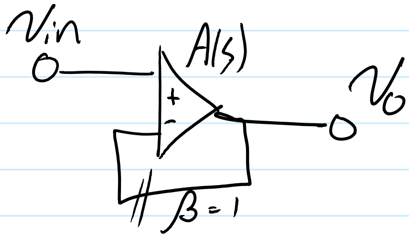
Discussion 7

Wednesday, March 13, 2013 3:11 PM

HW - Problem 2



$$\frac{V_o}{V_{in}} = \frac{A(s)}{1+\beta A(s)} \leftarrow \text{general} \qquad @_{DC} = \frac{A_o}{1+\beta A_o} \approx \frac{1}{\beta}$$

$\beta A_o >> 1$

$$A(s) = \frac{A_o}{(1+s/\omega_{p1})(1+\frac{s}{\omega_{p2}})} \qquad (1+s/\omega_{p1})(1+\frac{s}{\omega_{p2}}) = P(s) \text{ denominator}$$

$$\frac{V_o}{V_{in}} = \frac{A_o/P(s)}{1+\beta A_o/P(s)} = \frac{A_o}{P(s)+\beta A_o} = \frac{A_o}{(1+s/\omega_{p1})(1+s/\omega_{p2})+\beta A_o}$$

$\omega_{p2} = 100\,\omega_{p1}$

@ Low frequencies, ($s/\omega_{p2} << 1$)

$$= \frac{A_o}{(1+s/\omega_{p1})+\beta A_o} \rightarrow \text{pole is shifted by } (1+\beta A_o).$$

@ Higher Frequencies ($s/\omega_{p1} >> 1$)

$$\frac{V_o}{V_{in}} = \frac{A_o}{\frac{s}{\omega_{p1}}(1+\frac{s}{\omega_{p2}})+\beta A_o}$$

$$= \frac{A_o/(\frac{s^2}{\omega_{p1}\omega_{p2}}+\beta A_o)}{1+\frac{s}{\omega_{p1}\beta A_o + s^2/\omega_{p2}}}$$

Problem 5 : $\boxed{W = 10\mu m}$

Telescopic Opamps

$$\frac{A_o}{1+\beta A_o} =$$

↑ for buffer [illegible]

Op-Amps

- High Gain [illegible]

$1 + \beta A_o$
↑ 1 for buffer

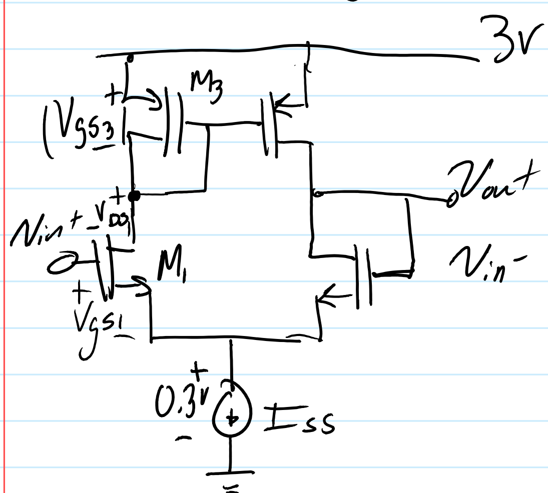
Op-Amps
- High Gain ($10 - 10^5$)

up until the 80s
Designed GS building blocks
→ find the ideal op-amp

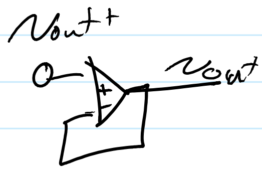
this, while still produced many good designs, → not done anymore

Today
- Multidimensional Optimization
  - Gain
  - Speed - (BW)
  - Power
  - insensitive to Variation (robust)
  - Sensitivity - dynamic Range - linearity
  - Output Swing
    ↳ size, power, speed
    → fully differential
    2x output swing

One Stage



$gain = g_m(r_{on} || r_{op})$
Max gain ~20



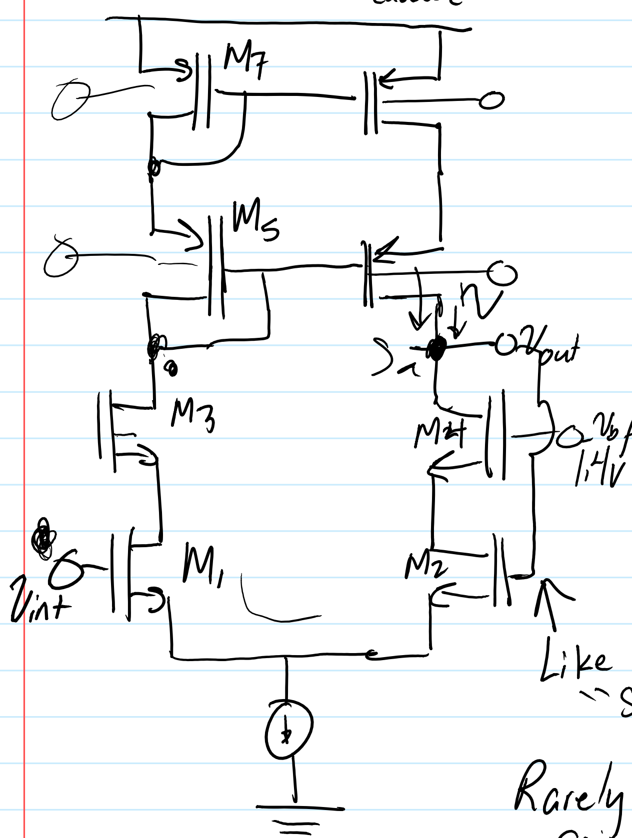
$V_{in,min} = V_{css} + V_{gs1}$
$V_{gs} = 1V$, $V_{Th} = 0.7V$ $V_{ov} = 0.3v$
$V_{in,min} = 1.3v$

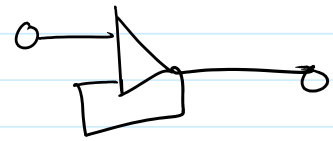
$V_{in,max} = V_{DD} - |V_{gs3}| + V_{Th1}$

$V_{in,max} = 3v - 1v + .7 = 2.7v$

Telescopic (cascode) Opamp

Telescopic ^cascode Opamp





Output Swing

$2(V_{DD} - (V_{OD1} + V_{OD3} + |V_{OD5}| + |V_{OD6}|))$

↑ fully differtial

$\text{gain} = g_{mN}[(g_{mN} r_{oN}^2) \| (g_{mP} r_{oP}^2)]$

↑ Like "high swing current"
"strongly" Limit input range

Rarely used as a unity gain buffer
gain ~1500 with a single stage