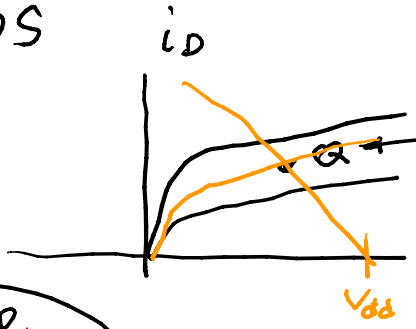
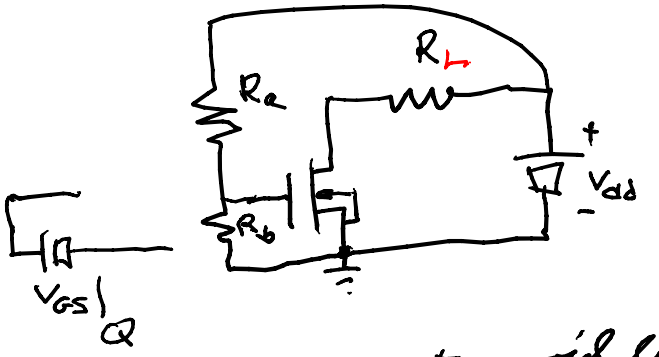
Biasing of MOS

NMOS



choose → chosen

fixed



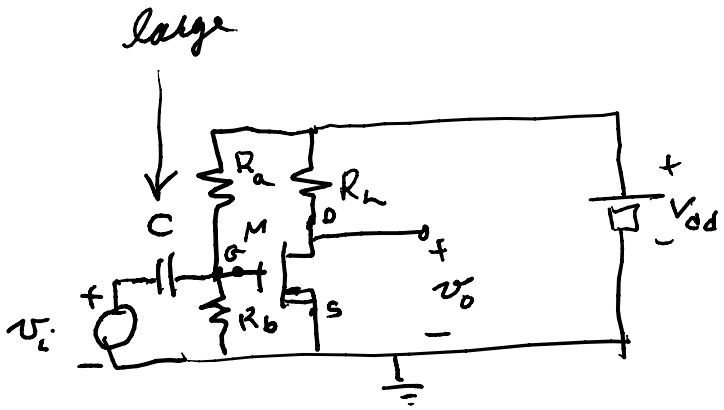
$$V_{GS}|_Q = \frac{R_b}{R_a+R_b} V_{dd}$$

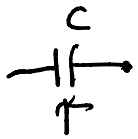
$$Q = \frac{1}{1+\left(\frac{R_a}{R_b}\right)} \cdot V_{dd}$$

to avoid loading a signal source choose R_a parallel R_b to be large

$$R_{||} = \frac{R_a R_b}{R_a+R_b} = \frac{R_a}{(1+(R_a/R_b)} \Rightarrow$$ choose R_a very large

large





$$Z_c = \frac{1}{sC} \Rightarrow Z_c(j\omega) = \frac{-j}{\omega C}$$

at a fixed ω; $|Z_c| = \frac{1}{\omega C}$

is small if C is large

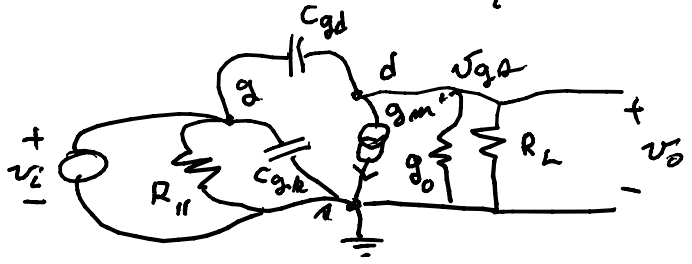
at bias $\omega = 0$ (read DC)

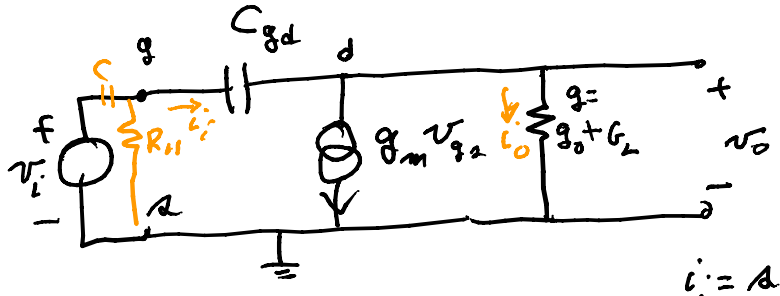
so $|Z_c(0)| = \infty$

Interested in $\frac{v_o(s)}{v_i}$ here battery ⇒ short

Capacitor ⇒ open short

M → small signal equivalent





$i_o = g v_o$

$i_o = i_i - g_m v_{g2}$

$= i_i - g_m v_i$

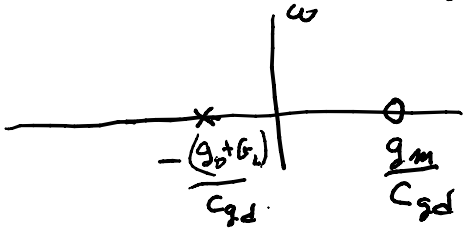
$i_i = s C_{gd} \cdot [v_i - v_o]$

$g v_o \simeq i_o = i_i - g_m v_i$

$= s C_{gd}(v_i - v_o) - g_m v_i \Rightarrow \frac{v_o}{v_i}$

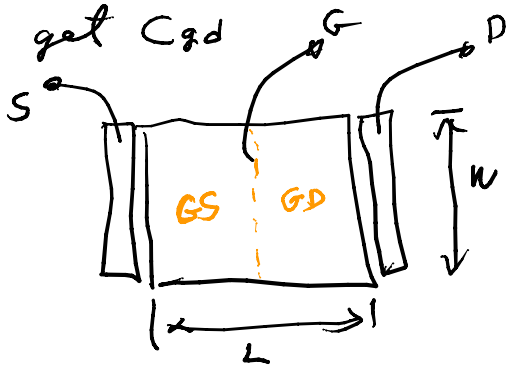
$g v_o + s C_{gd} v_o = (s C_{gd} - g_m) v_i \Rightarrow \frac{v_o}{v_i} = \frac{(s C_{gd} - g_m)}{(g_o + G_L) + s C_{gd}}$

$$\frac{v_o}{v_i} = \frac{s - g_m/C_{gd}}{s + \frac{g_o + G_L}{C_{gd}}}$$



$s = \sigma + j\omega$

to get C_{gd}

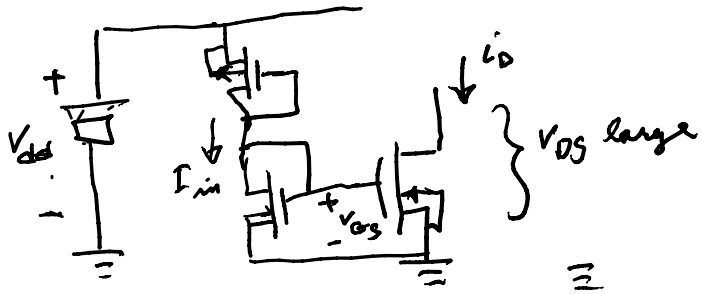


$C_{capac.} = \frac{\epsilon A}{d} = \epsilon_{SiO_2} \frac{WL}{2} \cdot \frac{1}{t_{ox}}$

// thickness

Note $e^{st} = e^{\sigma t + j\omega t} = e^{\sigma t} \cdot e^{j\omega t} = e^{\sigma t}(\cos(\omega t) + j \sin(\omega t))$

Current sources:



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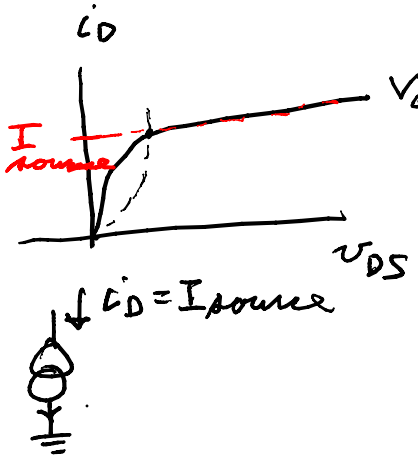
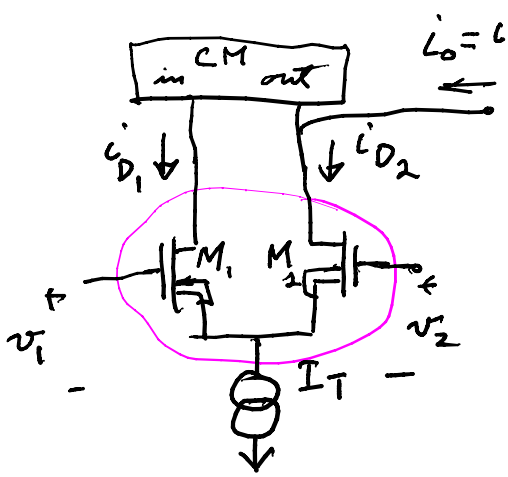


$V_{DS} > V_{GS} - V_{TO}$

Differential pair

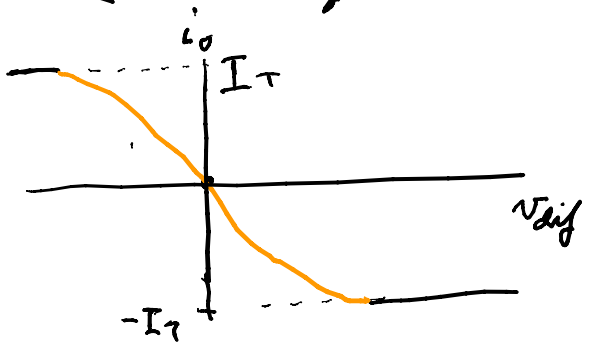


$i_o = i_{D_2} - i_{D_1}$

CM = current mirror

I_T = tail current source

$I_T = i_{D_1} + i_{D_2}$; $v_{dif} = v_1 - v_2$



how to make the current mirror