

Midterm #2 - clutter policy

Project 2-3 person teams

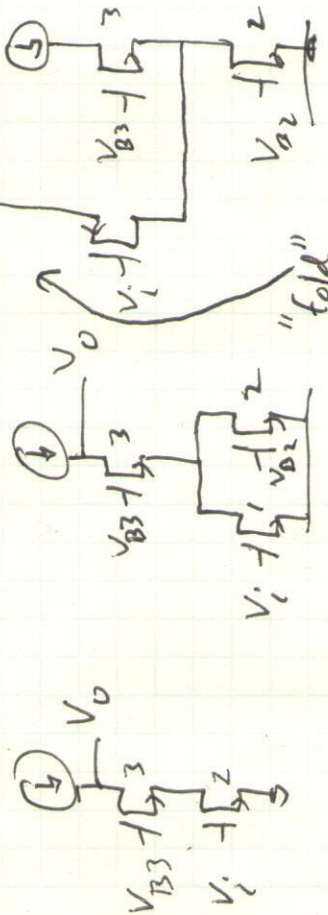
Real project specs

Real VT variation, (but not P)

analog front end: sample battery, temp, other inputs
PGA + ADC
switched capacitor

Folded cascode - industry workhorse
in/out swing
biasing

Simplest "folding"



$$-g_{m2} (g_{m3} r_{o3} || R_{12}) - g_{m1} (g_{m3} r_{o3} (g_{o1} || R_{o2}) || R_{op})$$

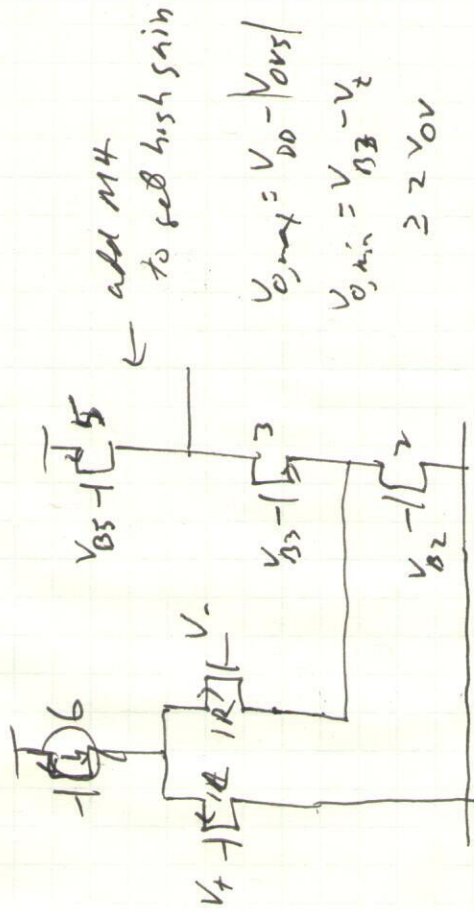
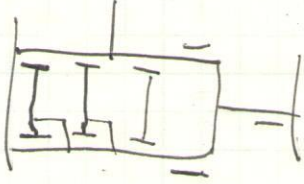
Same!

Last time: telescopic

Good gain
"single pole"
- good PM
- mirror doublet?
- cascode pole?

Sad in/out swing

Solution: folded cascode



add M4
to feed back gain

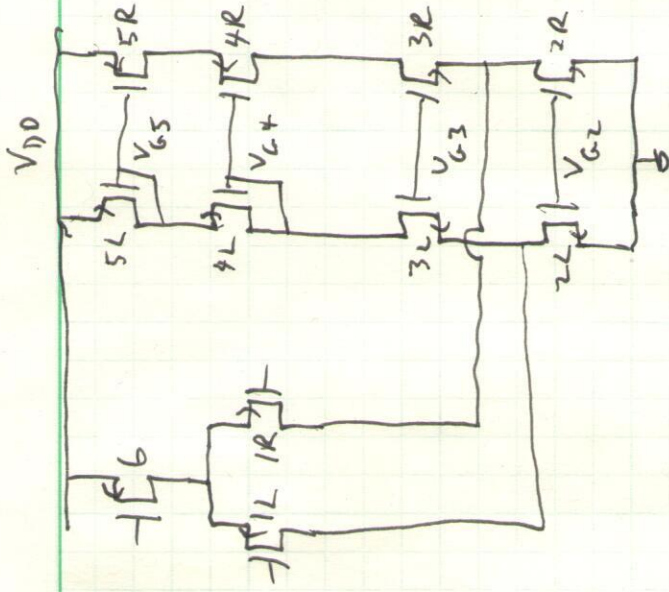
$$V_{o,max} = V_{DD} - V_{ovs1}$$

$$V_{o,min} = V_{B3} - V_{V2} \geq 2 V_{ov}$$

$$A_v = -g_{m1} r_{o5}$$

$$V_{icm,max} = V_{DD} - |V_{TP}| - |V_{ov}|_{ov8}$$

$$V_{icm,min} \geq V_{ov2} - |V_{TP}| \text{ easily } < 0$$



Simplest mirror bias (self-biased)

need V_G for 2, 3, 6

Bias currents

$$I_{D6} = 2I_1$$

$$I_2 = I_1 + I_3$$

$$I_5 = I_4 = I_3$$

often $I_1 = I_3$ so then often

$$\left(\frac{W}{L}\right)_1 = \left(\frac{W}{L}\right)_4 = \left(\frac{W}{L}\right)_5$$

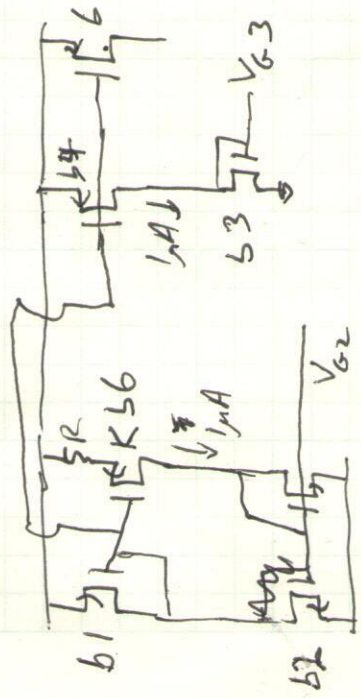
$$\left(\frac{W}{L}\right)_6 = 2 \left(\frac{W}{L}\right)_1 \leftarrow \text{may not care about } V_{ic, \max}$$

$$\left(\frac{W}{L}\right)_2 = 2 \left(\frac{W}{L}\right)_3$$

generally V_{G2} and V_{G4} is easy

need V_{G3} to be $\geq V_{tn} + 2V_{DVI} + V_{DVI}$

(and we are ignoring body effect)



if $\left(\frac{W}{L}\right)_{b3} = \frac{1}{4} \left(\frac{W}{L}\right)_{b2}$ then $V_{OV, b3} = 2 V_{OV, b2}$

in practice, make $\left(\frac{W}{L}\right)_{b3} < \frac{1}{4} \left(\frac{W}{L}\right)_{b2}$

type 1/5, 1/6

Same game for "high swing" mirror

