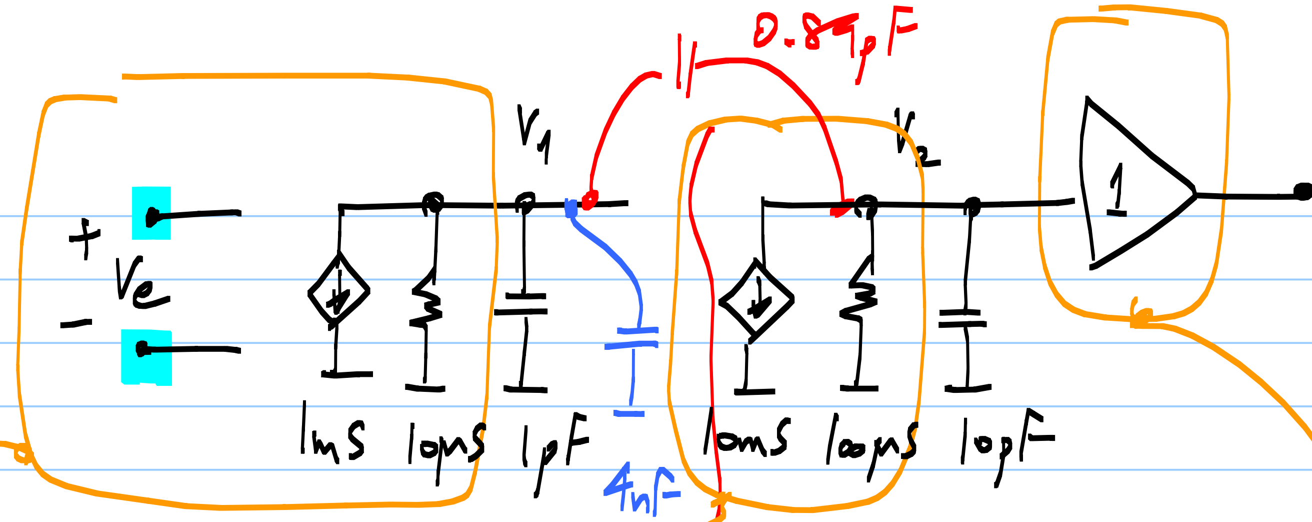
Lecture 14

$K = 10$

Differential amplifier

Common Source amp.

Buffer



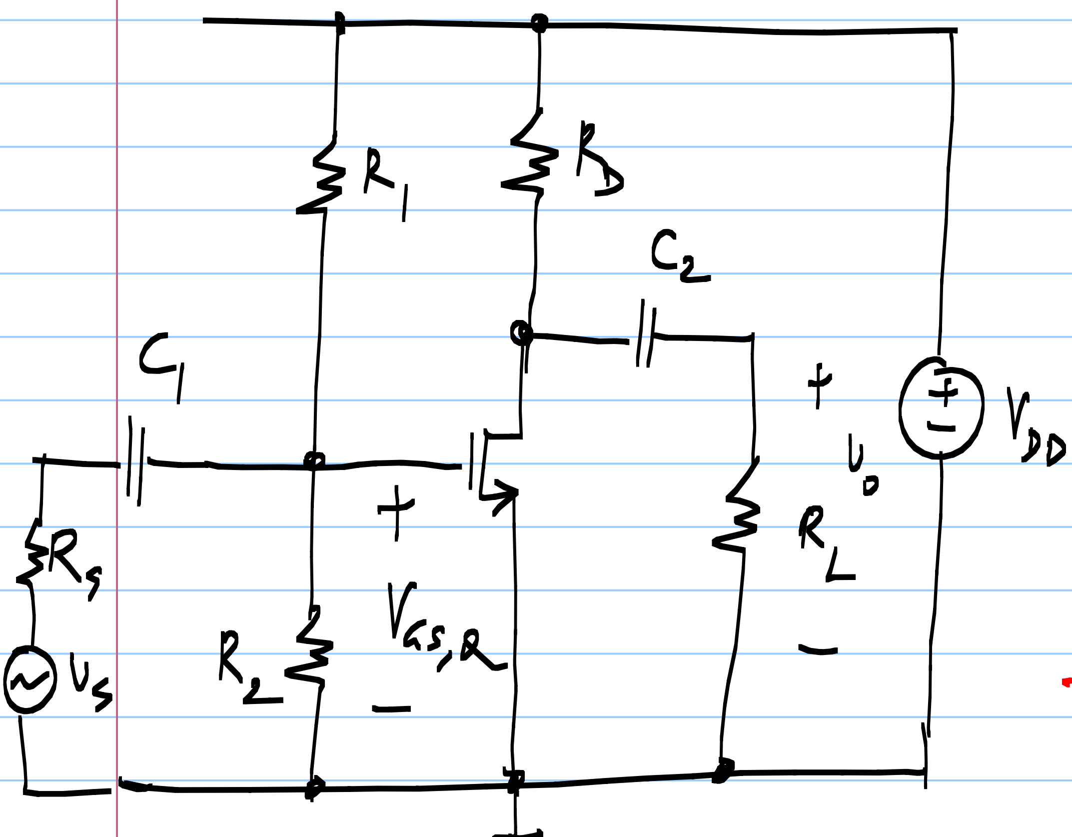
$\omega_{u,loop} = 2.5\ \text{Mrad/s}$

$\left(\frac{g_{m1}}{C}\right) \cdot \frac{1}{K}$

$110\ \text{Mrad/s}$ ✓

$\frac{1mS}{0.9pF} \cdot \frac{1}{10} = \frac{10^{-3}}{10^{-12}} \cdot \frac{1}{10}(1.1)$

Common source amplifier:



$C_{1,2}$: large

Gain:

$$\frac{v_o}{v_s} = -g_m (R_D \| R_L) \left[\frac{R_1 \| R_2}{R_S + R_1 \| R_2} \right]$$

$$g_m = \underbrace{\mu_n C_{ox} \frac{W}{L}}_{K_n} \cdot (V_{GS,Q} - V_T)$$

$\mu_n C_{ox}$: $150 \mu A/V^2$, $200 \mu A/V^2$

V_T: 0.5V, 0.6V

$V_{GS,Q} = 1.5V$

K_n, V_T: Vary with process & temp.

$$g_m = \underbrace{\mu_n C_{ox} \frac{W}{L}}_{K_n} \cdot (V_{GS_1} - V_T) = \sqrt{2 \cdot K_n \cdot I_D}$$

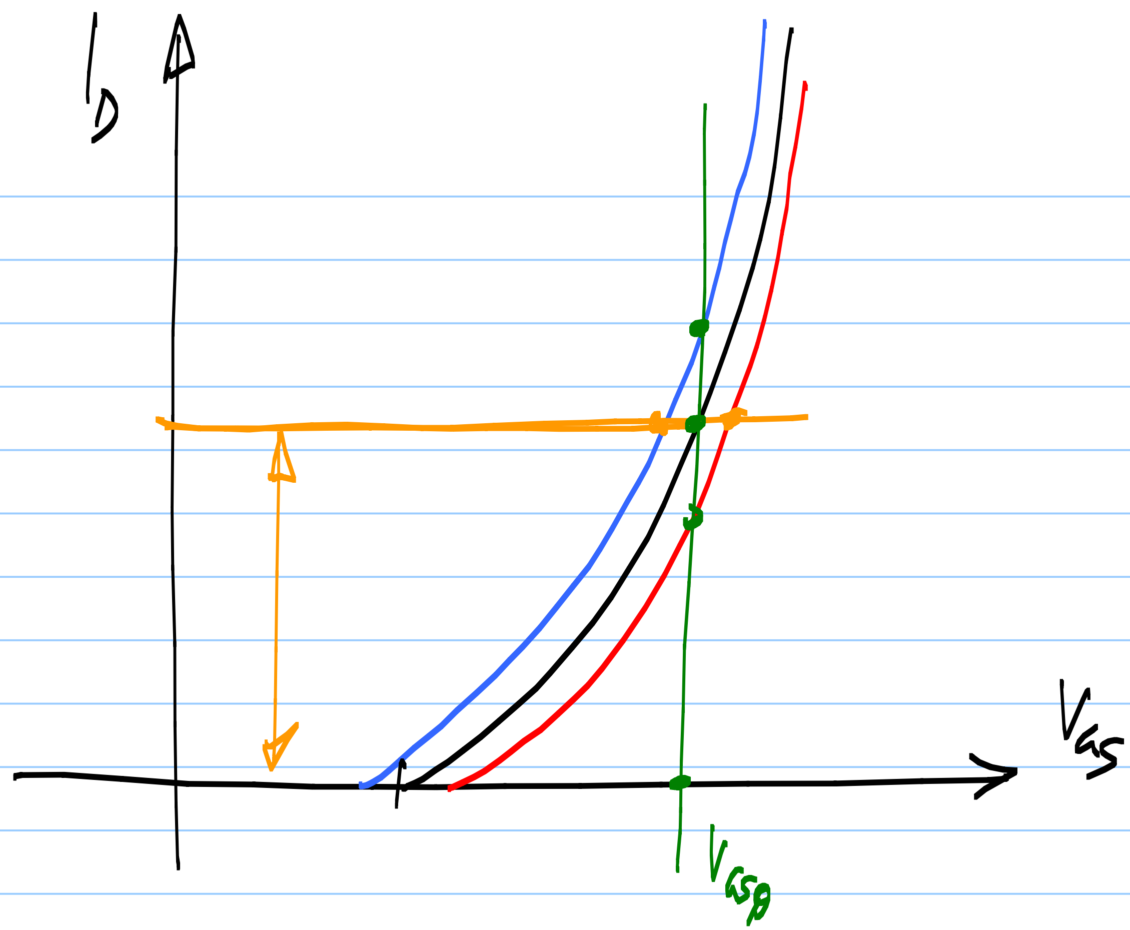
ΔK_n, ΔV_T

Biasing @ constant V_{GS}

Insensitive to ΔV_T

Less sensitive to ΔK_n

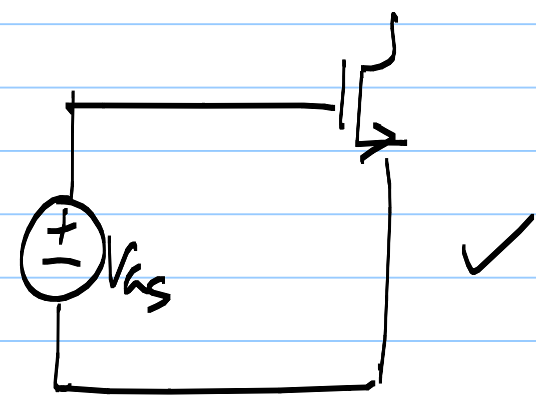
Biasing @ constant I_D

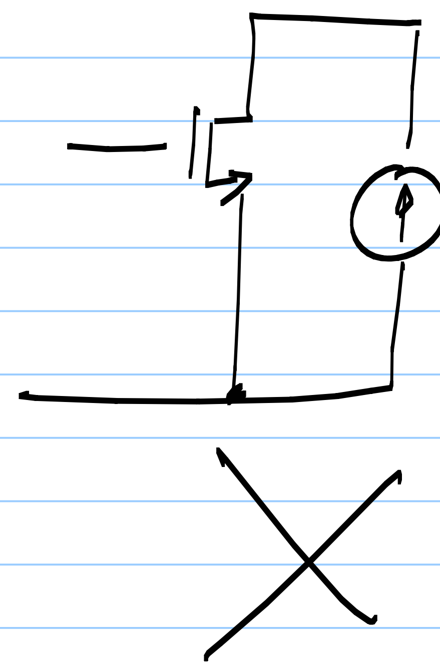


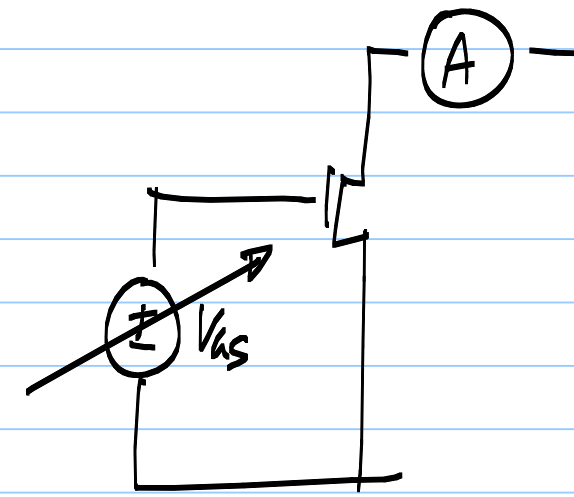
I_D
V_GS
V_GSQ

Biasing a transistor @ constant I_D (as opposed to constant V_{GS})

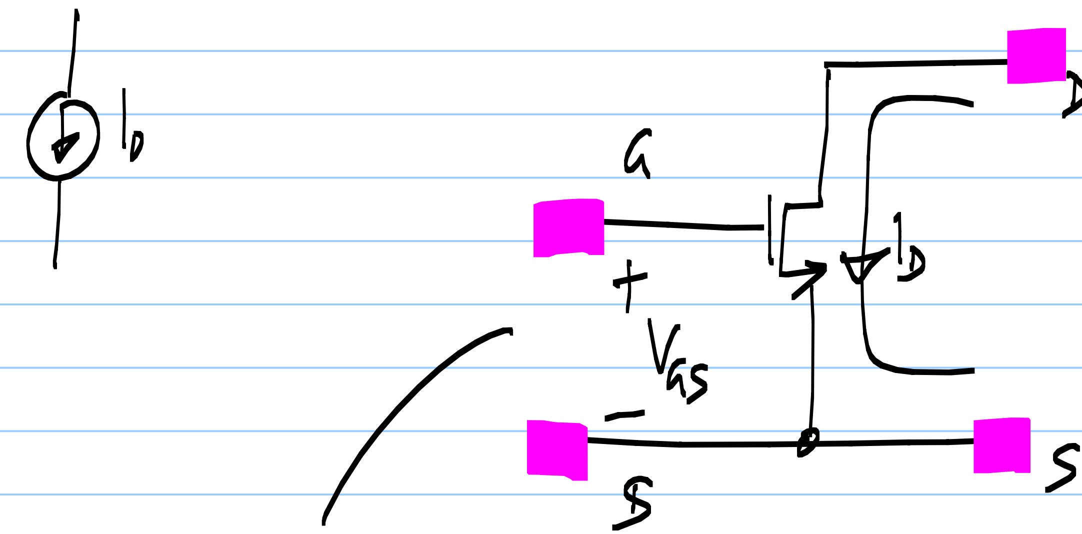
- Insensitive to V_T changes
- Less sensitive to k_n changes







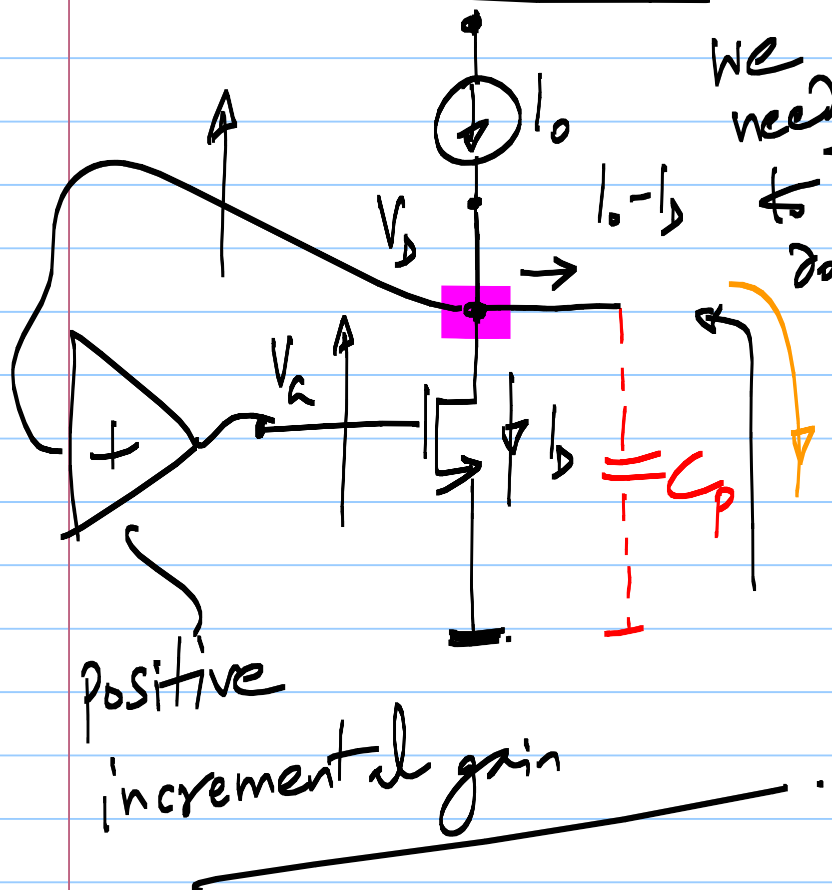
Biasing @ constant I_D $(=I_0)$ ≡ Adjust V_{GS} until the desired I_D flows



Sense I_D @ Drain or Source

Vary V_G or V_S × → 4 topologies

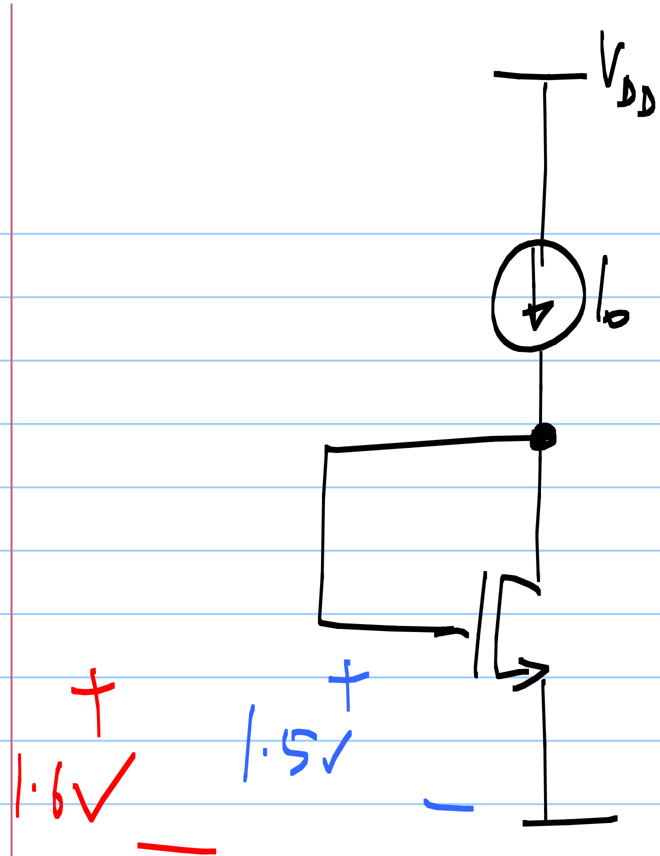
Sensing I_D @ drain ; Control the gate voltage.



we need to do this:

- $I_D > I_0$: must reduce V_a
- $I_D < I_0$: must increase V_a

- $I_D > I_0$: V_D decreases
- $I_D < I_0$: V_D increases



Simplest realization

$$V_{DS} \geq V_{GS} - V_T$$

$$\underline{\underline{\quad}}$$

$(V_T > 0)$

$V_T > 0 \Rightarrow$ transistor is in saturation