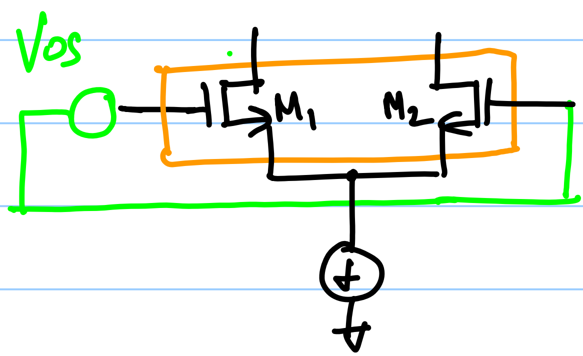
ECE 614 – Lecture 21

Note Title 11/4/2014

* Offset Cancellation Techniques



$$V_{OS} = \Delta V_{THN} + \frac{1}{2} V_{ov} \cdot \frac{\Delta(W/L)}{W/L}$$

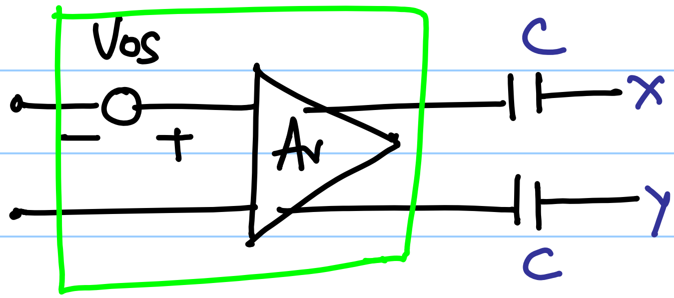
$$\sigma_{\Delta V_{THN}} \propto \frac{1}{\sqrt{WL}}$$

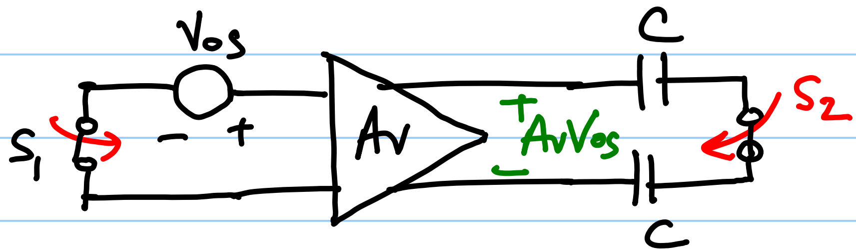
To reduce V_{OS}, $\underbrace{WL}_{\text{Area}} \uparrow$

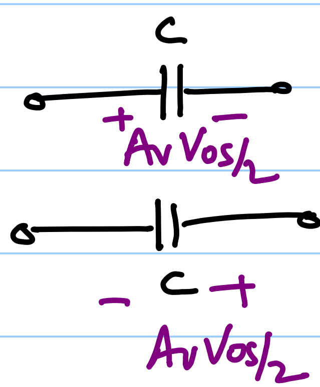
$\Rightarrow C_{in} \uparrow \Rightarrow$ may degrade speed & performance

$\Rightarrow$ higher power consumption

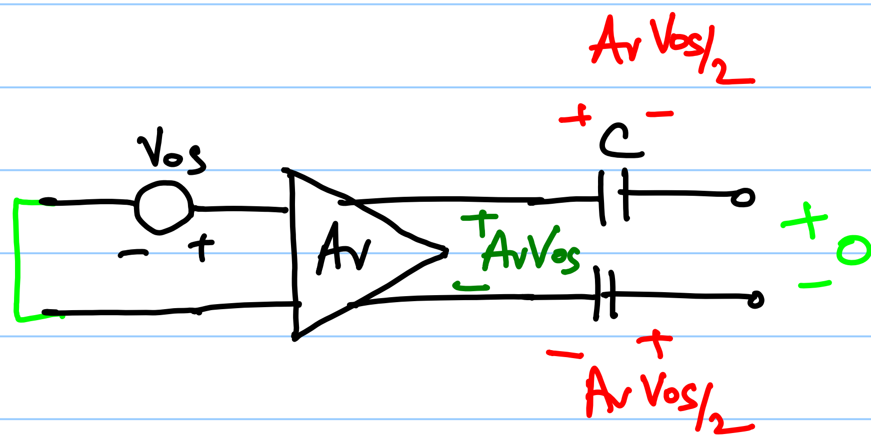
*Need to electronically cancel offset

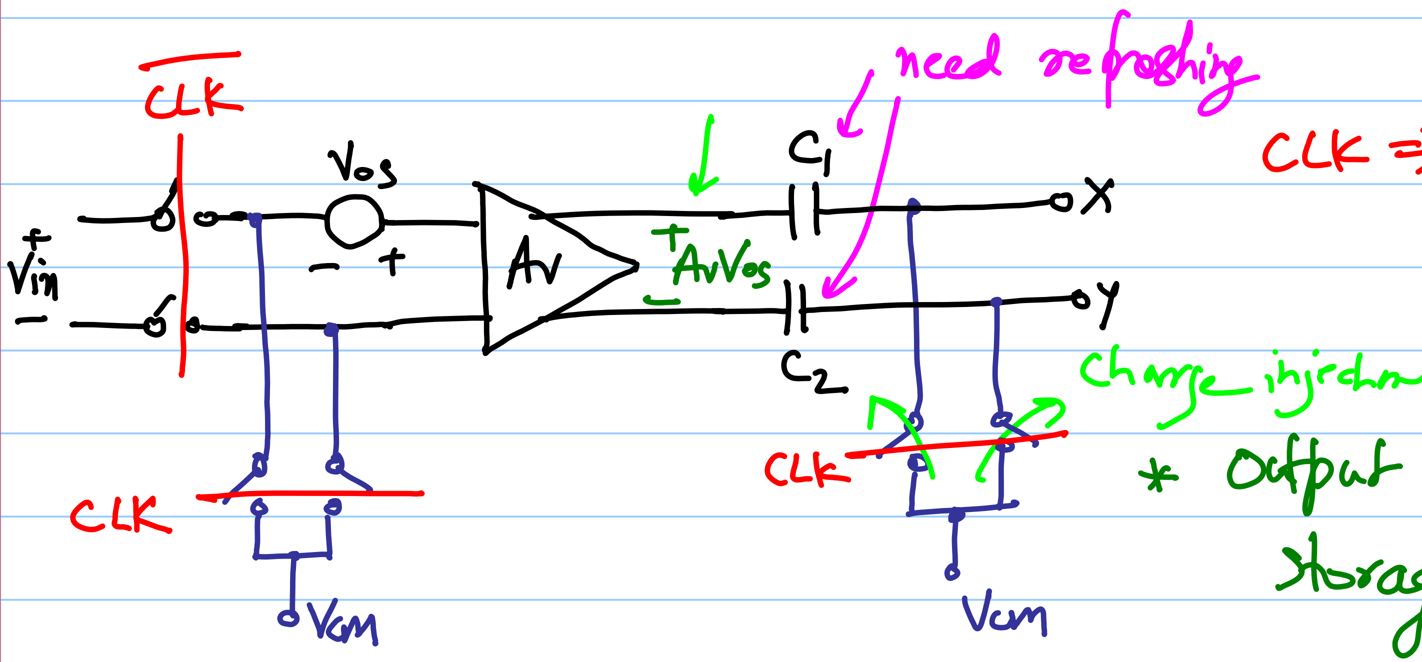






when all the voltages are settled, Av Vos is stored on the capacitors





CLK ⇒ offset storage phase

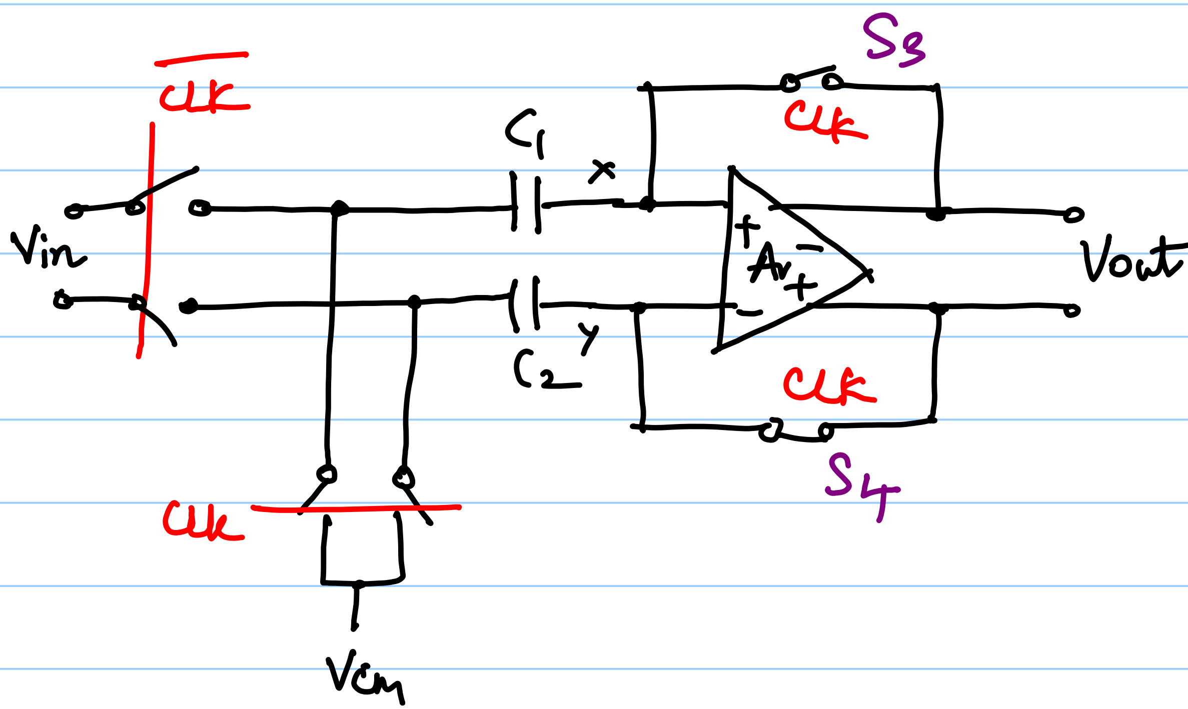
* Output offset storage

But, for large $|A_v|$ the circuit can saturate

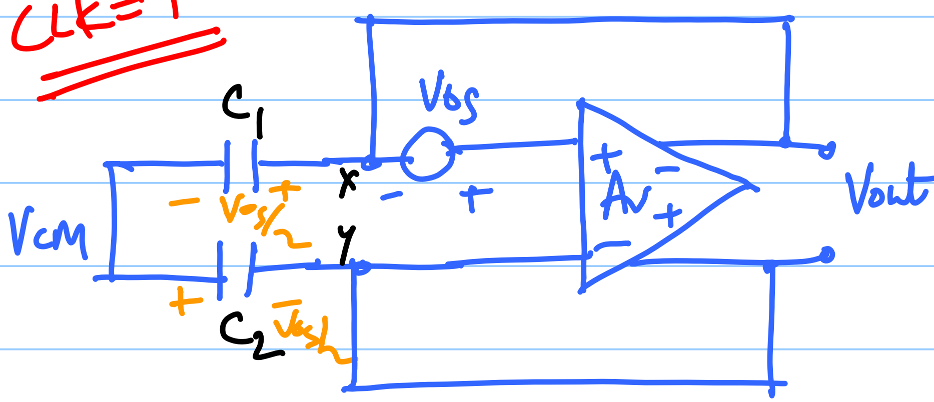
$|A| \le 10$

* Need to store the offset of the input side

$|A_v|$ is large
$\Rightarrow |A_v| >> 1$



CLK=1

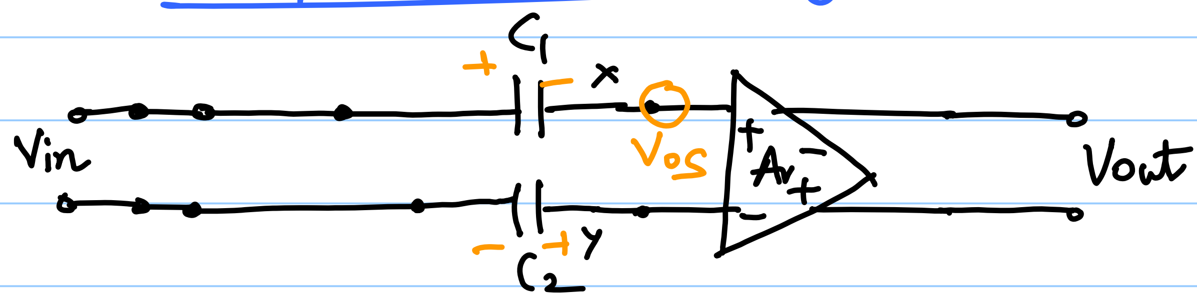


$V_{out} = V_{xy}$

$(V_{out} - V_{os})(-A_v) = V_{out}$

$\Rightarrow V_{out} = \frac{A_v}{1+A_v} V_{os}$

Input offset Storage and Cancellation



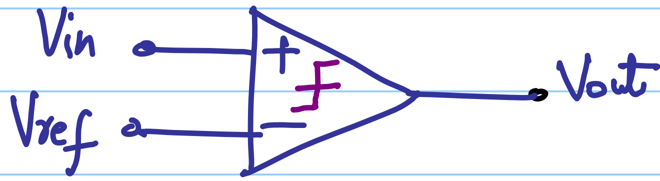
$$\frac{A_v}{1+A_v}V_{os} - V_{os} = V_{os}\left[\frac{A_v - 1 - A_v}{1+A_v}\right]$$

$$= -\frac{V_{os}}{1+A} \simeq -\frac{V_{os}}{A}$$

Input referred offset is $\frac{V_{os}}{A}$

not zero!

Regenerative Comparators



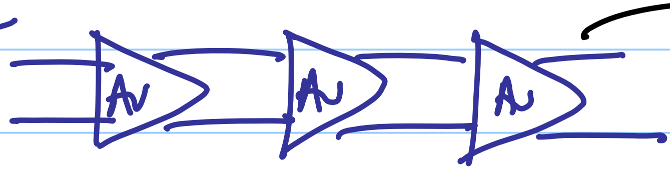
If $V_{in} > V_{ref} \Rightarrow V_{out} = V_{DD}$

else, $V_{out} = 0$.

high input resolution ⇒ ~1 μV ⇒ high gain

high speed operation ⇒ high speed

Ideal



gain: A_v

BW: f_0

⇒ Cascade several stages to get large gain

n stages

$$\text{gain} = A_v^n$$

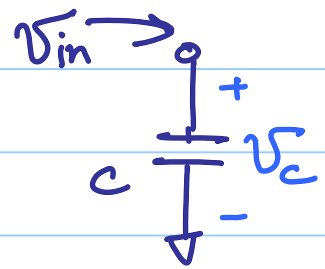
$$\frac{A_v^n}{(1+jf/f_0)^n}$$

$$f_{3dB,n} = f_0 \sqrt{2^{1/n} - 1}$$

Idea 2: Use positive feedback

Lets say we want to compare V_{in} with $V_{ref} \triangleq 0$.

input sampled on the capacitor C



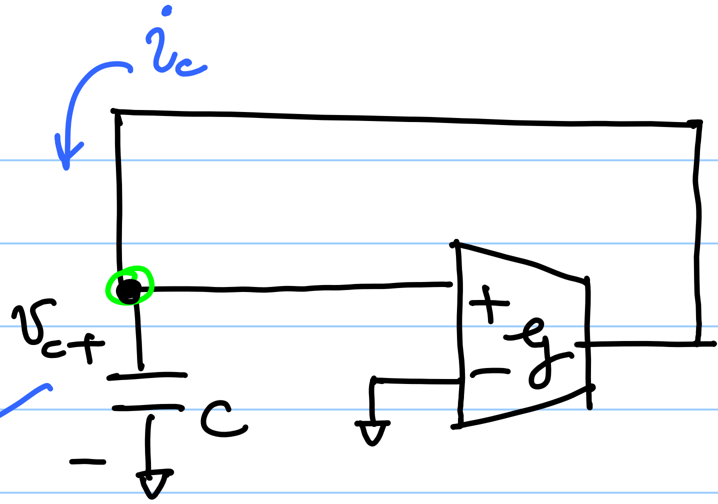
* Add more charge if $V_{in} > 0$

  ⇒ inject current into C

  ⇒ V_c will reach ∞

* Conversely steal current from C

  V_c will decrease to $-\infty$



@ $t=0$, $v_c = v_0$

@ $t \to \infty$

$v_c \to \infty$ for $v_0 > 0$

$v_c \to -\infty$ for $v_0 < 0$

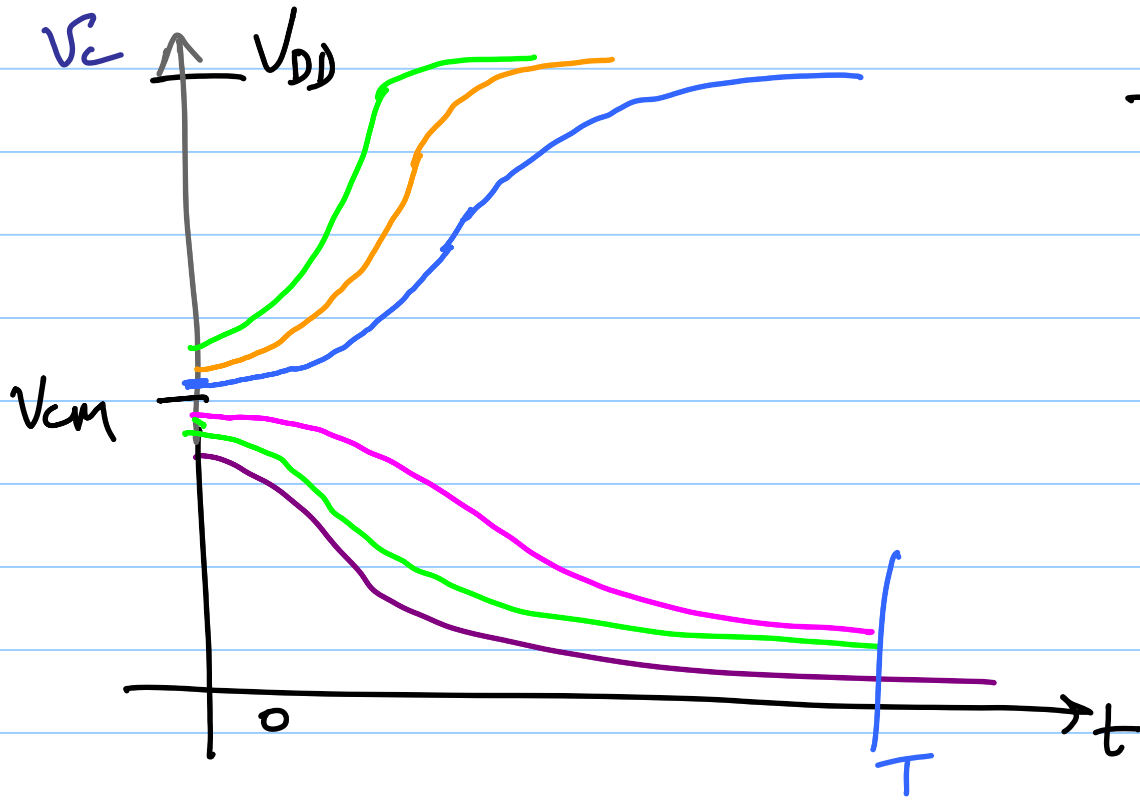
$$i_c = C\frac{dv_c}{dt} = g v_c$$

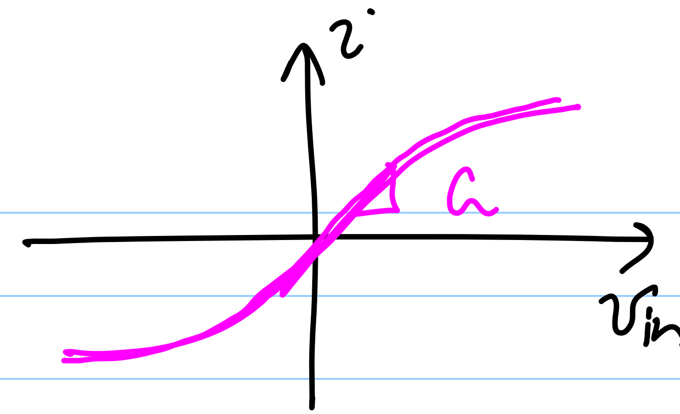
$$v_c(t) = v_0 e^{+\frac{tG}{C}}$$

pole in the RHP

⇒ will eventually hit the rails

time-constant $\tau = \frac{C}{G}$





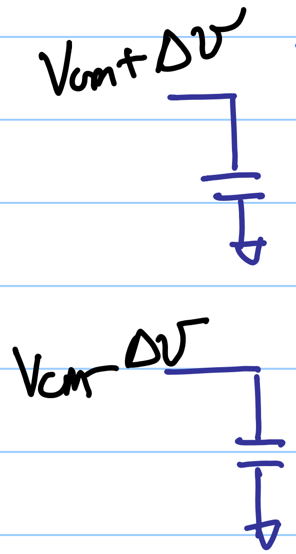
$\tau_c = \frac{C}{G} \Rightarrow$ regenerative time-constant

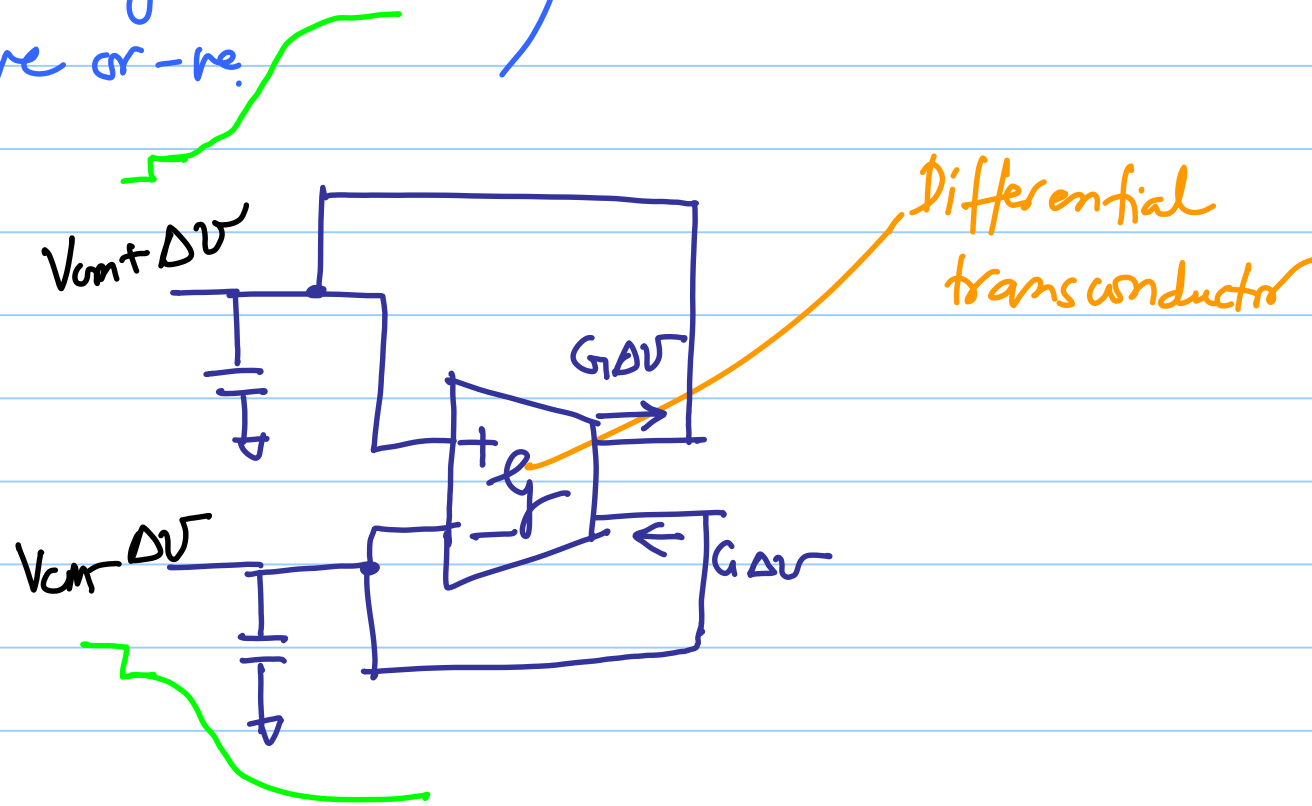
* minimum resolvable voltage $\sim \frac{V_{DD}}{e^{TG/C}}$, T is the settling time

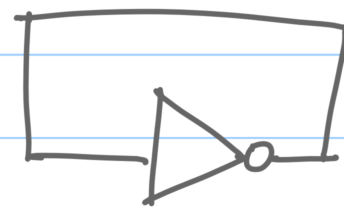
Differential Signals:

Compare the two inputs and figure out if the difference is +ve or −ve

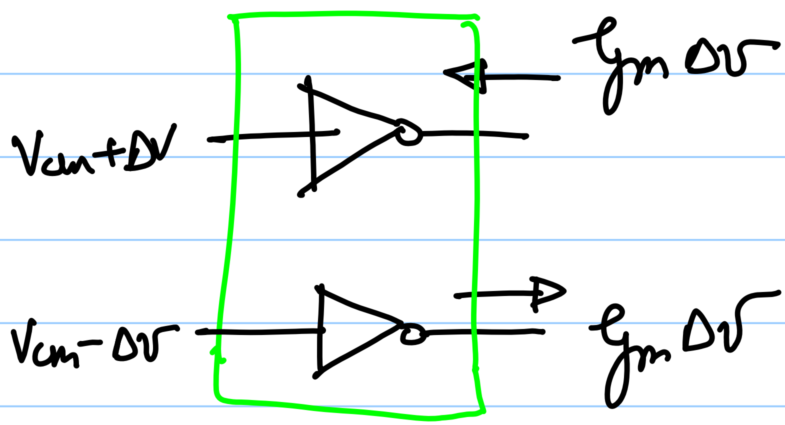
ΔV is the initial signal



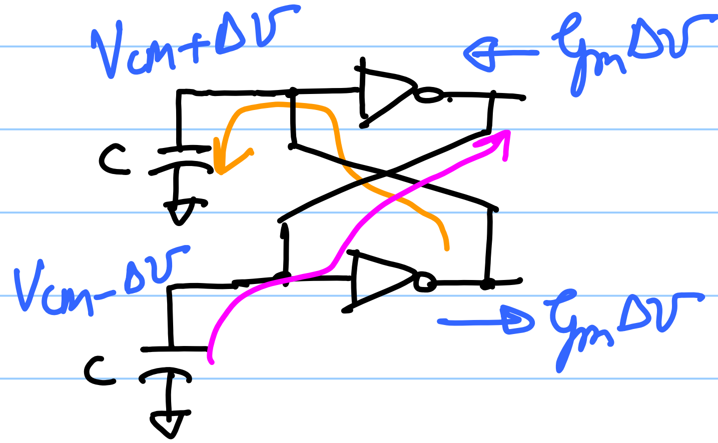




high gain around the V_{sp}



differential g_m



redraw