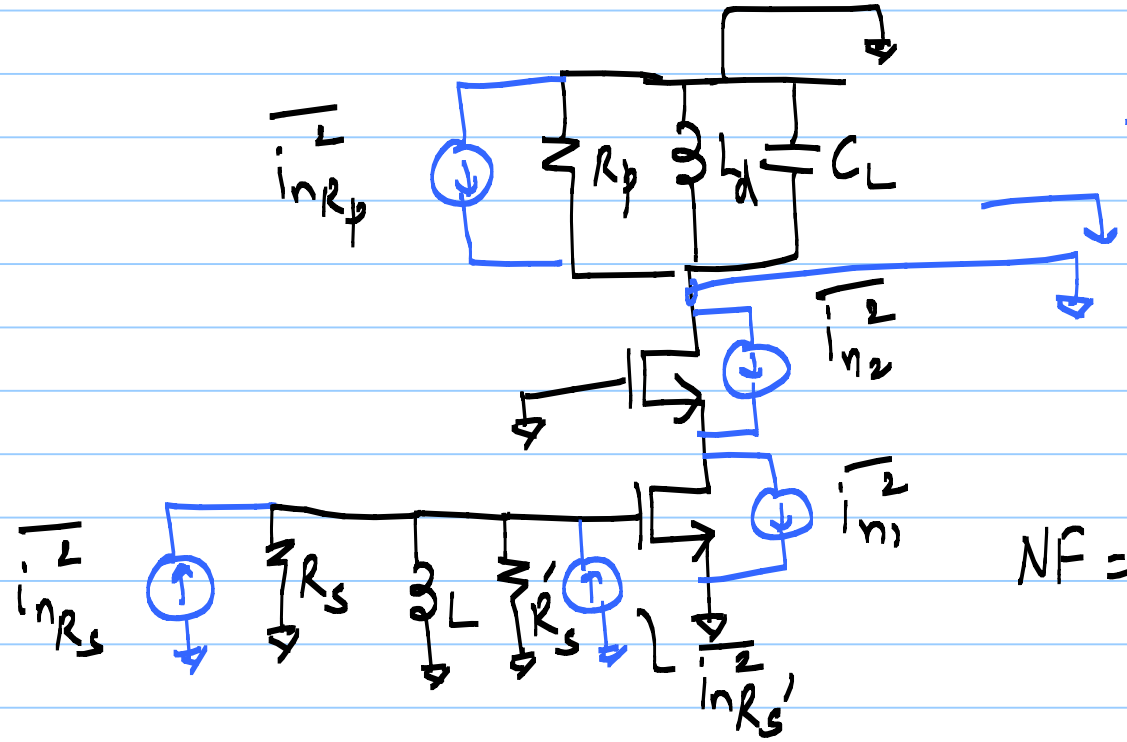


$gain = -\frac{g_m R_p}{2}$

NF = ?

Even if M_1, M_2 & R_p are noiseless,

$F = 2$, $NF = 3\,dB$



$$\overline{i^2_{sc_n}} = \overline{i^2_{n_{R_p}}} + \overline{i^2_{n_1}} + g_{m_1}^2 \frac{R_s^2}{4}\left[\overline{i^2_{n_{R_s}}} + \overline{i^2_{n_{R_s'}}}\right]$$

$$NF = \frac{\overline{i^2_{sc_n}}}{g_{m_1}^2 \frac{R_s^2}{4} \cdot \overline{i^2_{n_{R_s}}}}$$

$$NF = \frac{g_{m_1}^2 R_s^2/4\ \overline{i^2_{n_{R_s}}} + g_{m_1}^2 R_s^2/4\ \overline{i^2_{n_{R_s'}}} + \overline{i^2_{n_{R_p}}} + \overline{i^2_{n_1}}}{g_{m_1}^2 R_s^2/4\ \overline{i^2_{n_{R_s}}}}$$

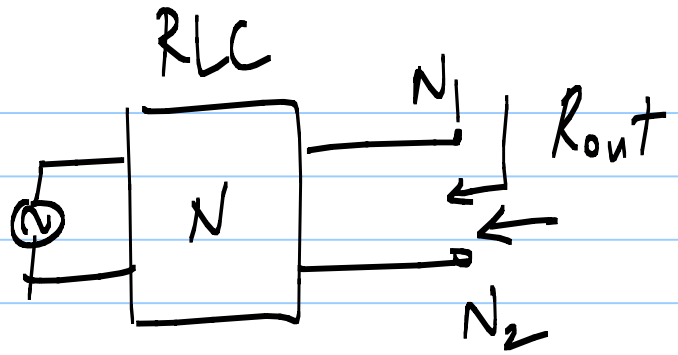
$$NF = 2 + \frac{4kT/R_p \cdot \Delta f + \frac{8kT g_{m1} \cdot \Delta f}{3}}{g_{m1}^2 \frac{R_s^2}{4} \cdot \frac{4kT}{R_s} \Delta f}$$

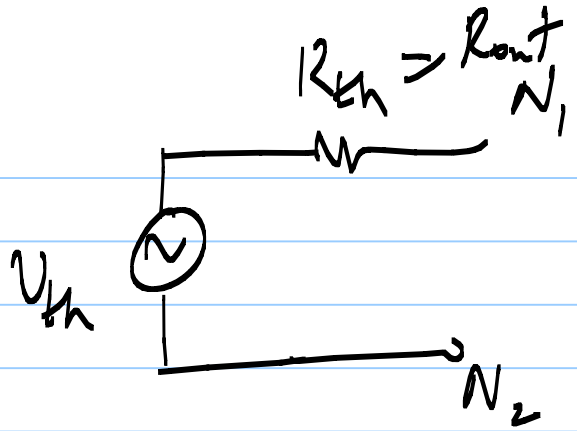
$$= 2 + \frac{4}{g_{m1}^2 R_s R_p} + \frac{8}{3 g_{m1} R_s}$$

fundamentally limited to be $\geq 3dB$

maximize Q of drain LC tank

maximize g_{m1}





Noise produced by network N across $N_1 - N_2$ } = Noise produced by R_{th}