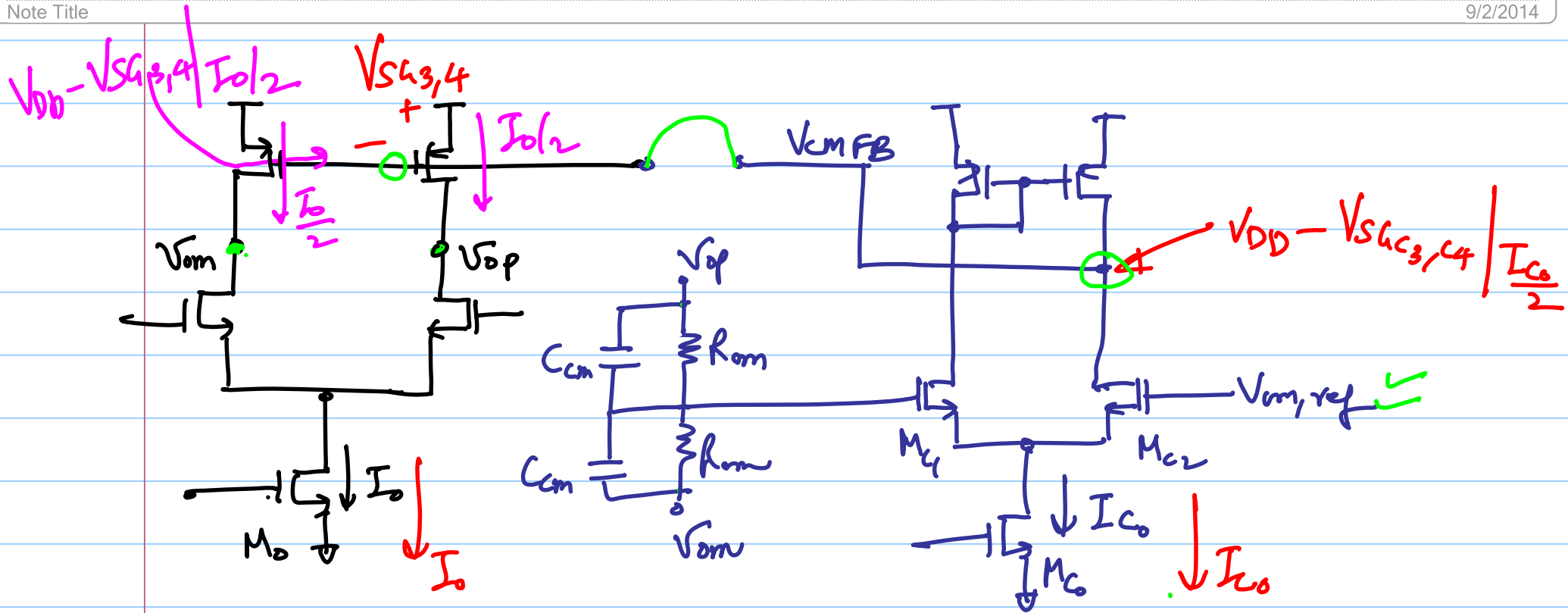


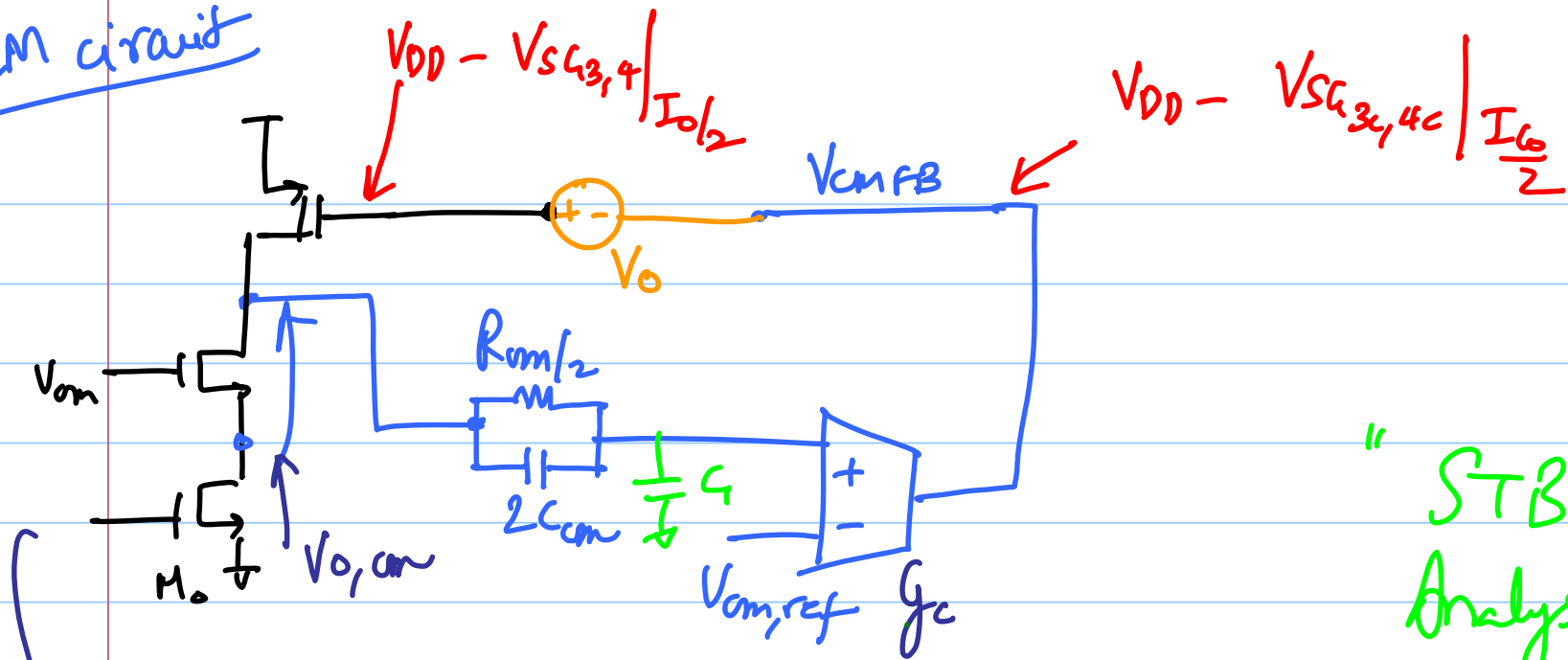
ECE 614 - Lecture 3

Note Title

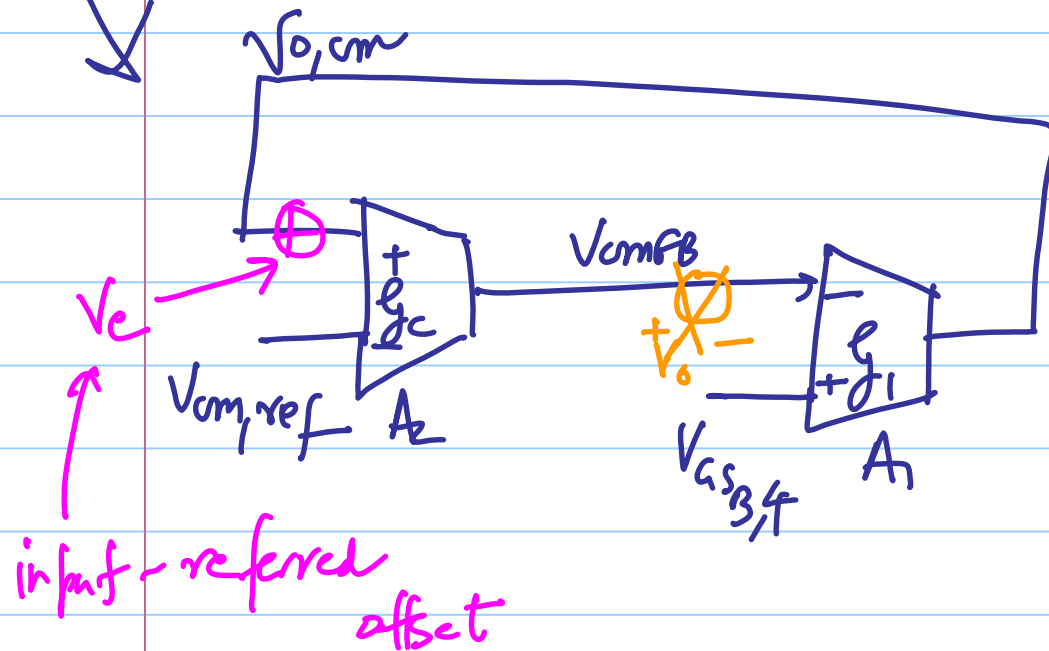
9/2/2014



CM circuit



STB Analysis



input referred ^{systematic} offset

$$\left| \underbrace{\left(\frac{V_{op} + V_{cm}}{2} \right)}_{V_{e}} - V_{cm, ref} \right| \rightarrow \frac{\left(V_{DD} - V_{SG_{3,4}} \Big|_{\frac{I_{co}}{2}} \right) - \left(V_{DD} - V_{SG_{3,4}} \Big|_{\frac{I_o}{2}} \right)}{1 + \text{loop-gain}}$$

$V_{o, cm}$

To avoid systematic offset

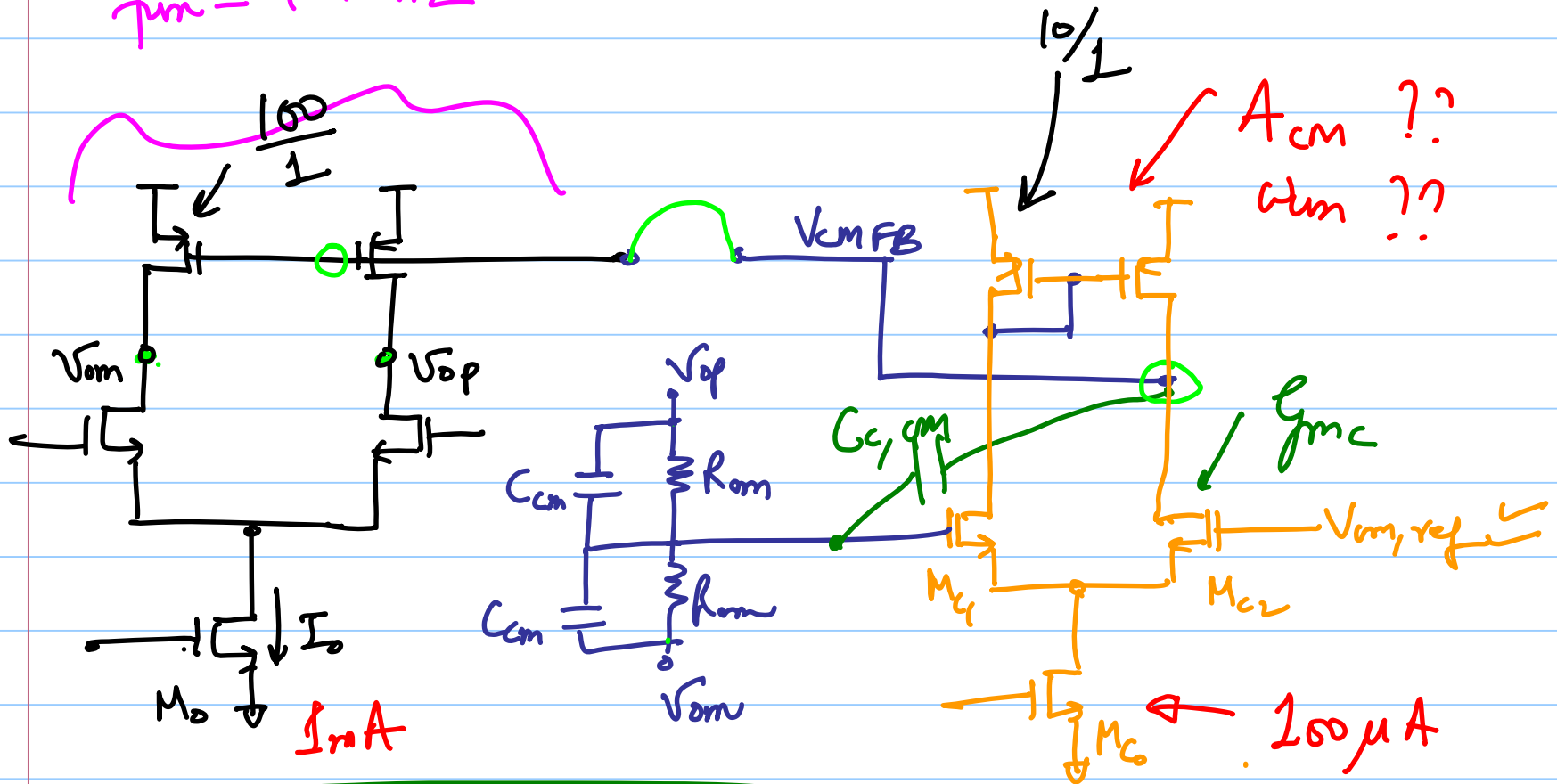
$$V_{SG_{3,4}} \Big|_{\frac{I_{co}}{2}} \stackrel{\Delta}{=} V_{SG_{3,4}} \Big|_{\frac{I_o}{2}}$$

$$\Rightarrow \frac{W_{3,4}}{(I_o/2)} \stackrel{\Delta}{=} \frac{W_{c3, c4}}{(I_{co}/2)}$$

* Current density in the CMFB SSM Amp
should be the same as the differential
amplifier

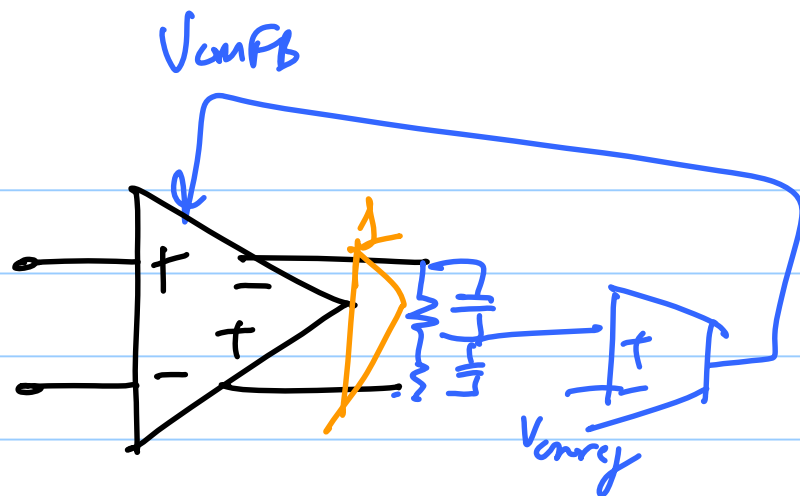
$$A_{OL} = 40 \text{ dB}$$

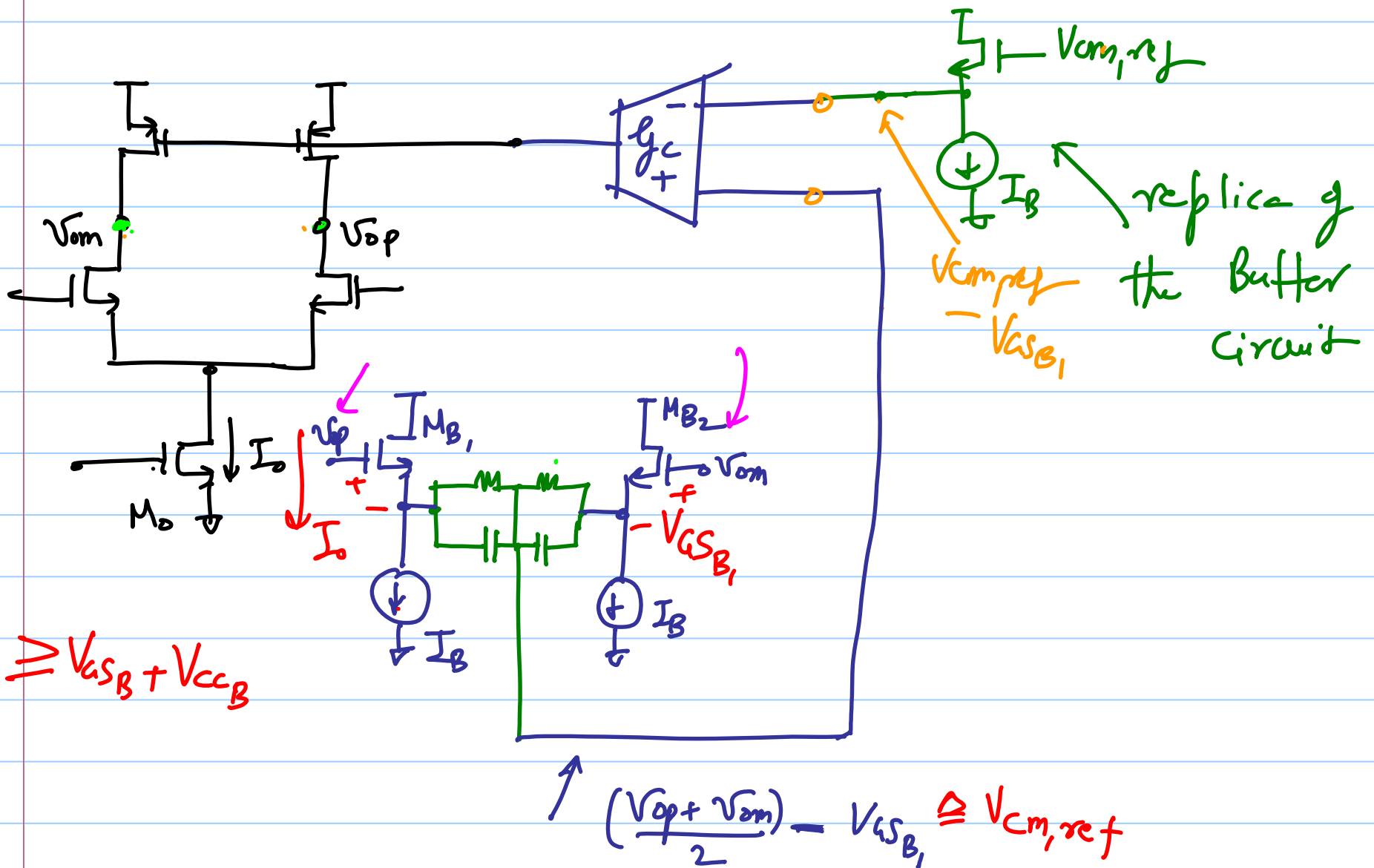
$$f_{un} = 10 \text{ MHz}$$



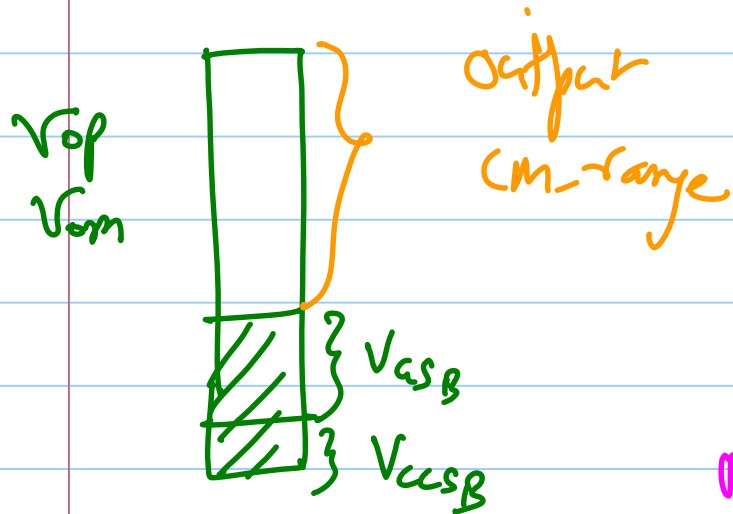
$$\omega_{un} = \frac{g_{m1}}{C_c}$$

$$\omega_{u, cmFB} = \frac{g_{mc}}{C_{c, cm}}$$





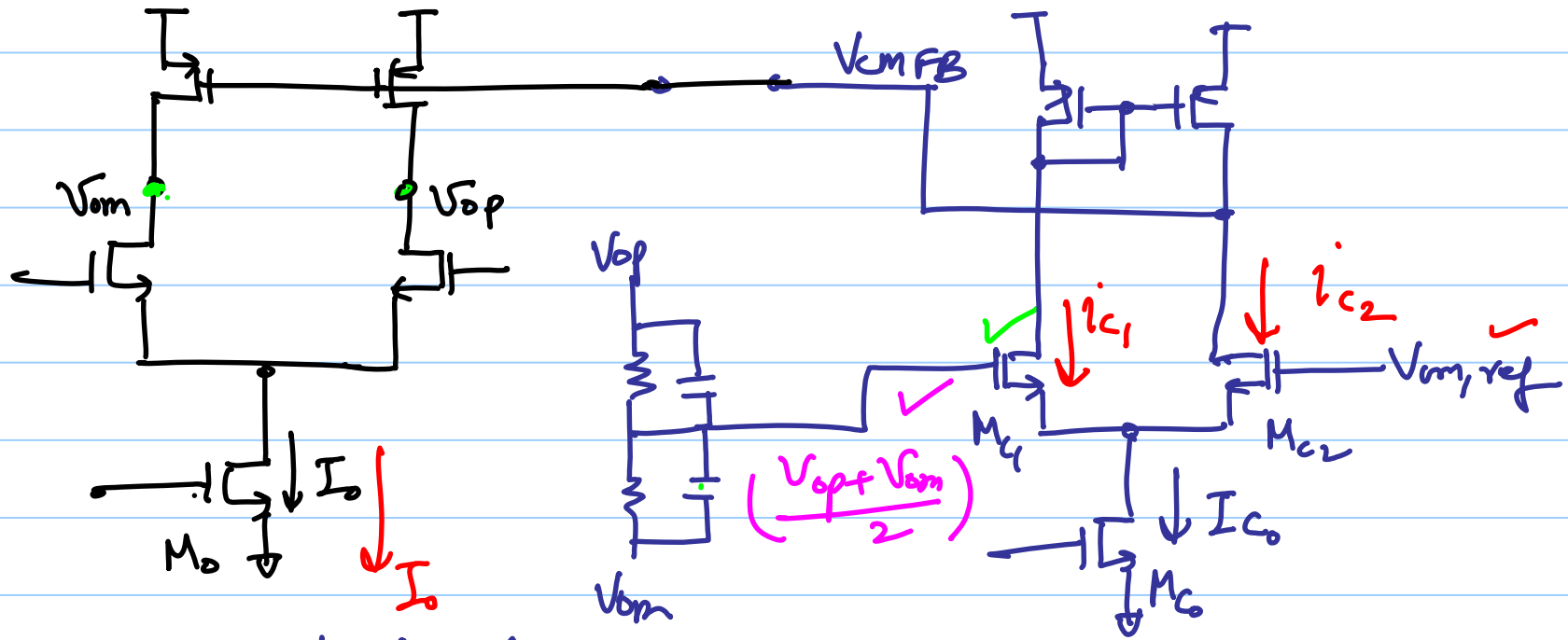
$$V_{o,cm} = \left(\frac{V_{op} + V_{om}}{2} \right) \rightarrow V_{cm,ref} + \underbrace{V_{asB}}_{\text{process dependent}}$$



CM-Swing constrained by the SF!

Not a smart solution!

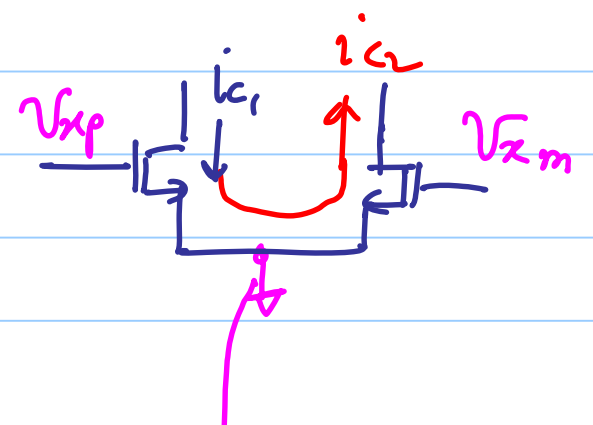
$$\left(\frac{V_{op} + V_{om}}{2} \right)$$



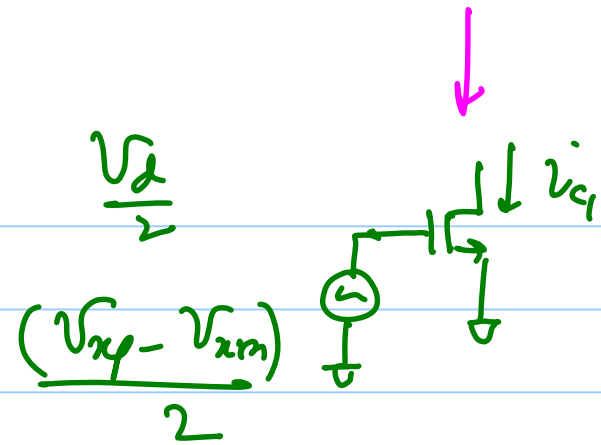
Notice:

Small signal current in M_{c1}

$$i_{c1} = \frac{g_{m_{c1}}}{2} \left[\underbrace{\left(\frac{V_{op} + V_{om}}{2} \right)}_{V_{xp}} - \underbrace{V_{cm,ref}}_{V_{xm}} \right]$$



$$i_{c2} = -i_{c1}$$



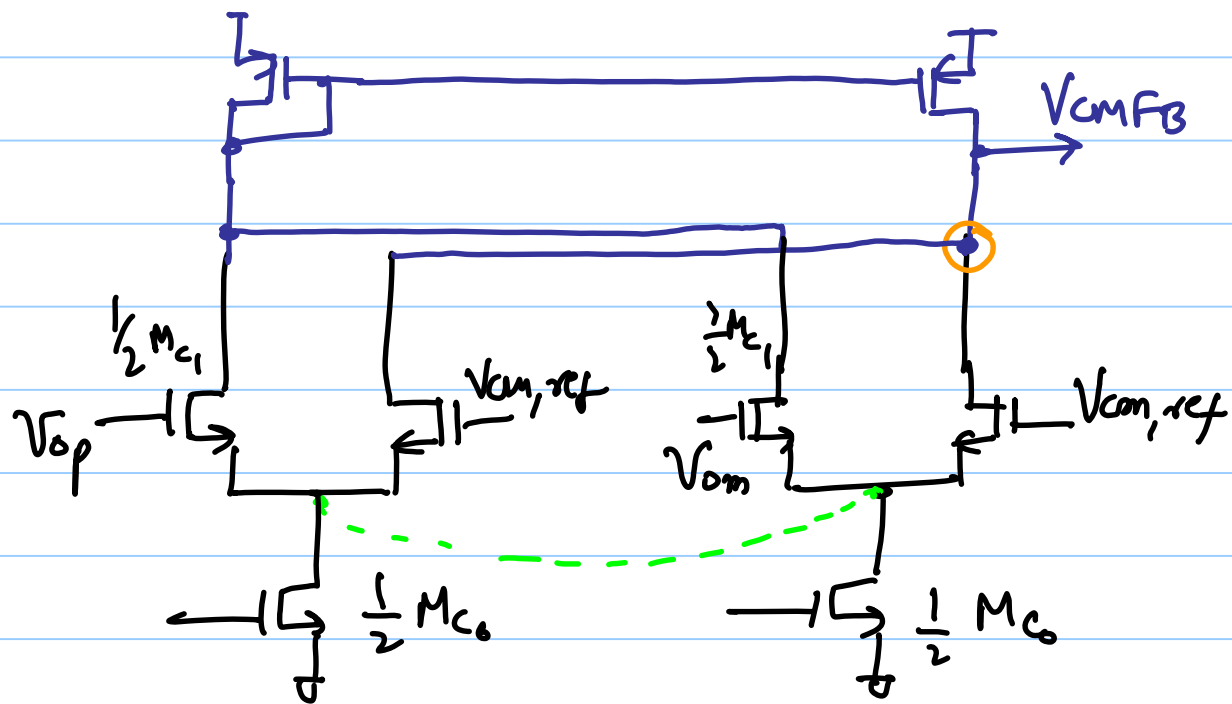
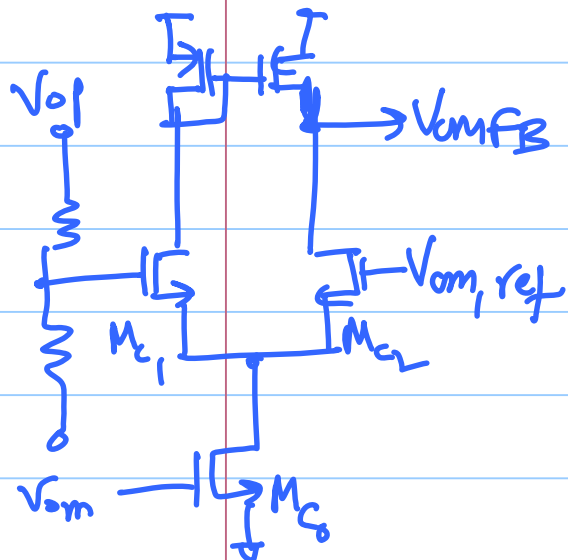
$$-i_{c2} = i_{c1} = \frac{g_{mc1}}{2} \left[\frac{V_{op} + V_{om}}{2} - V_{cm,ref} \right]$$

$$= \frac{g_{mc1}}{2} \left(\frac{V_{op}}{2} - \frac{V_{cm,ref}}{2} \right) + \frac{g_{mc1}}{2} \left(\frac{V_{om}}{2} - \frac{V_{cm,ref}}{2} \right)$$

$$= \underbrace{\frac{g_{mc1}}{4} (V_{op} - V_{cm,ref})}_{\text{diff-pair}} + \underbrace{\frac{g_{mc1}}{4} (V_{om} - V_{cm,ref})}_{\text{diff-pair}}$$

$$-i_{c2} = i_{c1} =$$

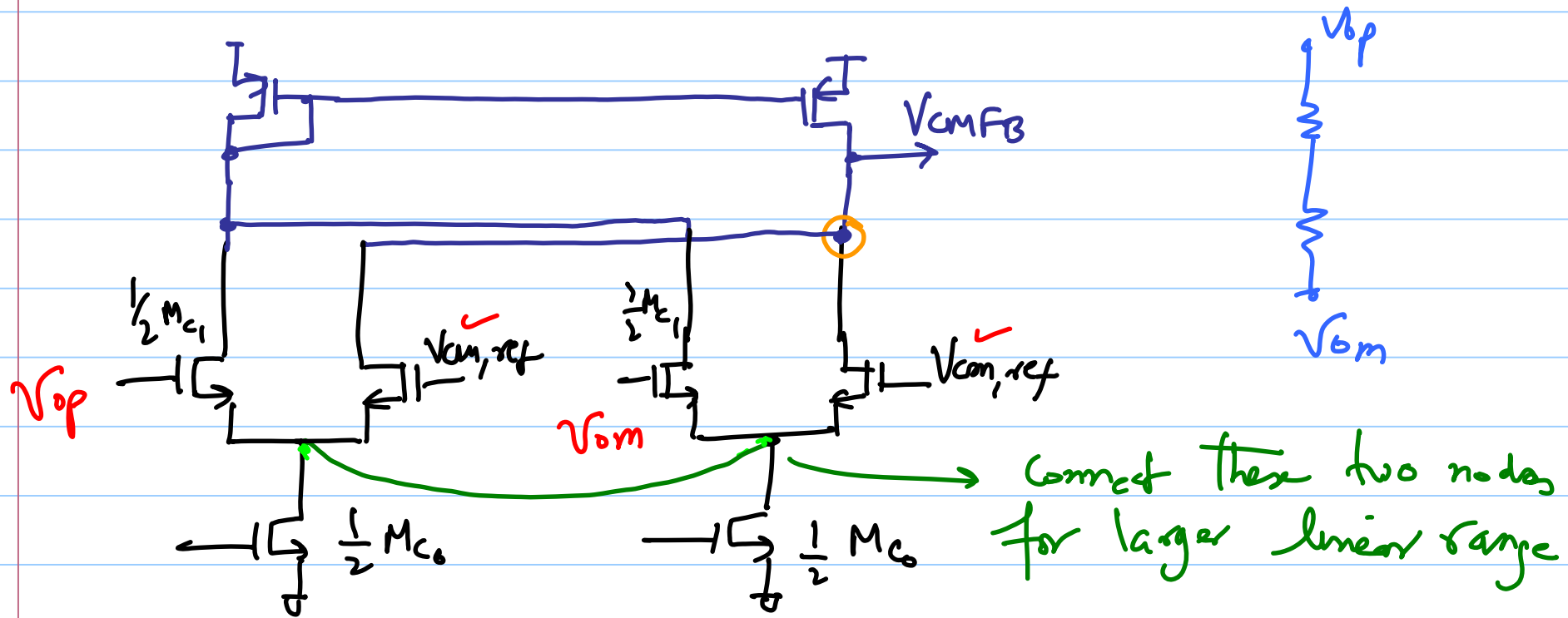
$$\frac{g_{m_{c1}}}{4} (V_{op} - V_{cm,ref}) \oplus \frac{g_{m_{c1}}}{4} (V_{om} - V_{cm,ref})$$



* "half the w's"

* if we connect

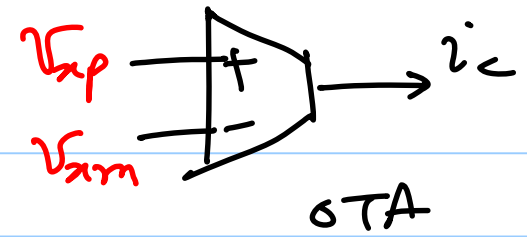
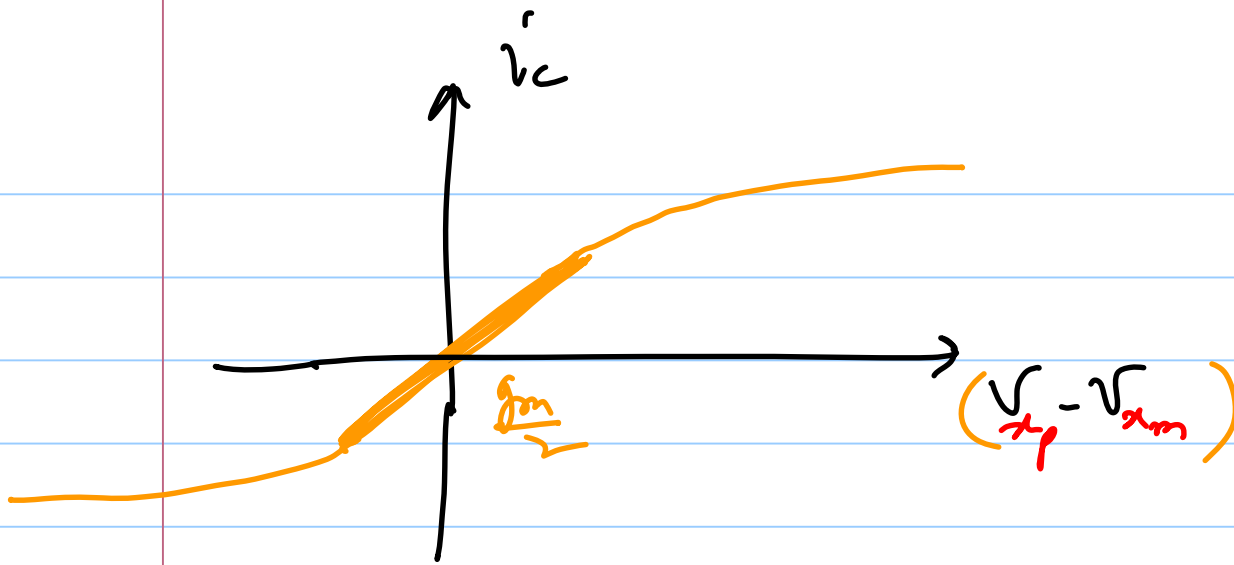
Dual Diff pair CM-detector



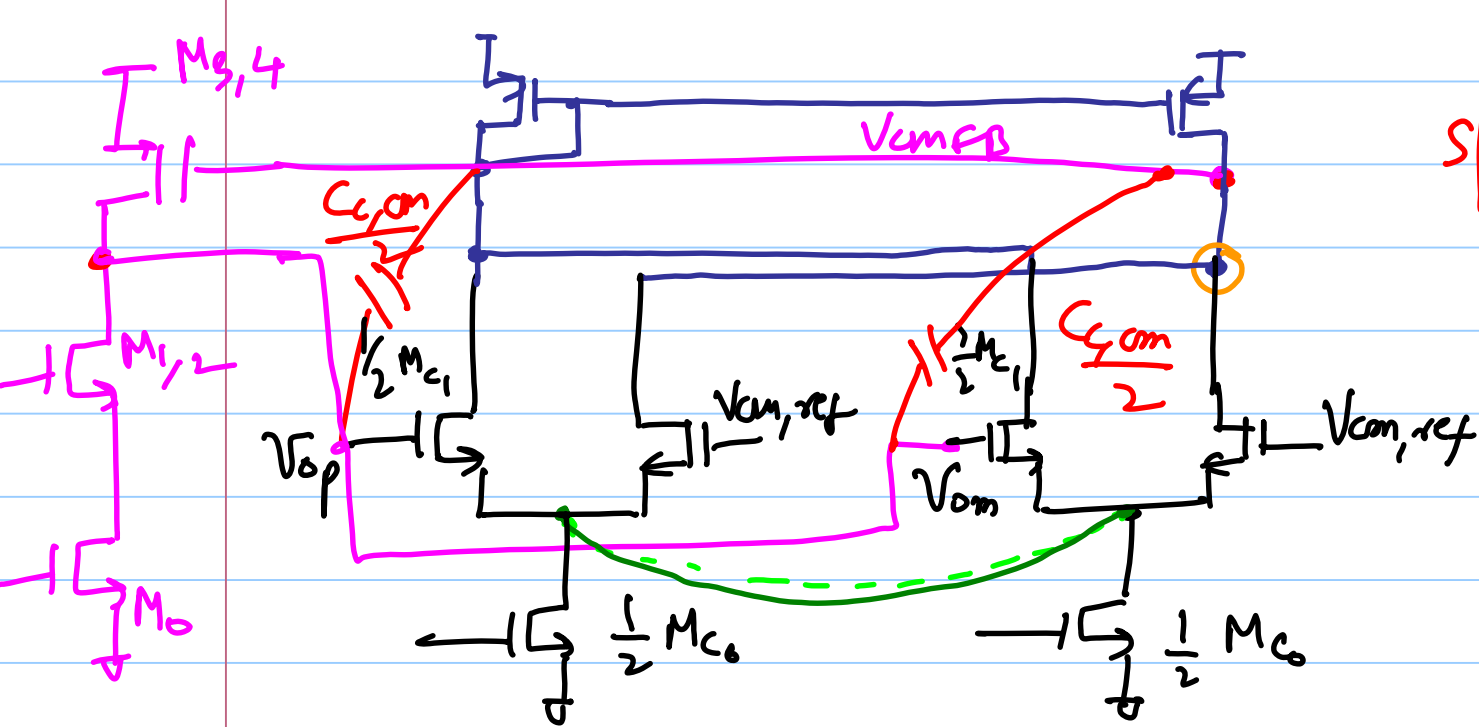
(+) No resistive loading of the output

(-) Output swing is limited due to the input CMR of the CM-detector

→ cannot use it for large output swings



Common-mode Equivalent circuit of CMFB loop



* "half the w's"

CMFB

Split the Compensation Cap

