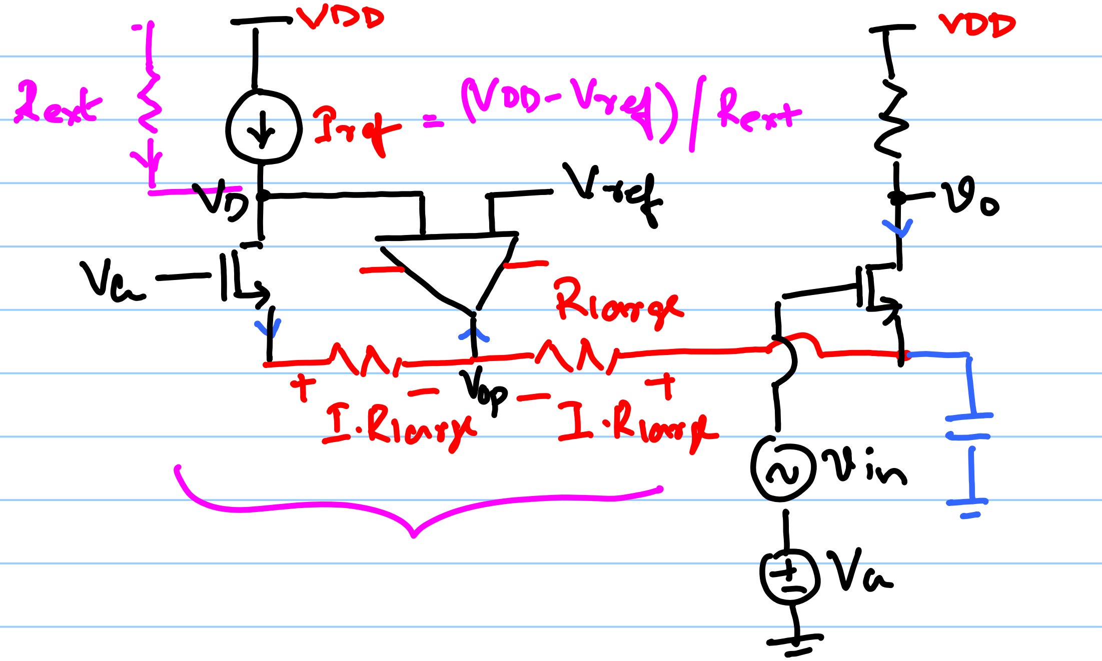
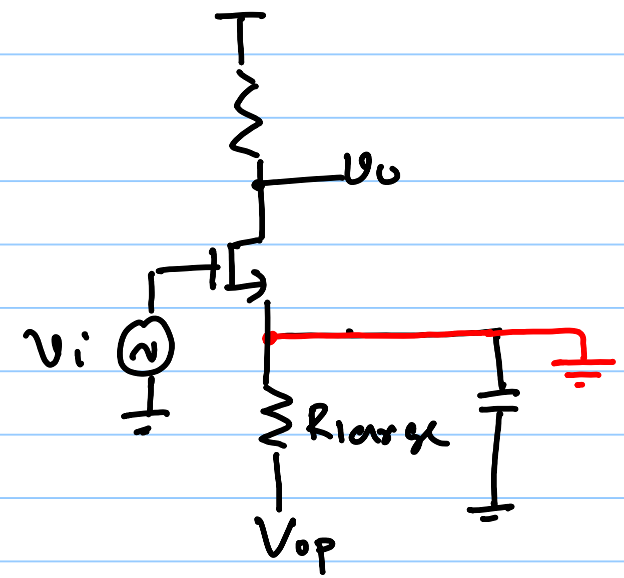
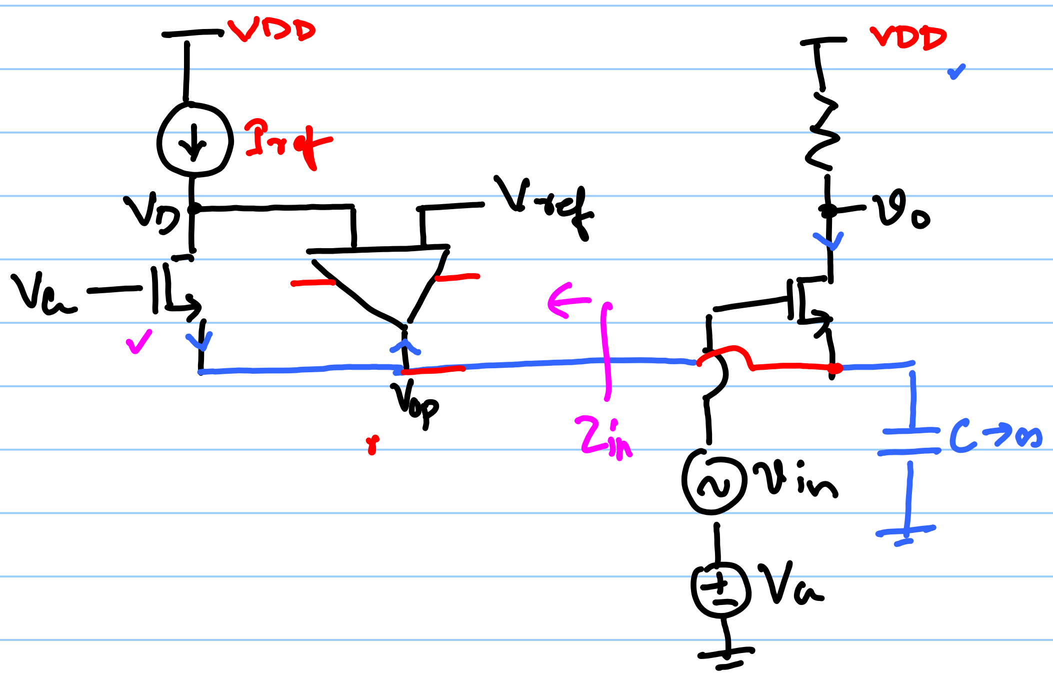
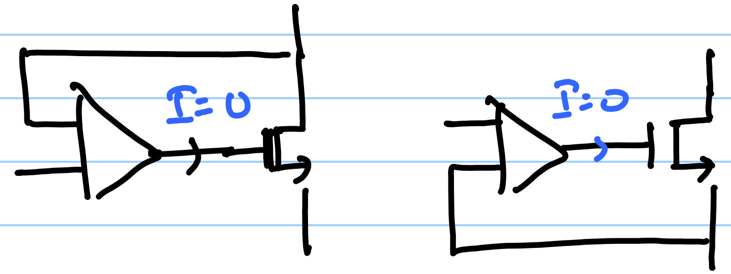
Lecture # 19

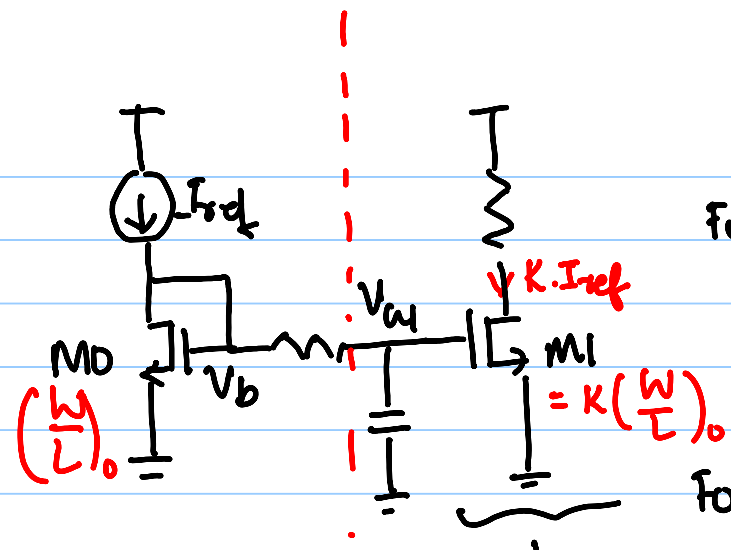
Note Title 16-09-2021











"Current Mirror"

For M0:

$$I_{DS} = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_0 (V_b - V_{tn})^2 = I_{ref}$$

For M1: $\left(\frac{W}{L}\right)_1 = K\left(\frac{W}{L}\right)_0$

$$I_{DS1} = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_1 (V_b - V_{tn})^2$$

$$= K \cdot \underbrace{\frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)_0 (V_b - V_{tn})^2}_{I_{ref}}$$

$$= K \cdot I_{ref}$$

Gain $= -g_m R_L$

$\left(\frac{W}{L}\right)_1 = K\left(\frac{W}{L}\right)_0$

$W_1 = K \cdot W_0$ ✓ ✓ #1

or $L_1 = \frac{1}{K} L_0$ #2

or $W_1 = M \cdot W_0$, $L_1 = N \cdot L_0$ } $\frac{M}{N} = K$ #3

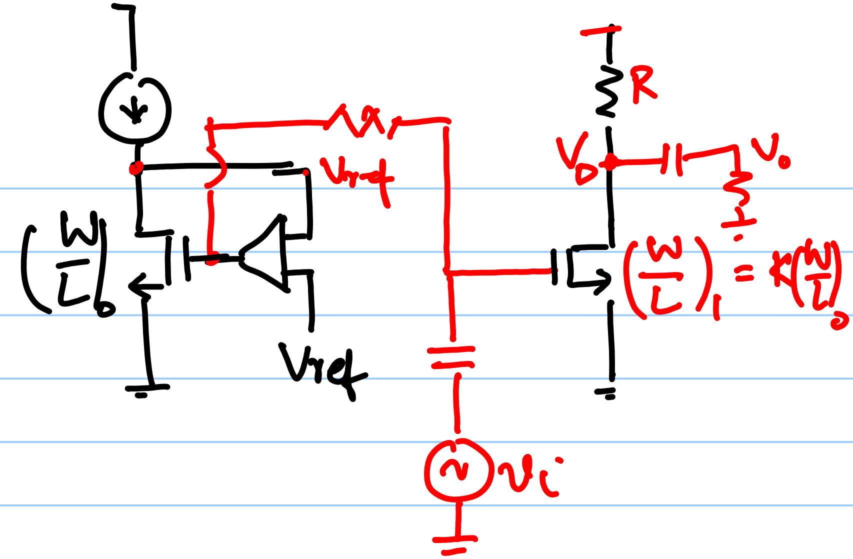
- For different length you will have different threshold voltage.

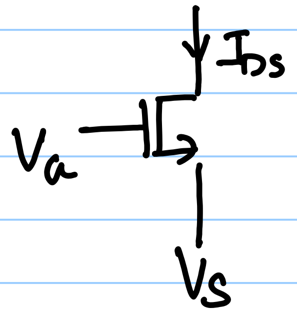
$\left(\frac{W}{L}\right)_1 = 4\left(\frac{W}{L}\right)_0$

#1 $L_1 = L_0$, $W_1 = 4W_0$ ✓

#2 $L_1 = \frac{L_0}{4}$, $W_1 = W_0$

#3 $L_1 = 2L_0$, $W_1 = 8W_0$ ✓





$$I_{DS} = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)(V_a - V_s - V_{tn})^2$$

MOSFET gives non-linear voltage controlled current source.

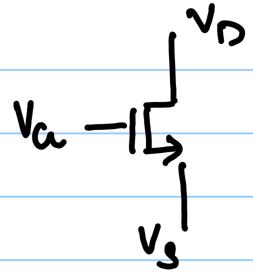
linear voltage controlled current source (VCCS)

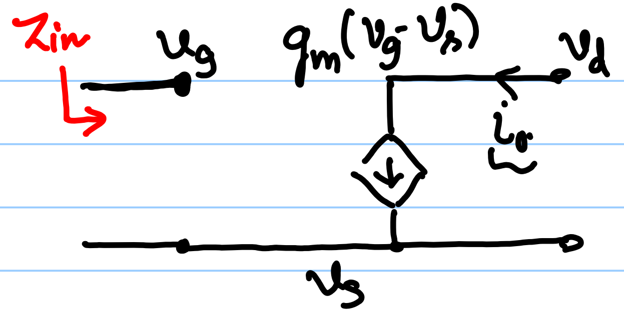
" " voltage source (VCVS)

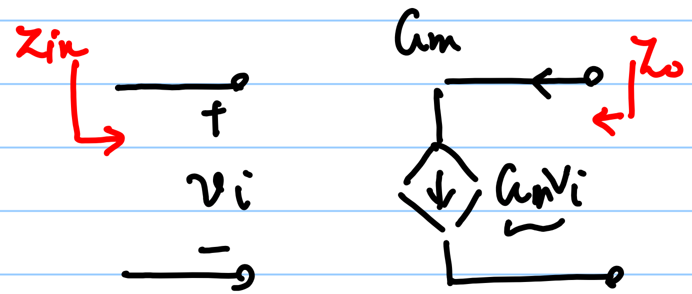
Current CCVS

Current CCCS

MOSFET as VCCS







Ideal VCCS

$$g_m = \sqrt{2 ? \mu_n C_{ox} \frac{W}{L}}$$

$Z_{in} = \infty$, $Z_o = \infty$

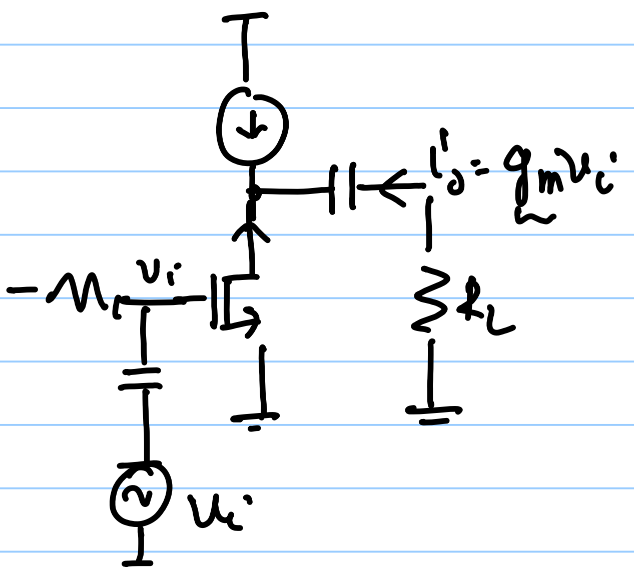
$I_o = g_m v_{gs}$

g_m: constant.

$Z_{in} = \infty$, $Z_o = \infty$

$I_o = G_m v_i$

G_m: constant



$i_o = \alpha . v_i$

$i_o = g_m v_i$

$\alpha = f(g_m)$

$$\frac{d\alpha}{d g_m} = 0$$