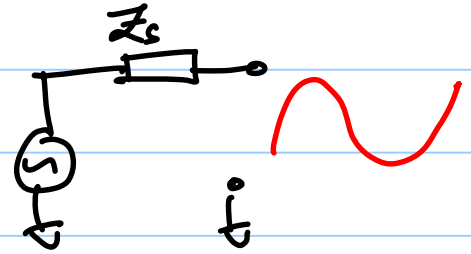
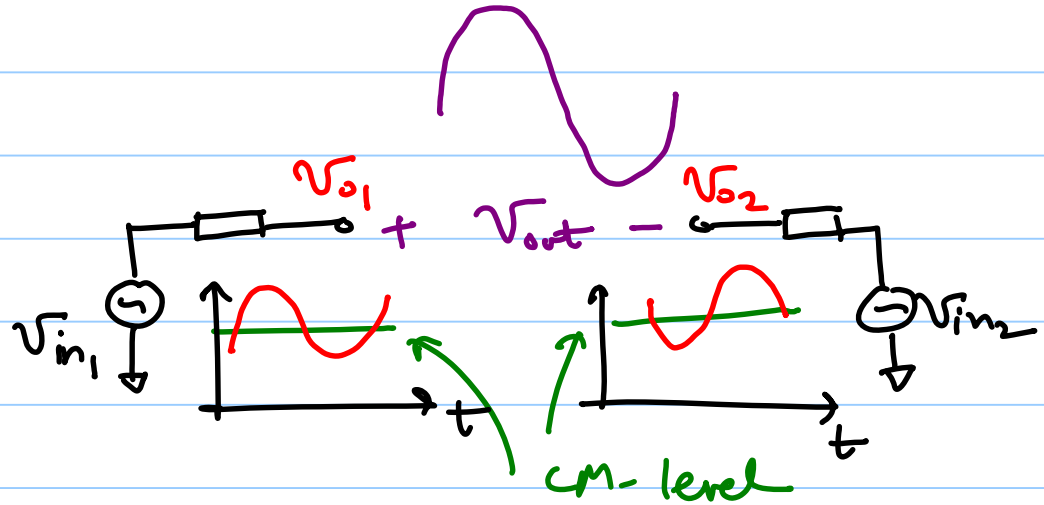
ECE 614 – Lecture 1

Note Title 8/26/2014

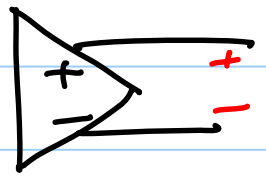
fully differential circuits:





cm-level : $V_{cm} = \frac{v_{o1} + v_{o2}}{2}$ ⇐ Average

differential signal: $v_d = v_{o1} - v_{o2}$ ⇐ Difference



(+) Rejects any CM disturbances

↳ V_{DD}/ GND noise

↳ Capacitively coupled noise

(+) 2X signal swing

↳ 6 dB more signal power

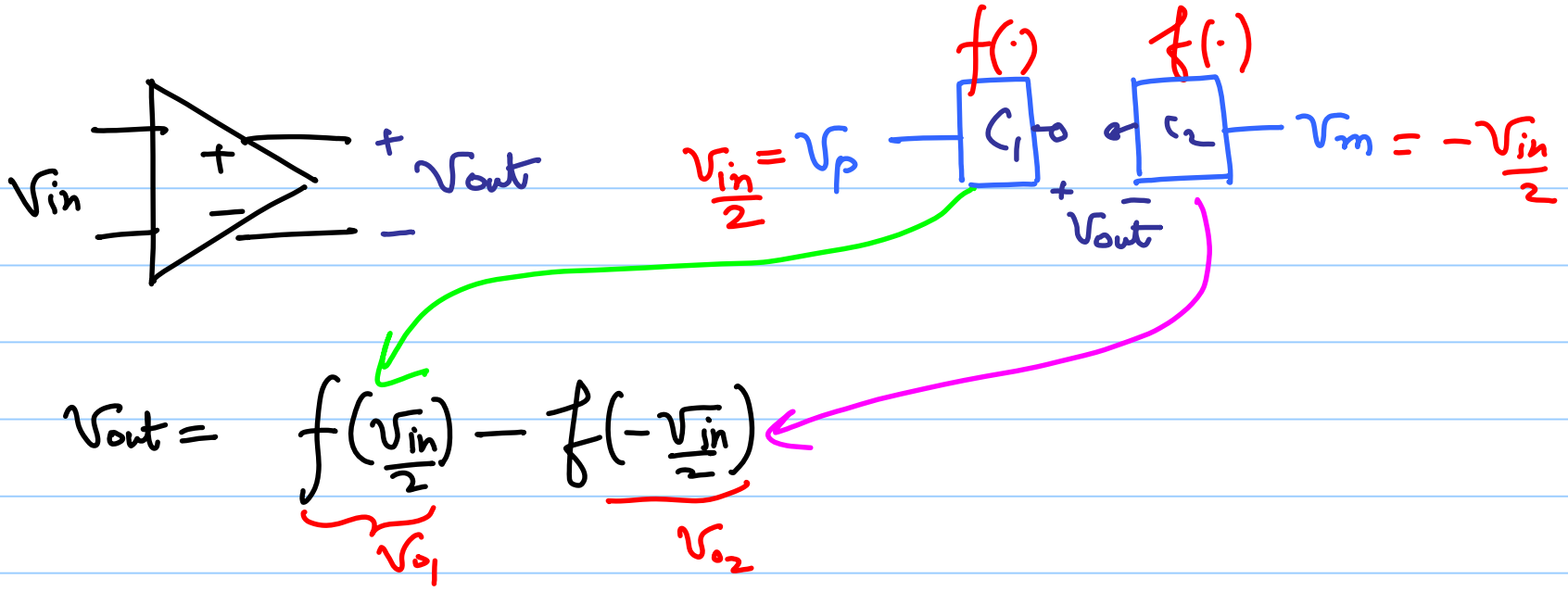
at 3dB increase in noise

⇒ 3dB gain in SNR

(+)

get rid of even-order non-linearity.

rejects



Differential circuit

$$V_{out} = \underbrace{f\left(\frac{V_{in}}{2}\right)}_{V_{o1}} - \underbrace{f\left(-\frac{V_{in}}{2}\right)}_{V_{o2}}$$

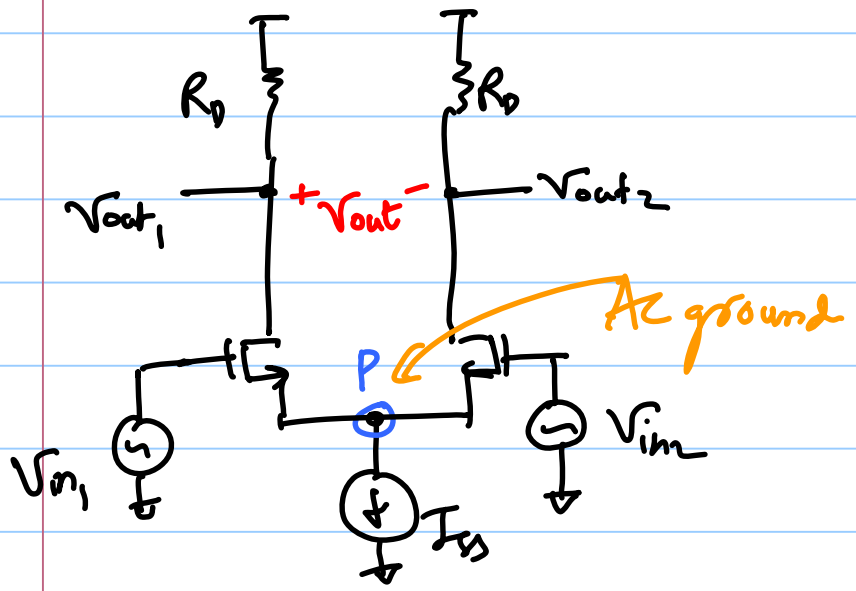
$$g_{odd}(x) = \frac{f(x) - f(-x)}{2} \quad \leftarrow \text{odd } f^n \text{ doesn't have even order term}$$

$$= a_1 x + a_3 x^3 + a_5 x^5$$

$$g_{even}(x) = \frac{f(x) + f(-x)}{2} \Rightarrow \text{CM output level}$$

Half Circuit Analysis ← Razavi

$$V_d = V_{in_1} - V_{in_2}$$

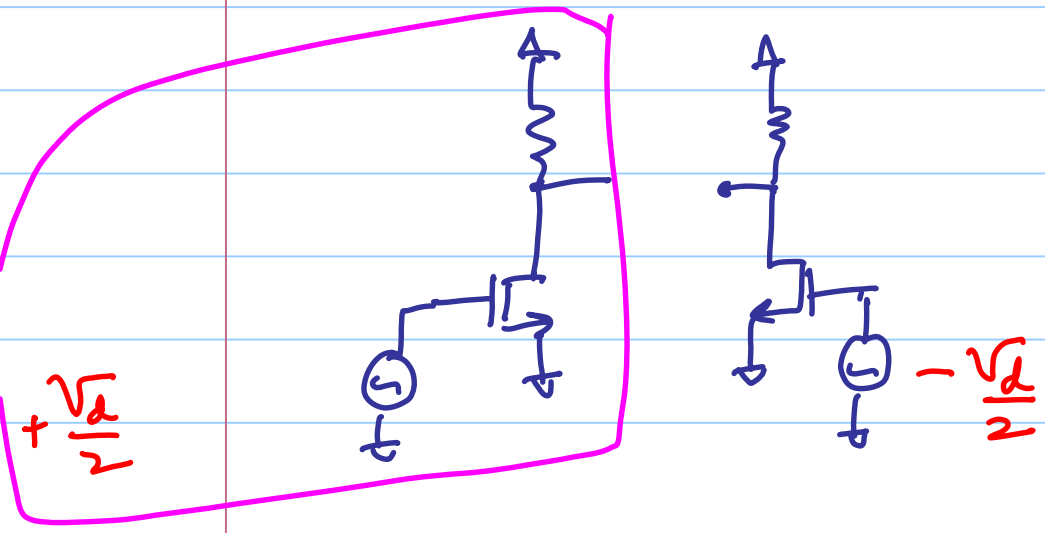


AC

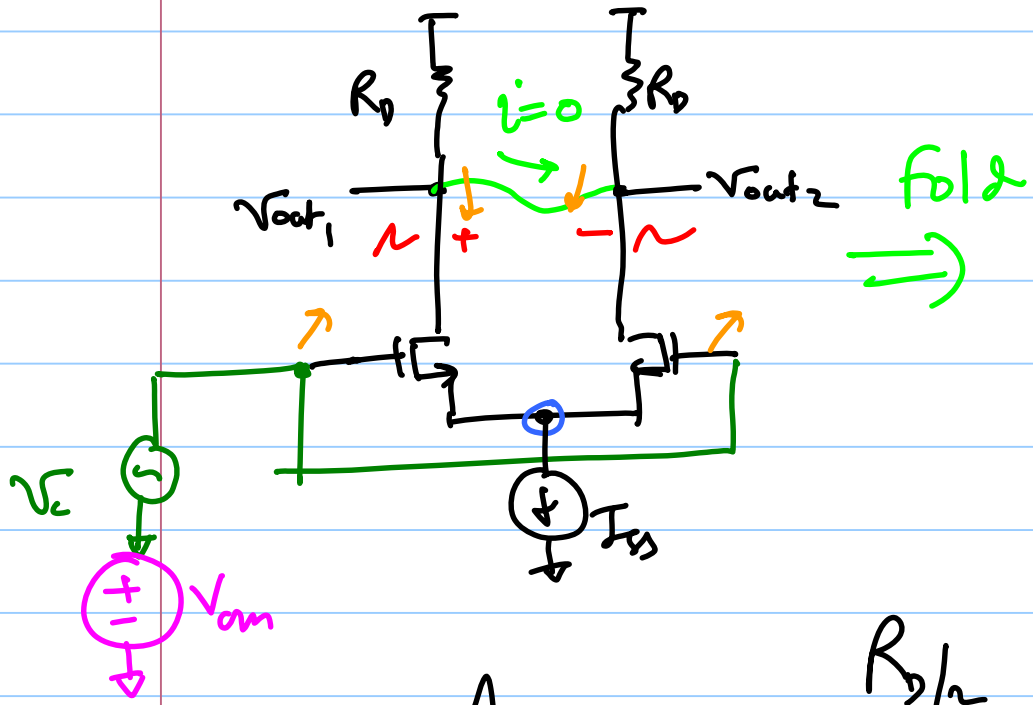
↙ Differential Half-Circuit

↘ CM-equiv. Circuit

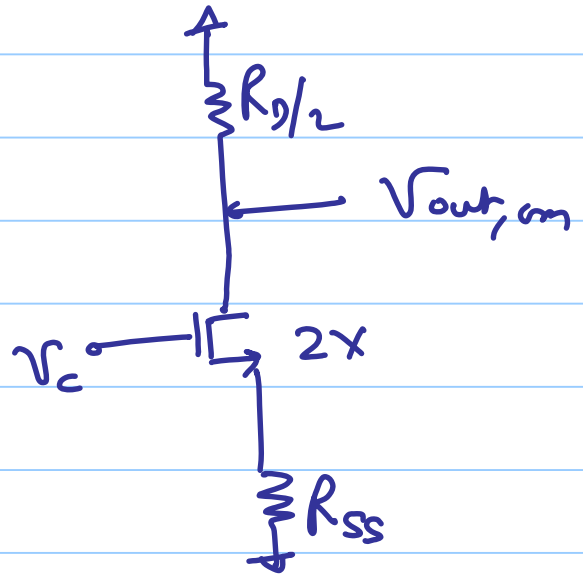
Differential Half Circuits:



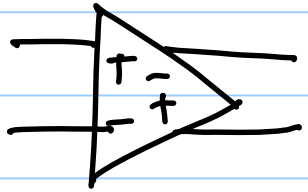
$$A_{DM} = -g_m(R_D \| r_o)$$

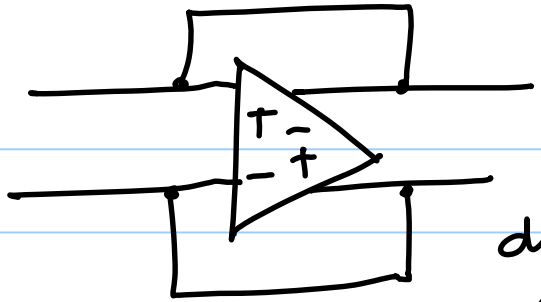


fold

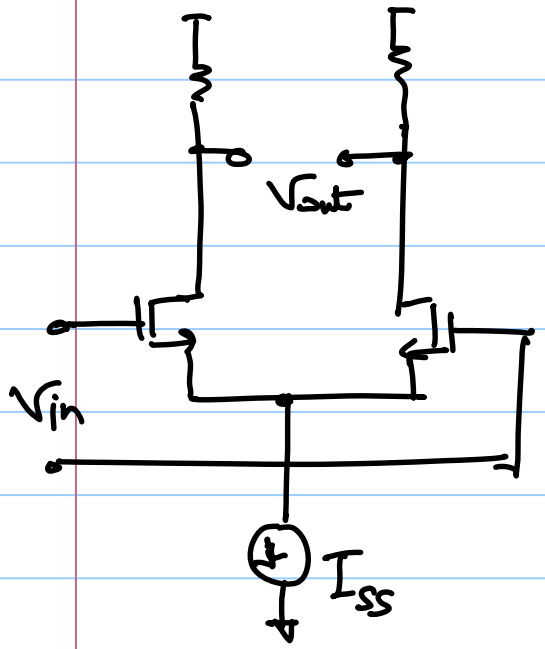


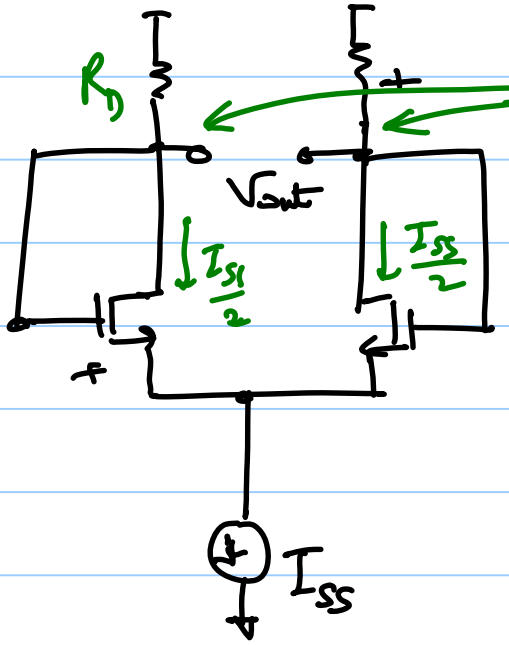
$$A_{v,cm} = -\frac{R_D/2}{\left(\frac{1}{2g_m}\right) + R_{SS}}$$





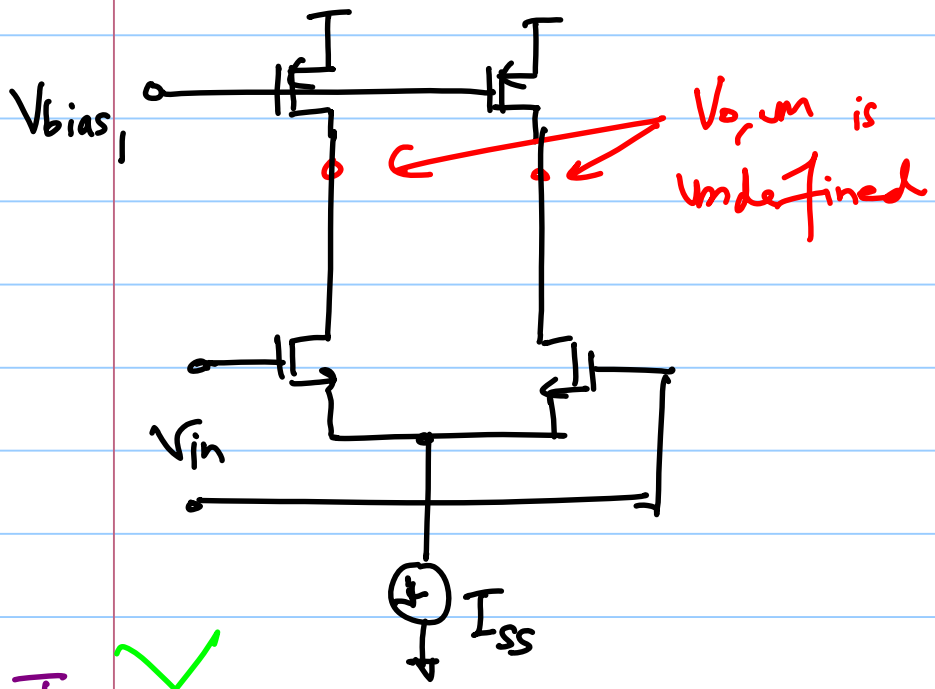
differential negative feedback



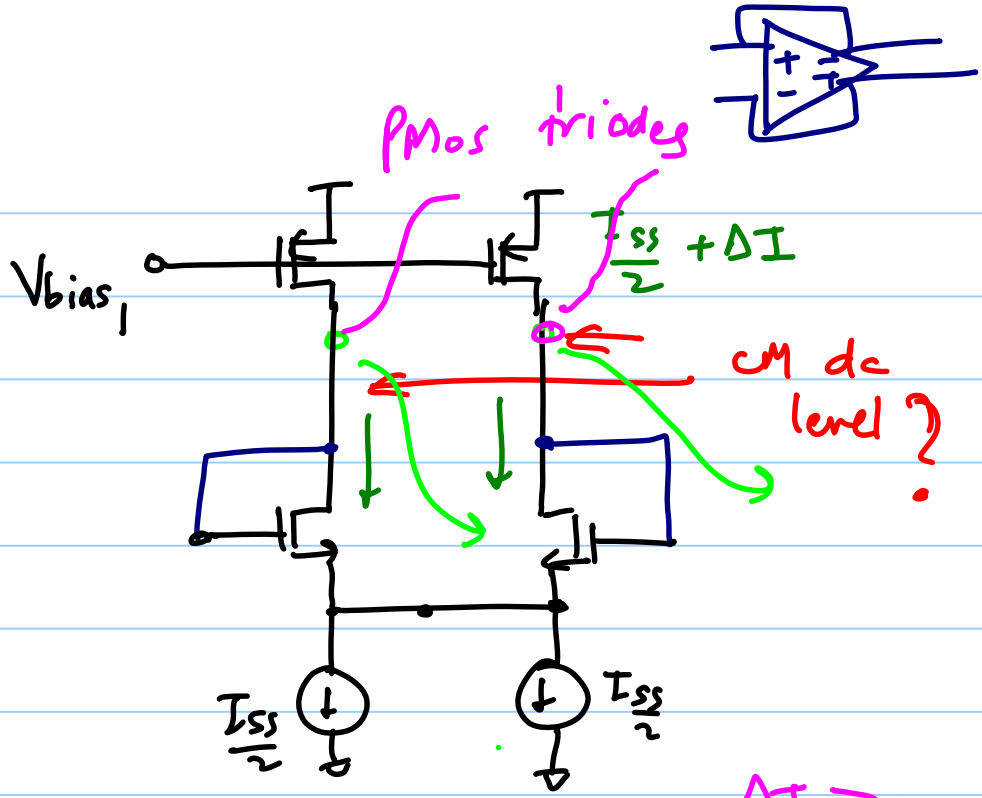


CM - level

$V_{DD} - \frac{I_{SS}}{2} R_D$

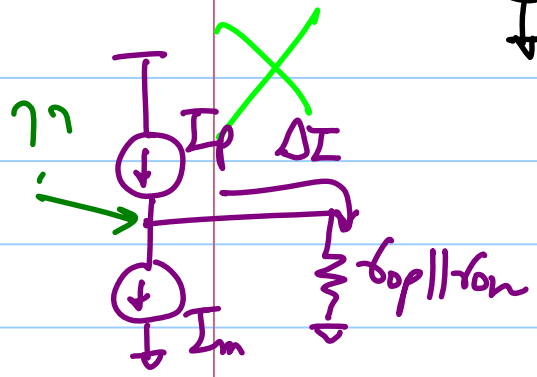


$V_{o,cm}$ is undefined



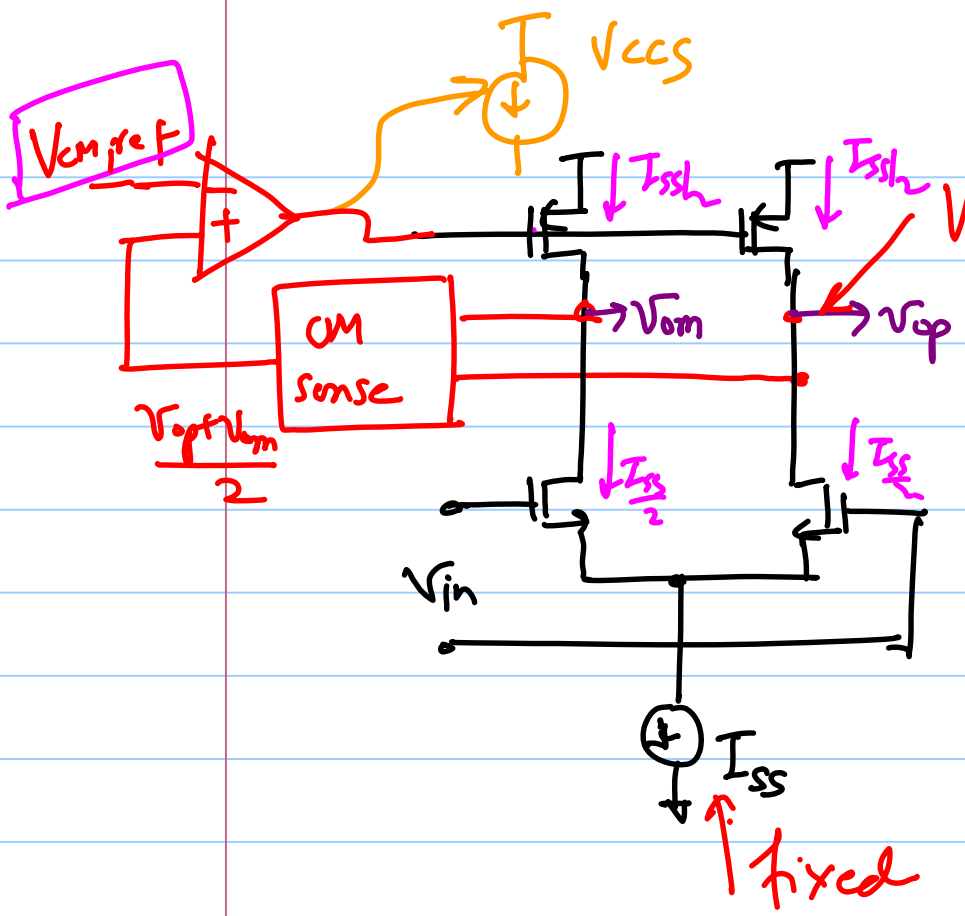
$\Delta I > 0$

$\Delta I < 0$



Can never have two "Independent" current sources tight to set a node voltage

CMFB loops



desired CM-level at the output

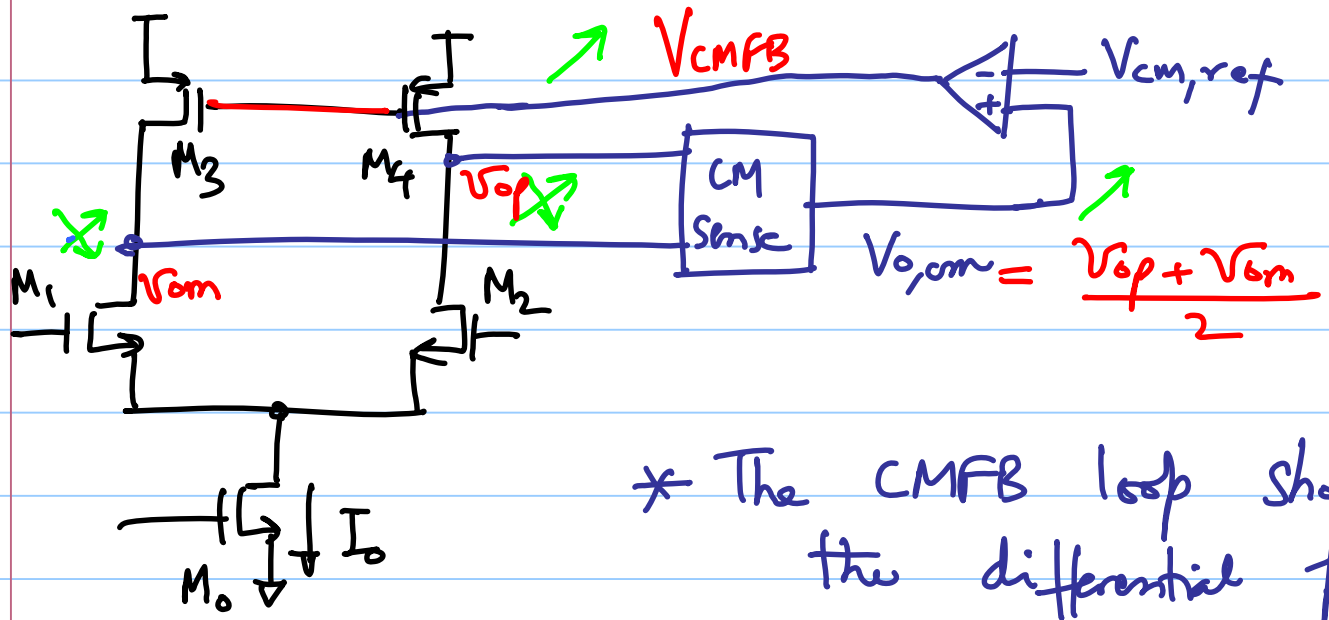
$\Delta I \to 0$ by the CMFB

Common-mode feedback loop

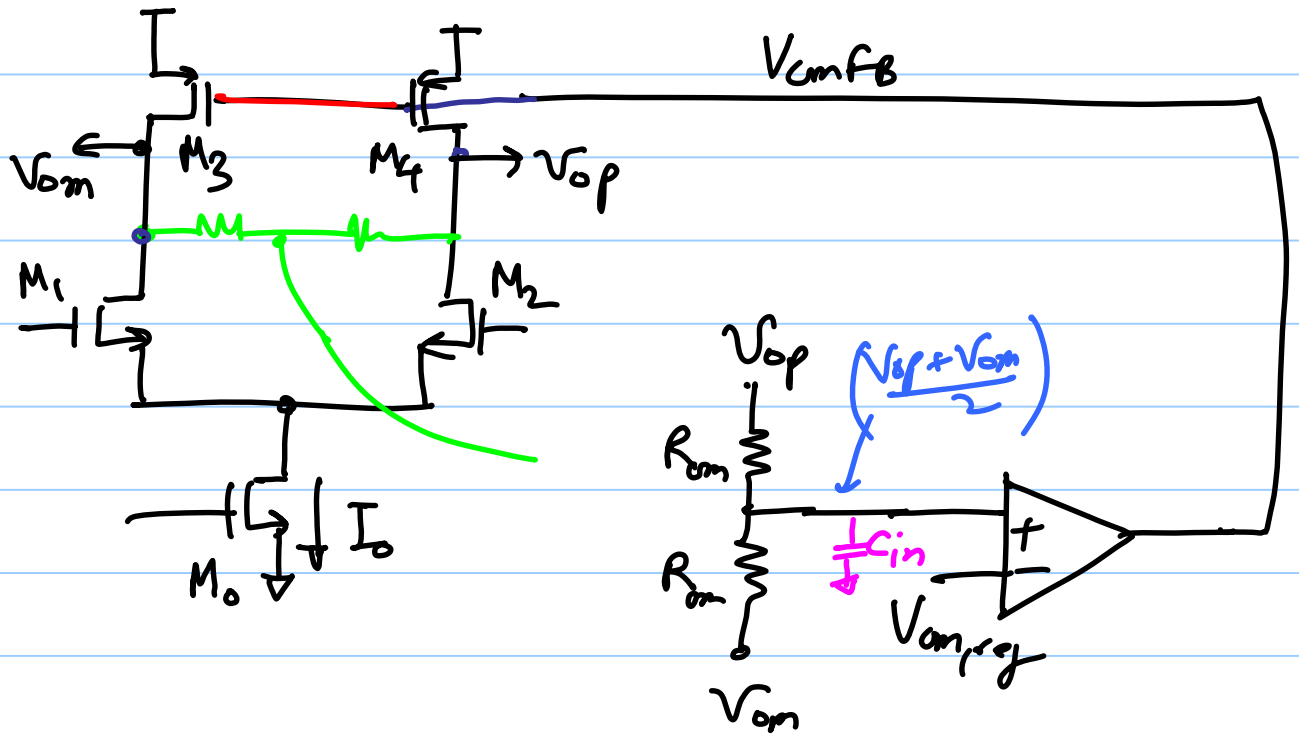
↳ $V_{ocm} \to V_{cm,ref}$

& $I_{pmos} = I_{n,mos}$

-ve feedback loop to set the output CM-level.



* The CMFB loop shouldn't disturb the differential picture


V_{cmFB}
V_{om}
M_3
M_4
V_{op}
M_1
M_2
I_o
M_o
V_{op}
$\frac{V_{op}+V_{om}}{2}$
R_{om}
R_{om}
$\frac{1}{sC_{in}}$
$V_{om,reg}$
V_{om}