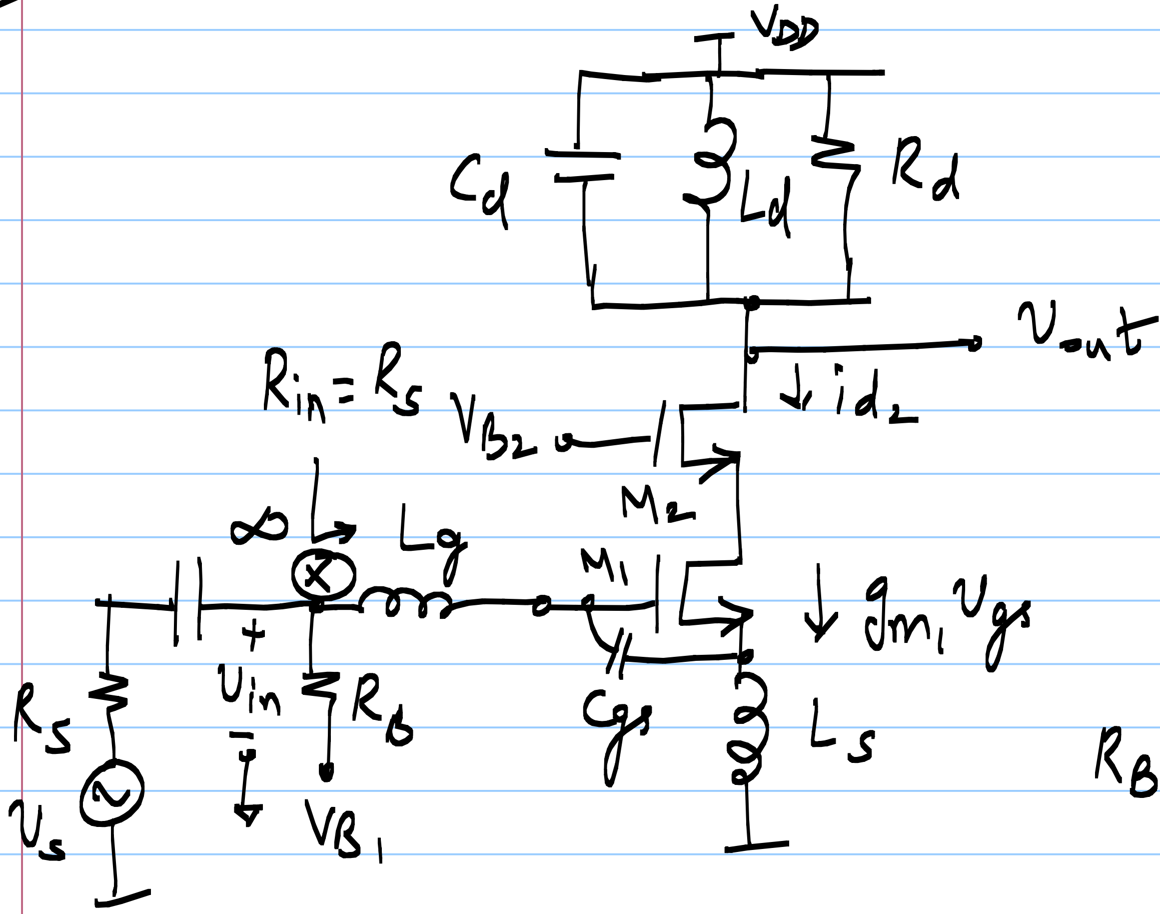
12/2/20

Lec 13

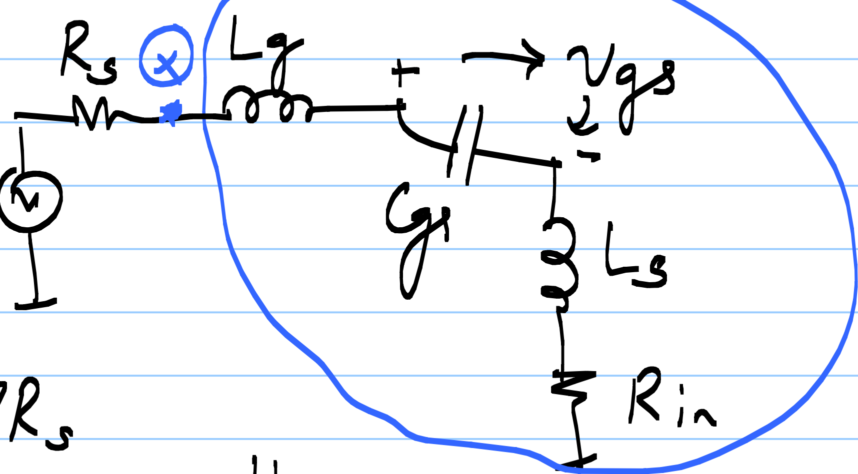


$$\omega_T L_s = R_{in} = R_s$$

$$v_{in} = \frac{v_s}{2}$$

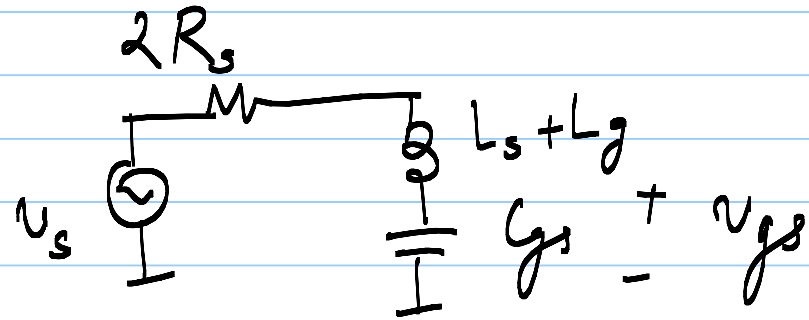
$$v_{gs} = ?$$

Thevenin equivalent @ x



$R_B >> R_s$

$\Downarrow$



$$Q_{in} = \frac{1}{2R_s(\omega C_{gs})} = \frac{\omega(L_s+L_g)}{2R_s}$$

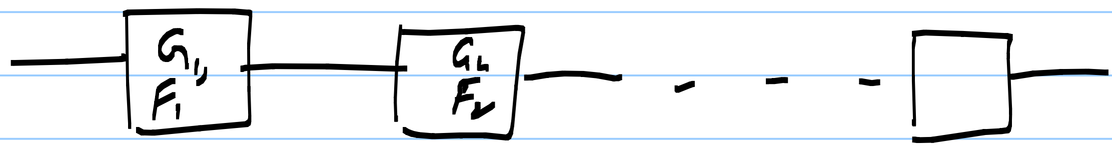
$$v_{gs} = Q_{in} \, v_s = 2 Q_{in} \cdot v_{in}$$

$$i_{d1} = g_{m1} v_{gs} = i_{d2}$$

$$v_{out} = -i_{d2} R_d = -g_{m1} R_d \cdot v_{gs}$$

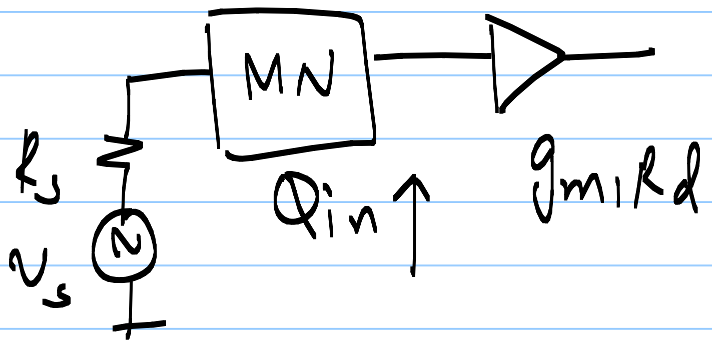
$$\left| \frac{v_{out}}{v_s} \right| = g_{m1} R_d \cdot Q_{in}$$ passive voltage gain

$$\left| \frac{v_{out}}{v_{in}} \right| = 2 g_{m1} R_d \cdot Q_{in}$$

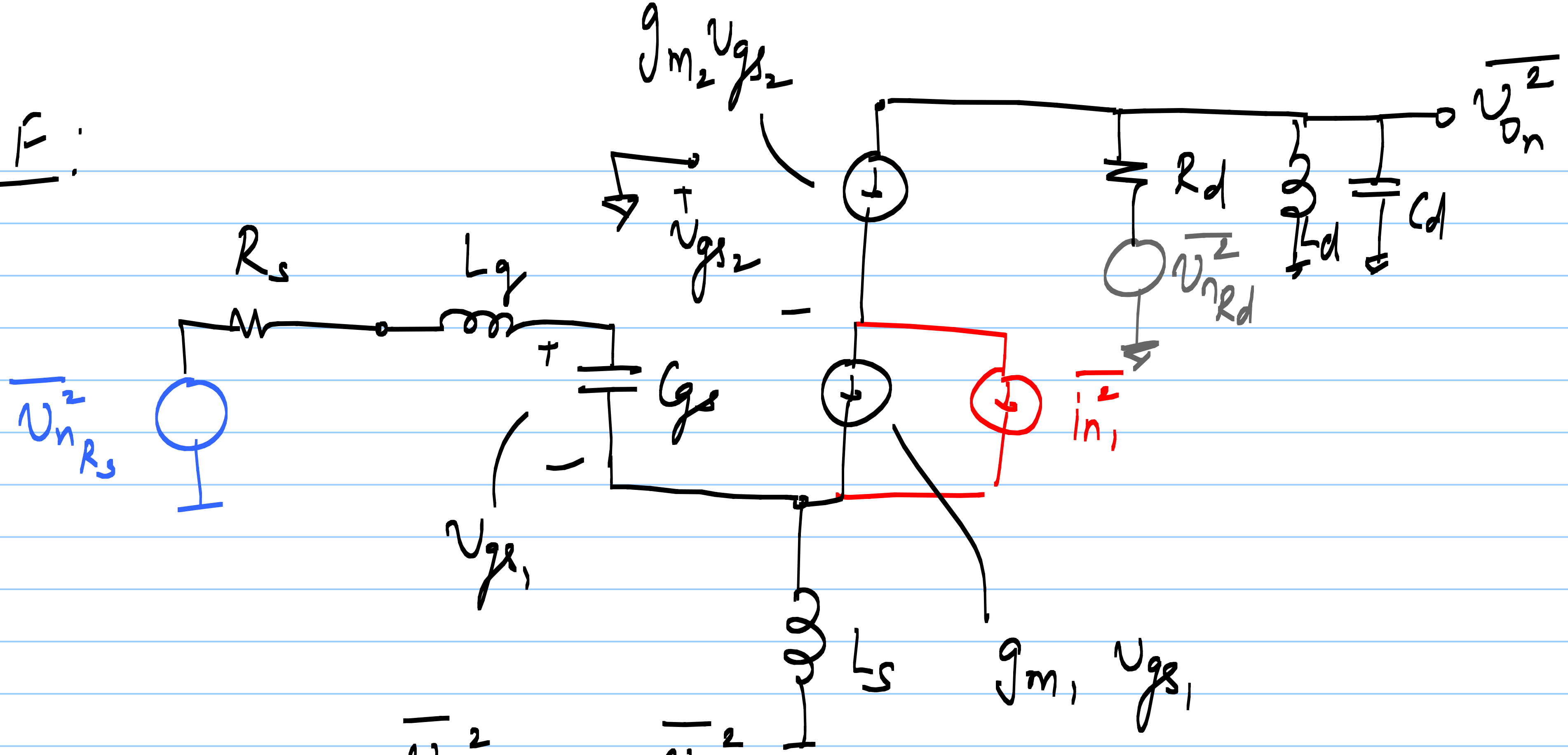


Large Q_{in} $\Rightarrow$ large gain

- ↳ small C_{gs} → small W,
  large I_{bias}
  - ↳ large ω_T → smaller L_s
    larger L_g
- ↳ NF should improve [Friis eq.]



NF:



$$F = 1 + \frac{\overline{v_{on_{M_1}}^2} + \overline{v_{on_{Rd}}^2}}{\overline{v_{on_{R_s}}^2}}$$

$$\frac{\overline{v_{on_{R_s}}^2}}{\Delta f} = \left|\frac{v_{out}}{v_{in}}\right|^2 \cdot \overline{v_{n_{R_s}}^2} = Q_{in}^2 \, g_{m_1}^2 R_d^2 \cdot 4kT R_s$$

$$\frac{\overline{v_{on}^2}_{Rd}}{\Delta f} = \frac{\overline{v_{n}^2}_{Rd}}{\Delta f} = 4kTR_d$$

$$\frac{\overline{v_{on}^2}_{M_1}}{\Delta f} = \,?$$

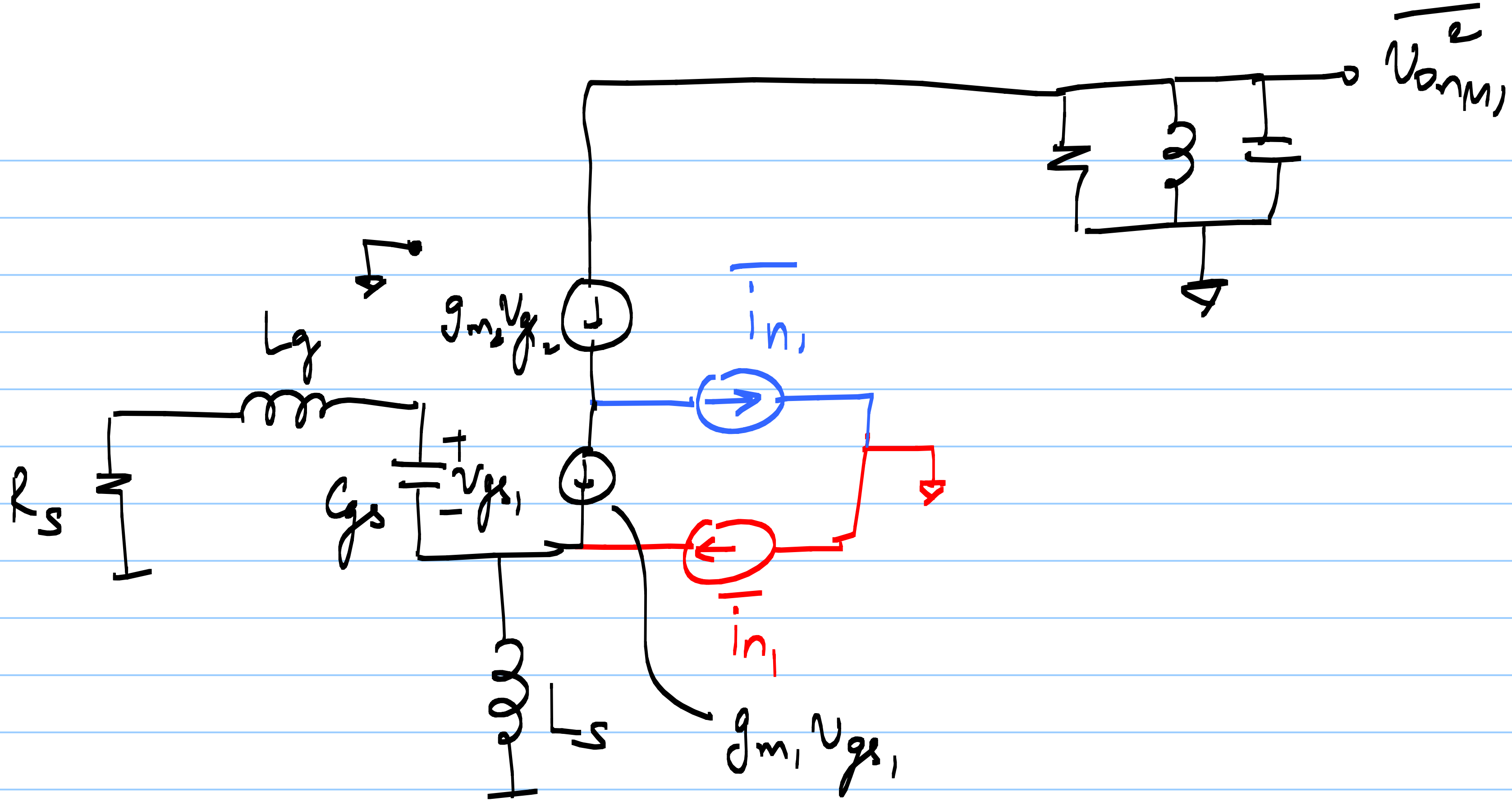
$\overline{i_{n_1}}$

$\overline{i_{n_1}}$

$\left\{ \text{pair of correlated noise sources} \right\}$

$\overline{v_{on}}_{M_1}$ due to $\overline{i_{n_1}} = -\overline{i_{n_1}} \cdot R_d$

$\overline{v_{on}}_{M_1}$ due to $\overline{i_{n_2}} =$



$$\overline{v_{onM_1}^2} = \left[\frac{R_d}{1+R_d\, g_{m_1}}\right]^2 \cdot \overline{i_{n_1}^2} \qquad \cancel{??}$$

$$= \left[\overline{i_{n_1}} \times \left(g_{m_1}R_s+1\right) \cdot R_d - \overline{i_{n_1}} \cdot R_d\right]^2 ??$$