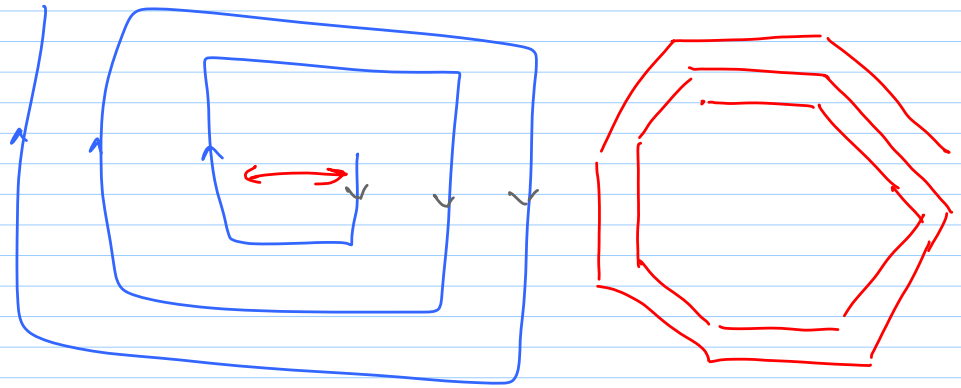
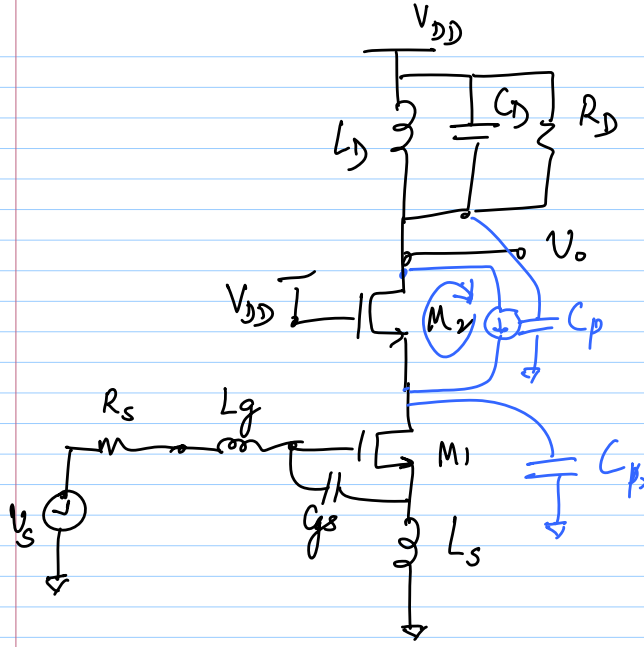
13-9-13

Lec 18





1) Maximize R_D
2) Maximize Q_{L_D} & Q_{C_D}
3) Maximize L_D
4) $C_D >> C_p$
5) $(W/L)_2 = (W/L)_1$

DESIGN PROCEDURE

1) Fix L_D, C_D & R_D ← (BW criteria)
2) Gain = $Q_{in} \cdot g_m \cdot R_D$
3) $\frac{\omega_o}{BW} = Q_{in}$ ← $C_{gs} = f(Q_{in})$ ↳ (W/L)
4) g_m = gain / $R_D \cdot Q_{in}$ → I_D
5) $I_D > I_{bias}$ ⇒ ↑(W/L), ↓I_D keeping g_m constant ⇒ ω_T ↓.

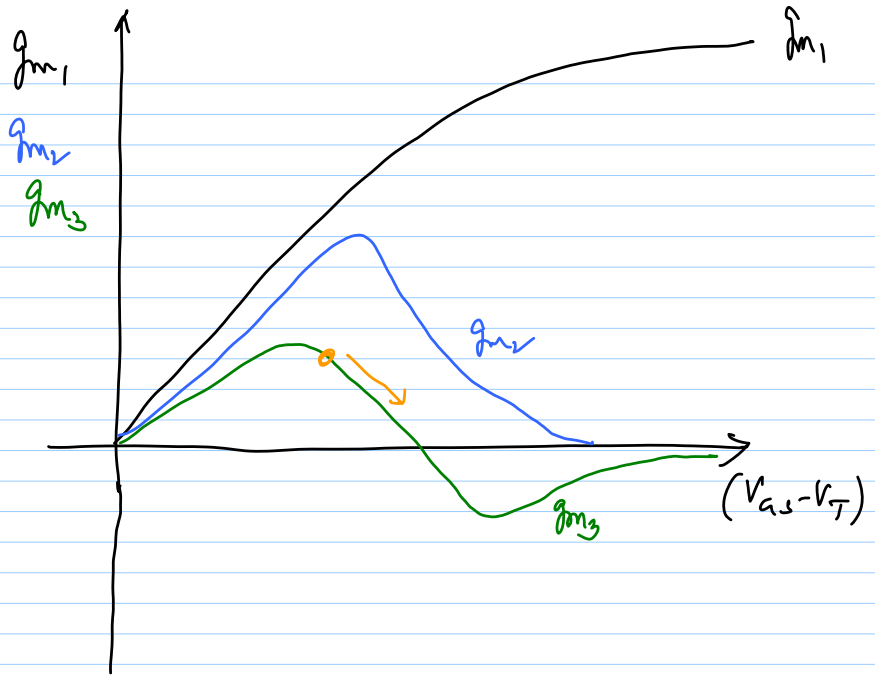
C_{gs} ↑ ⇒ Q_{in} ↓ ⇒ g_m has to increase

6) $\omega_T L_S = R_s$ ⇒ L_S
7) $\omega_o = \frac{1}{\sqrt{(L_S + L_g) \cdot C_{gs}}}$ ⇒ L_g

✓ Gain, ✓ R_s, ✓ ω_o, ✓ NF, ✓ IIP3, ✓ I_{bias}, ✓ BW

Typical NF = 1.5 to 2 dB

→ Inherently iterative



$$g_{m_1} = g_m = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_{V_{DS}=\text{const}}$$

$$g_{m_2} = \left.\frac{\partial^2 I_D}{\partial V_{GS}^2}\right|_{V_{DS_0}}$$

$$g_{m_3} = \left.\frac{\partial^3 I_D}{\partial V_{GS}^3}\right|_{V_{DS_0}}$$

If gate noise exists

$$Q_s = \frac{1}{\omega C_{GS} R_s}$$

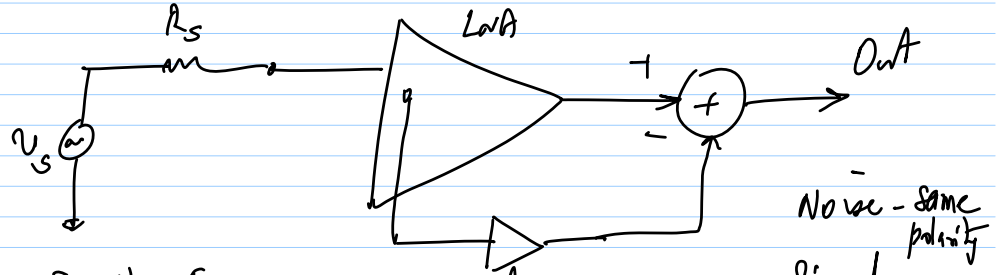
$$F = F_{min} + \left[\frac{\gamma}{\alpha g_m R_s}\right]\left[1 - \frac{Q_{opt}^2}{Q_s^2}\right]$$

$$Q_{s_{opt.}} \simeq 4.5$$

$$W_{opt} = \frac{3}{2} \cdot \frac{1}{\omega L C_{ox} R_s Q_{sp}} \simeq \frac{1}{3\omega L C_{ox} R_s}$$

$$F = 1 + 2.4 \underbrace{\gamma}_{\alpha}\left[\frac{\omega}{\omega_T}\right]$$

Noise cancelling LNA



Example 5.20 in Razavi