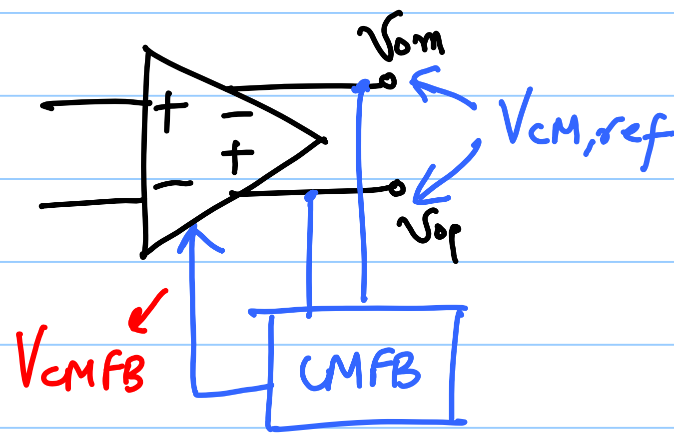
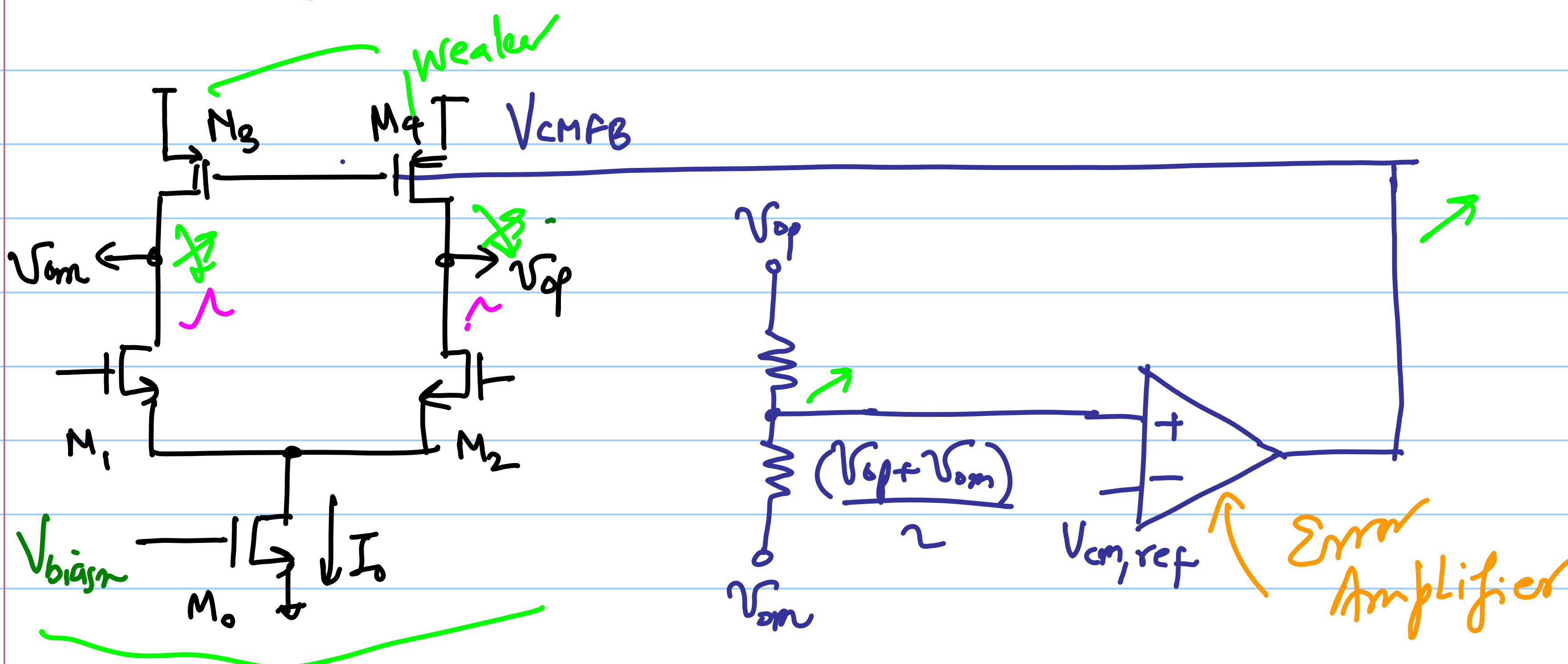
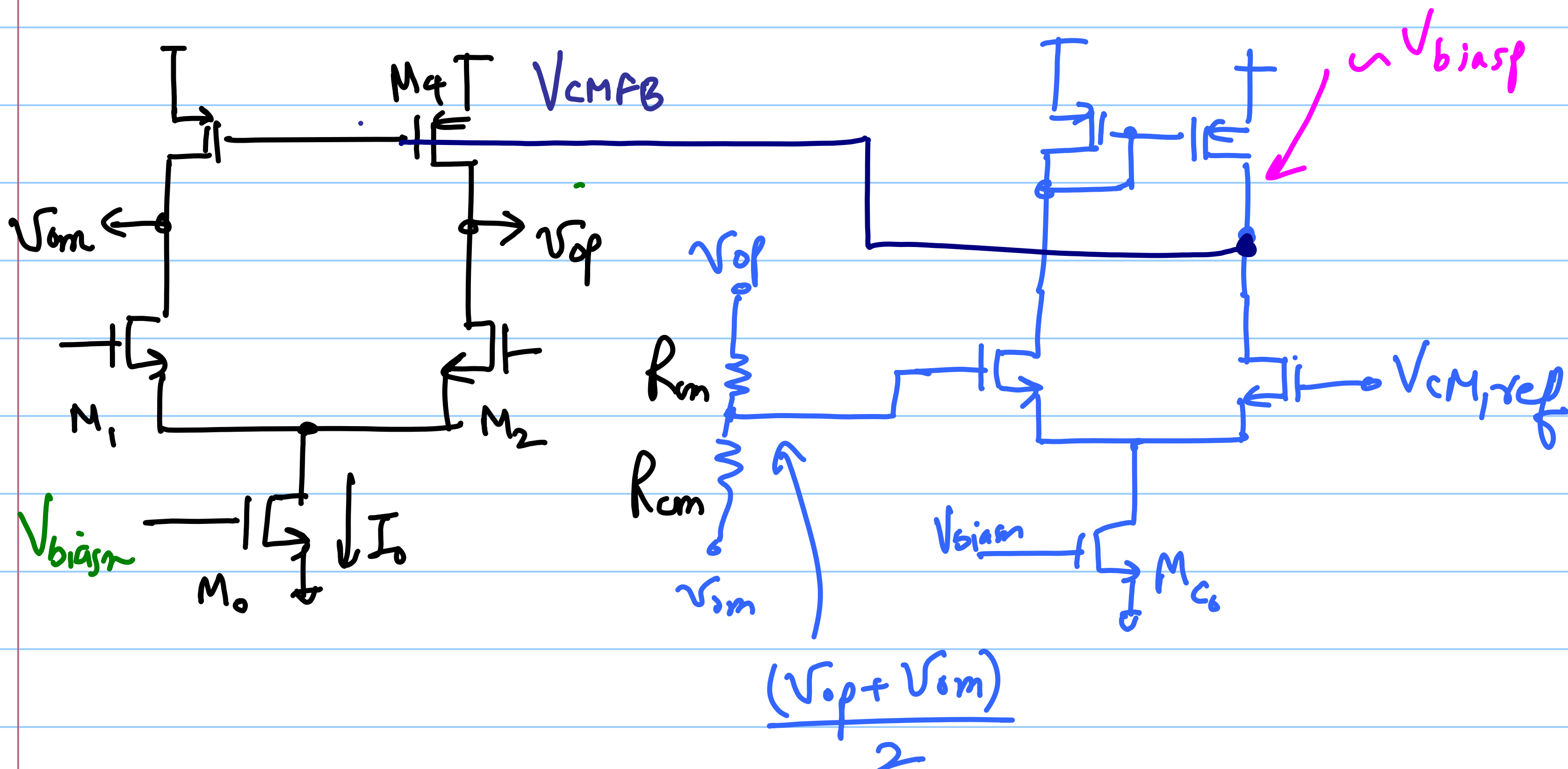
ECE 614 – Lecture 2

Note Title 8/28/2014

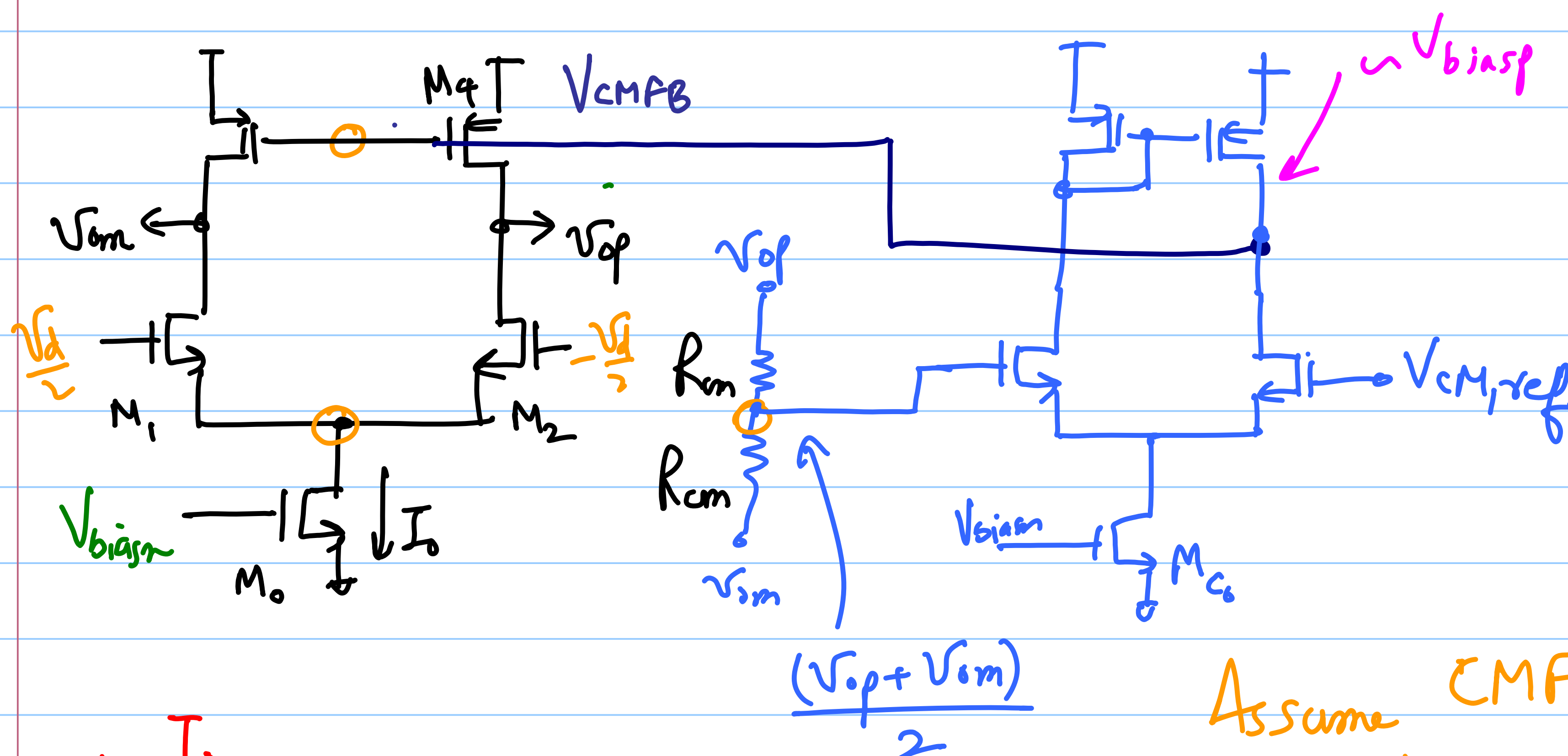




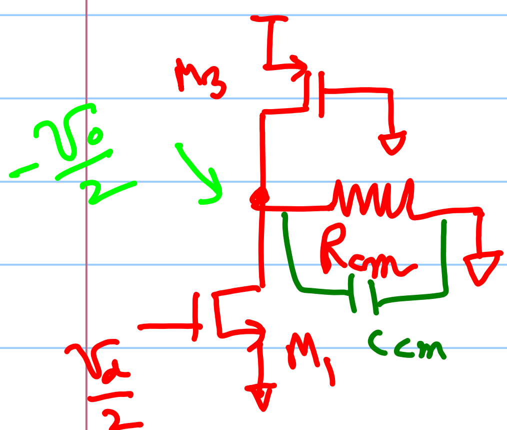


M4
VCMFB
Vom
Vop
M1
M2
Vbiasn
Io
M0
Vop
Rcm
Rcm
Vom
$\frac{(V_{op}+V_{om})}{2}$
Vbiasn
Mc0
VCM,ref
~ Vbiasp

Differential Half Circuit:

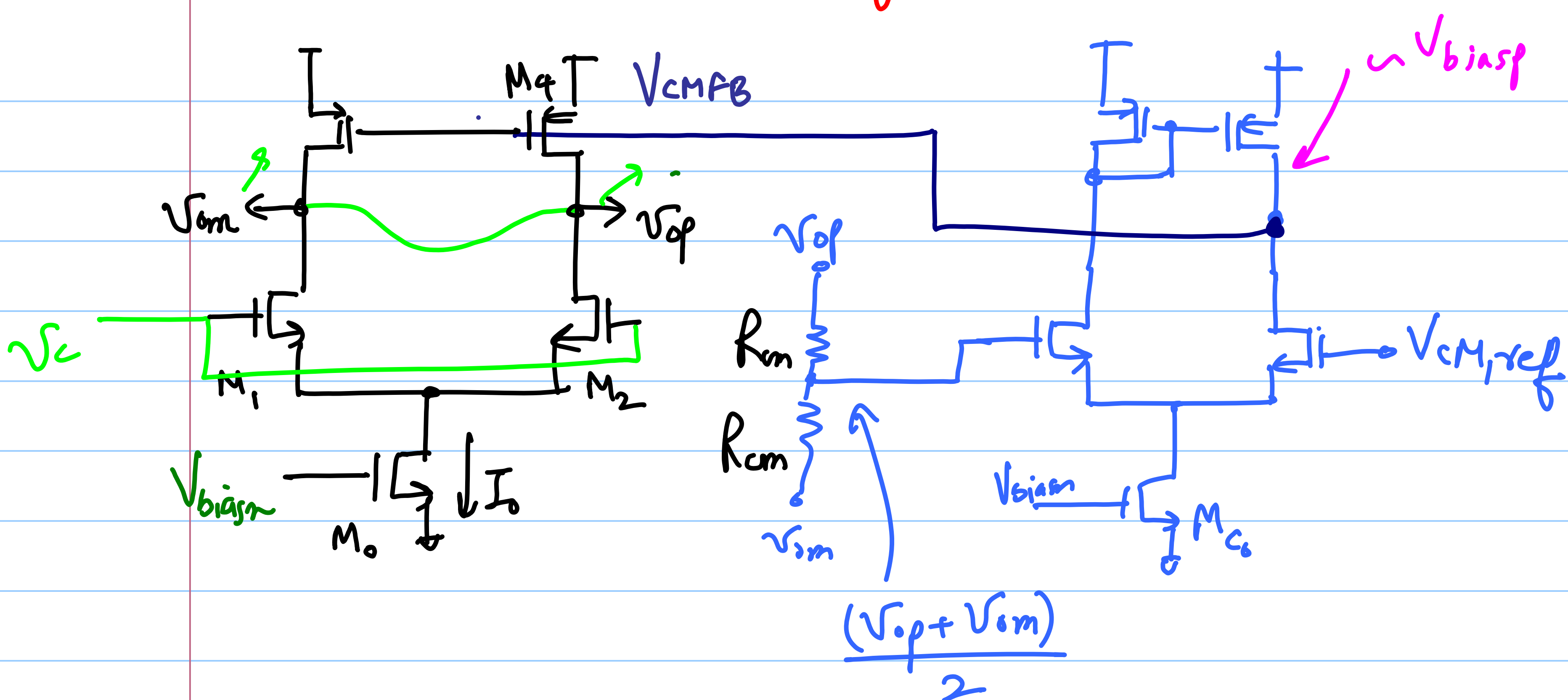


Assume CMFB loop is stable

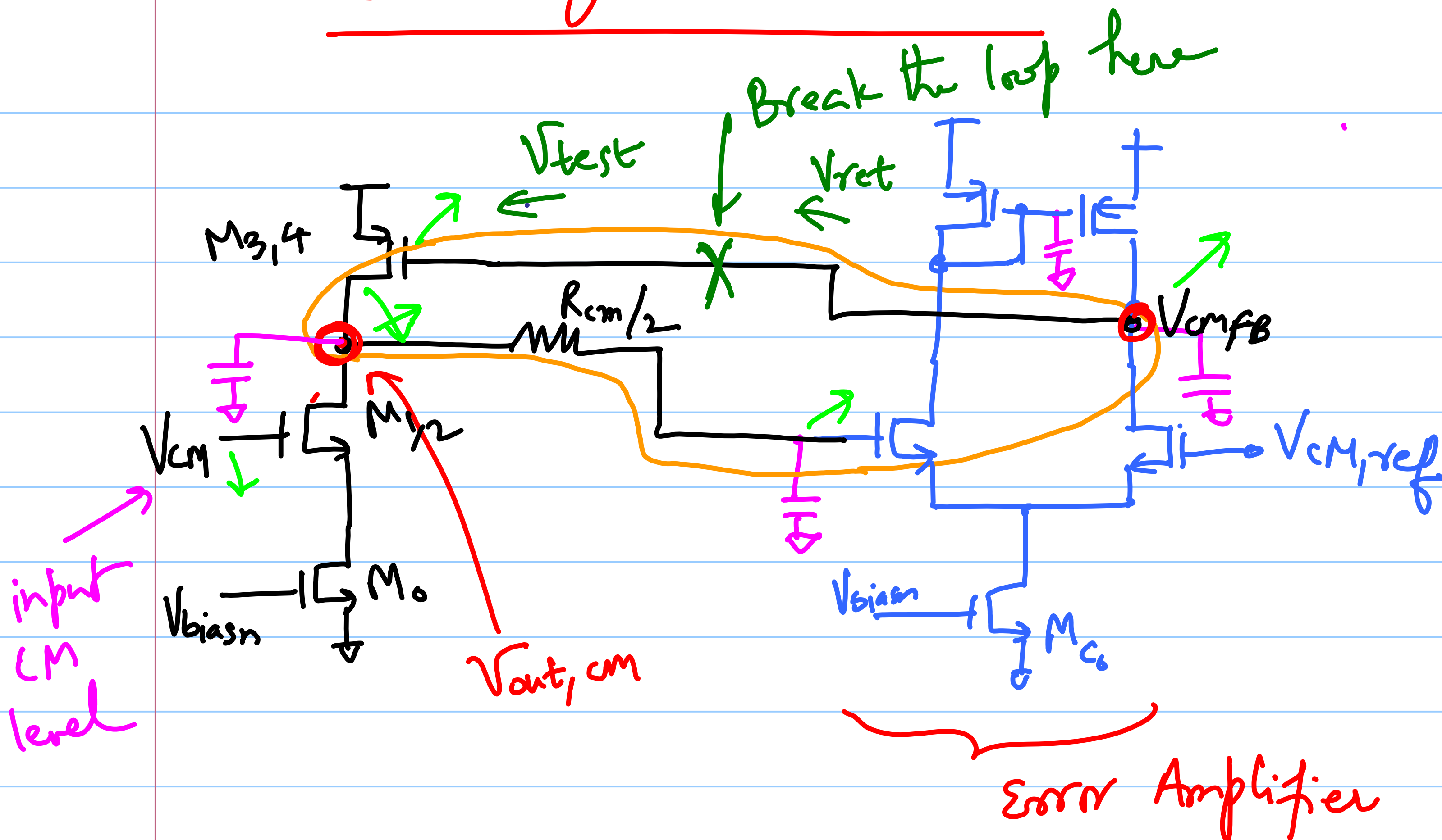


$$\frac{v_o}{v_d} = g_{m1}\left(r_{o1} \| r_{o3} \| R_{cm}\right)$$

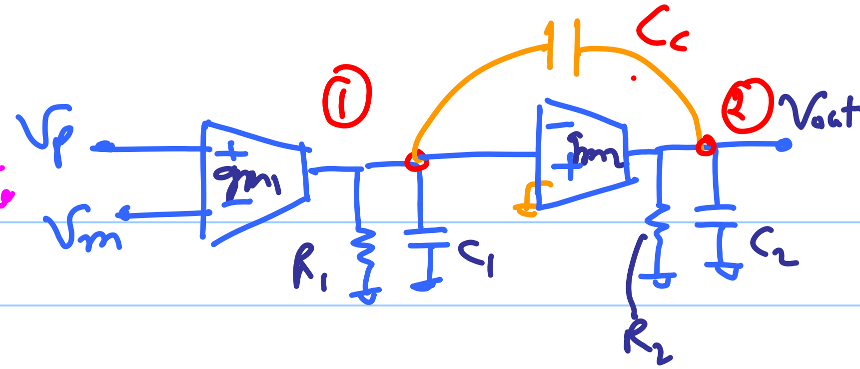
Common-mode Equivalent Circuit



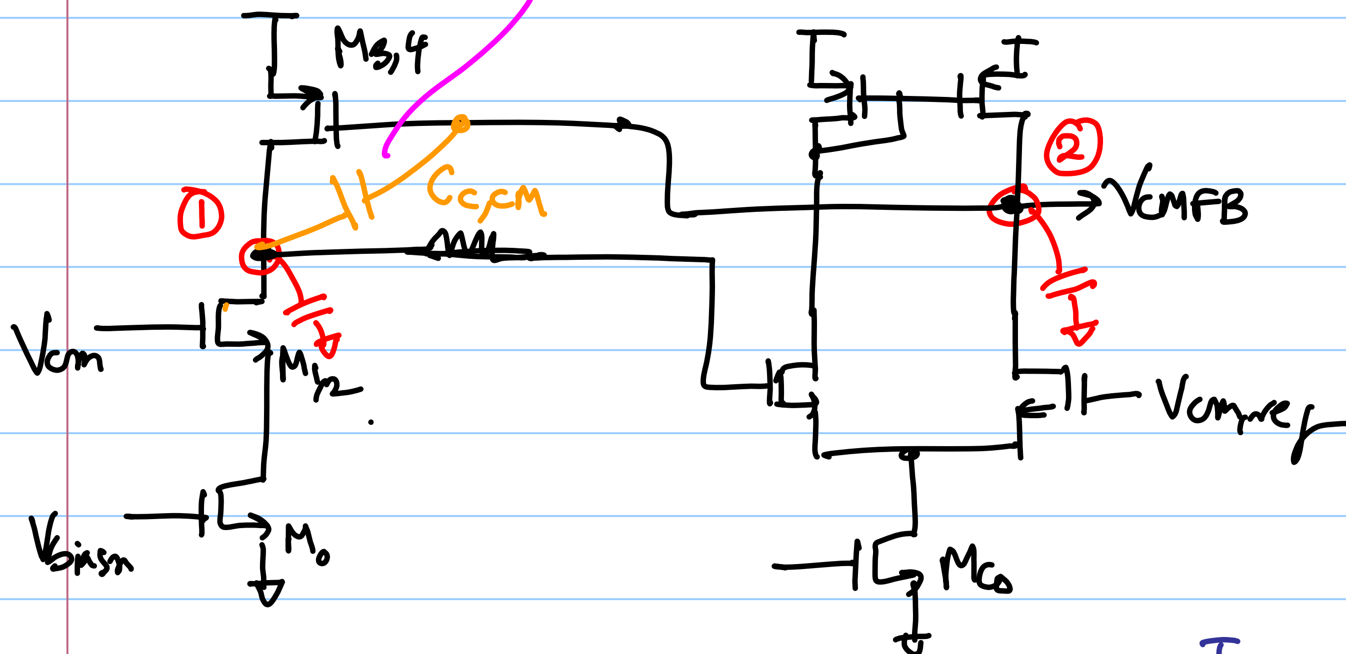
CM Equiv Circuit

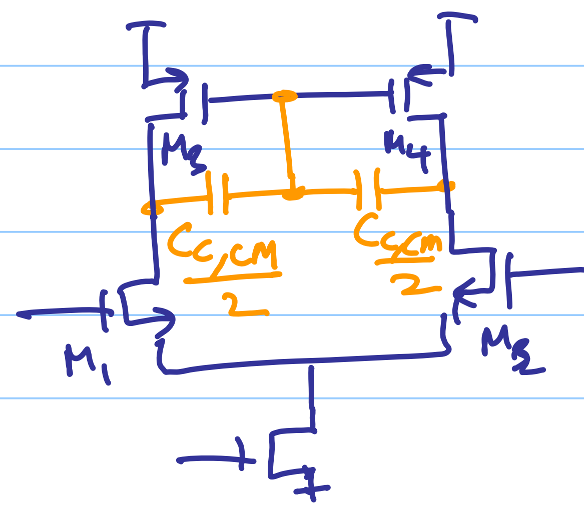


Ignoring $R_{cm}/2$

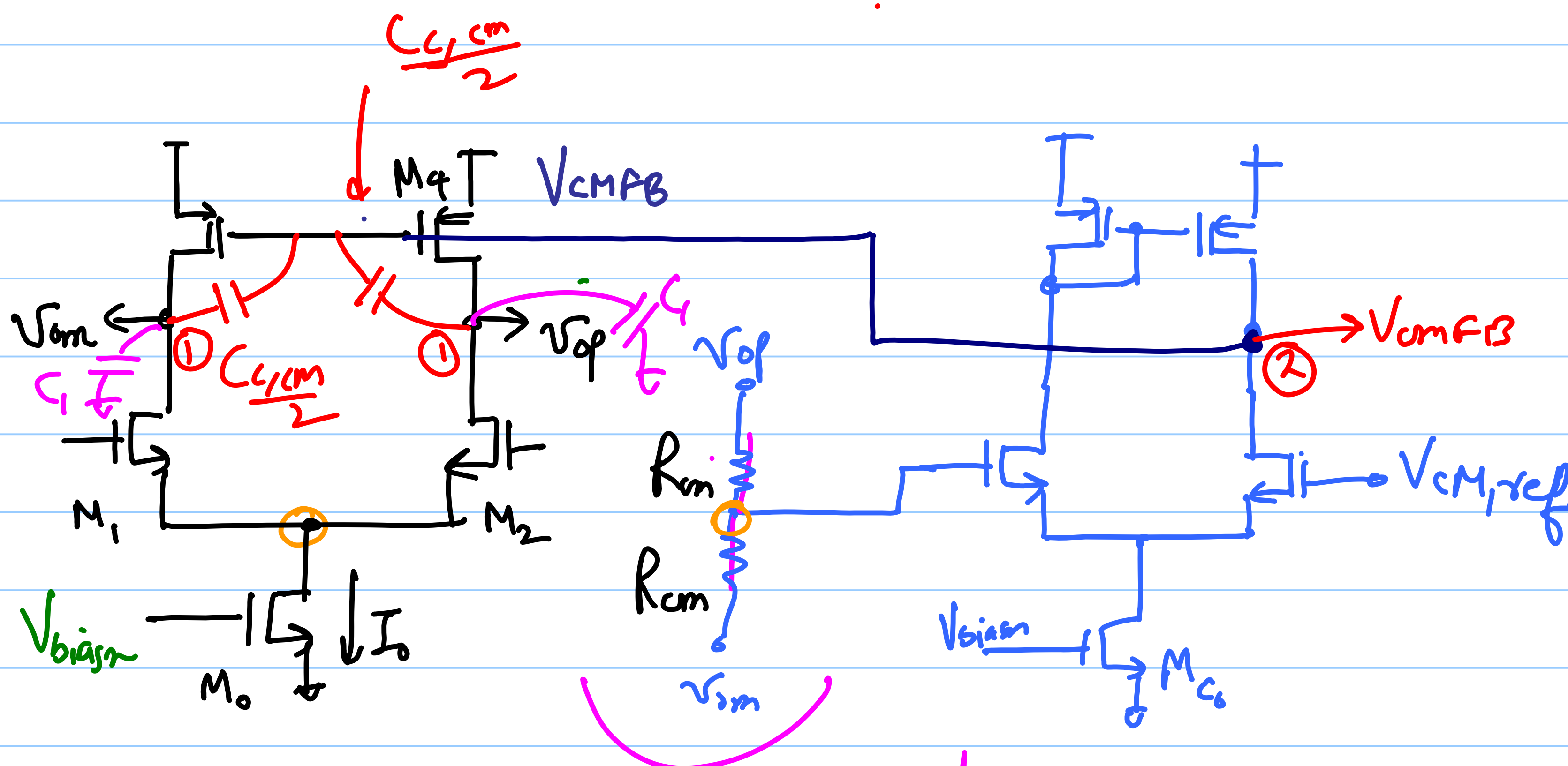


compensation cap for the CMFB circuit





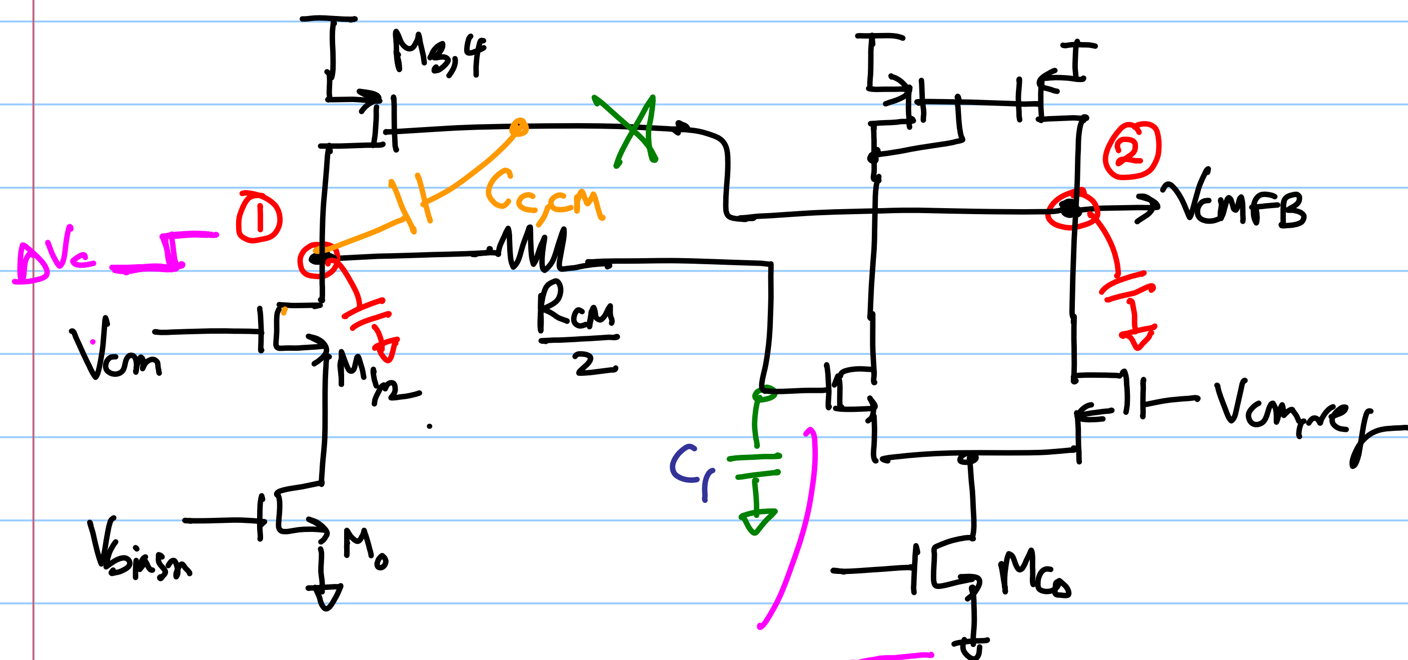
The overall circuit



we ignored this!

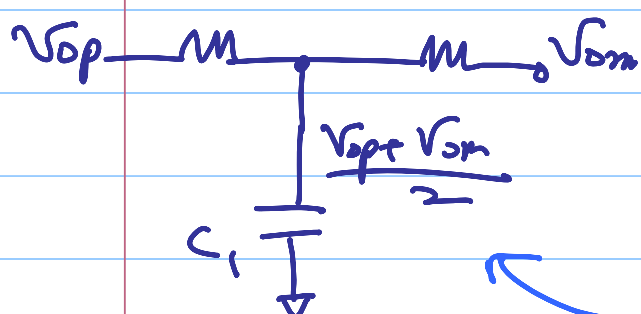
* $C_{c,cm}$ loads the differential picture

* Lets place $\frac{R_{cm}}{2}$ back into the CMFB Equiv circuit.



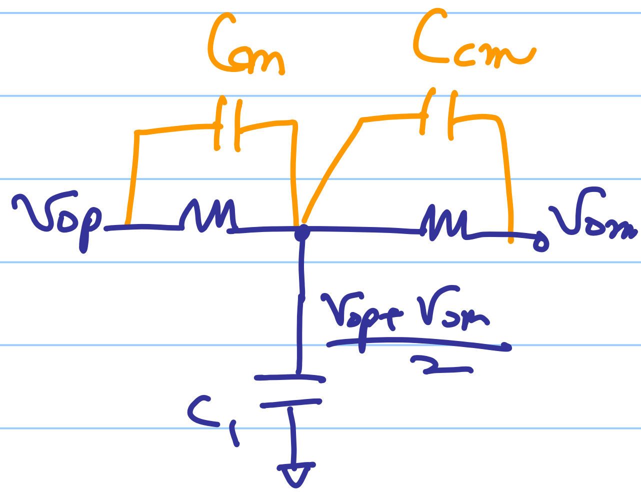
$R_{cm} \uparrow$

↑ excess delay in the loop



works at smaller frequencies
but at larger frequencies
↳ phase lag ⇒ delay

* we may have instability in the CMFB loop as the CM detector doesn't "work" at high frequencies



← responds at high frequencies

at high frequencies, the CM-detector output

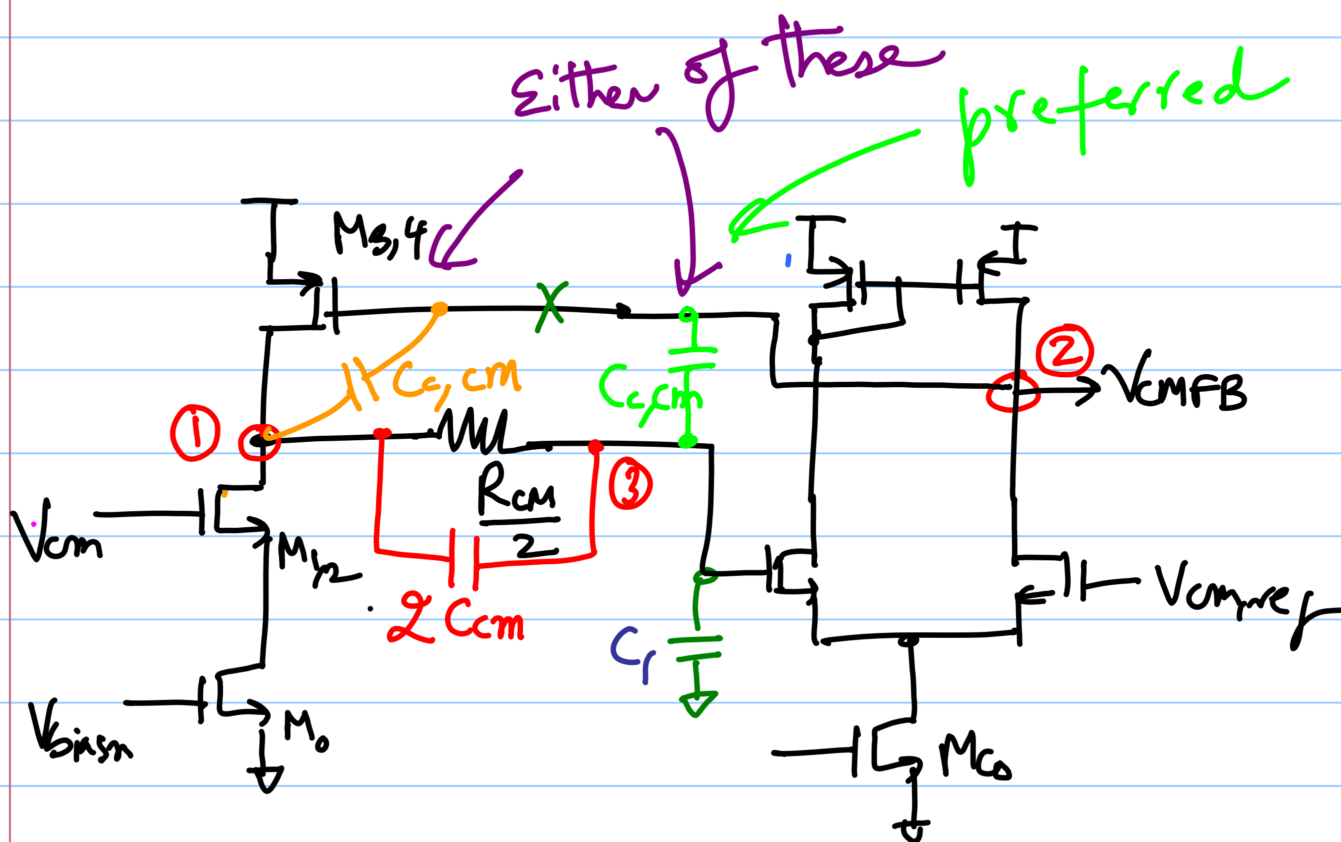
$$V_{op}\left(\frac{C_{cm}}{2C_{cm}+C_1}\right)+V_{om}\left(\frac{C_{cm}}{2C_{cm}+C_1}\right)$$

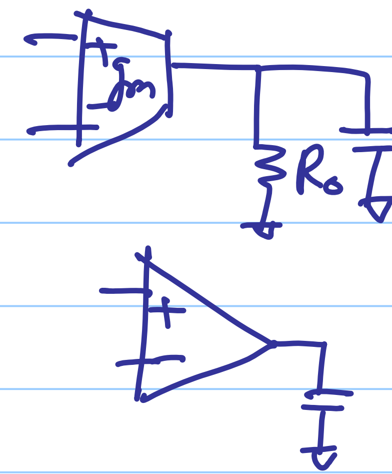
$$=\left(\frac{V_{op}+V_{om}}{2}\right)\underbrace{\left(\frac{2C_{cm}}{2C_{cm}+C_1}\right)}_{<1}$$

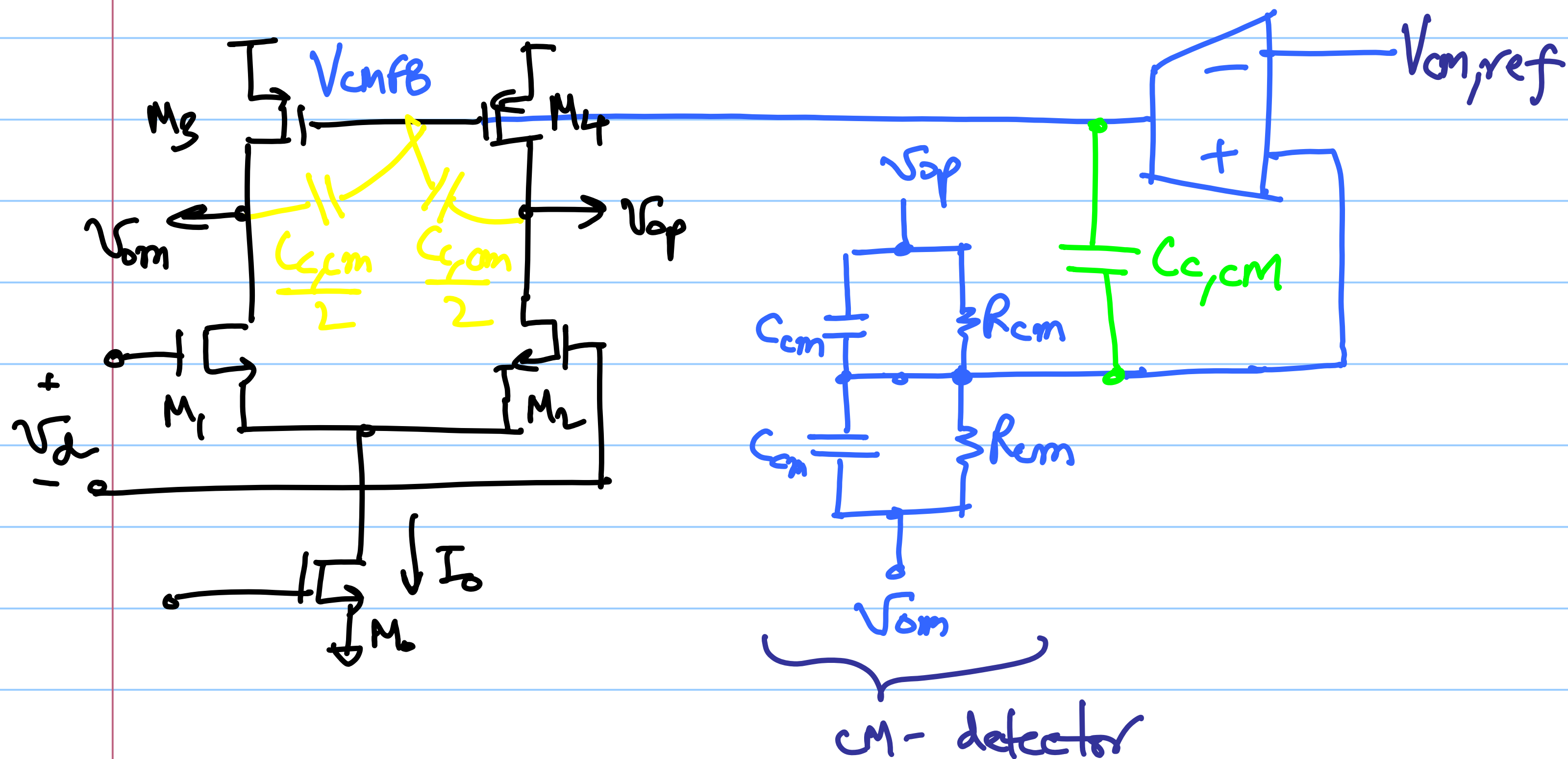
← parasitic cap causes attenuation

but no phase lag at high frequencies

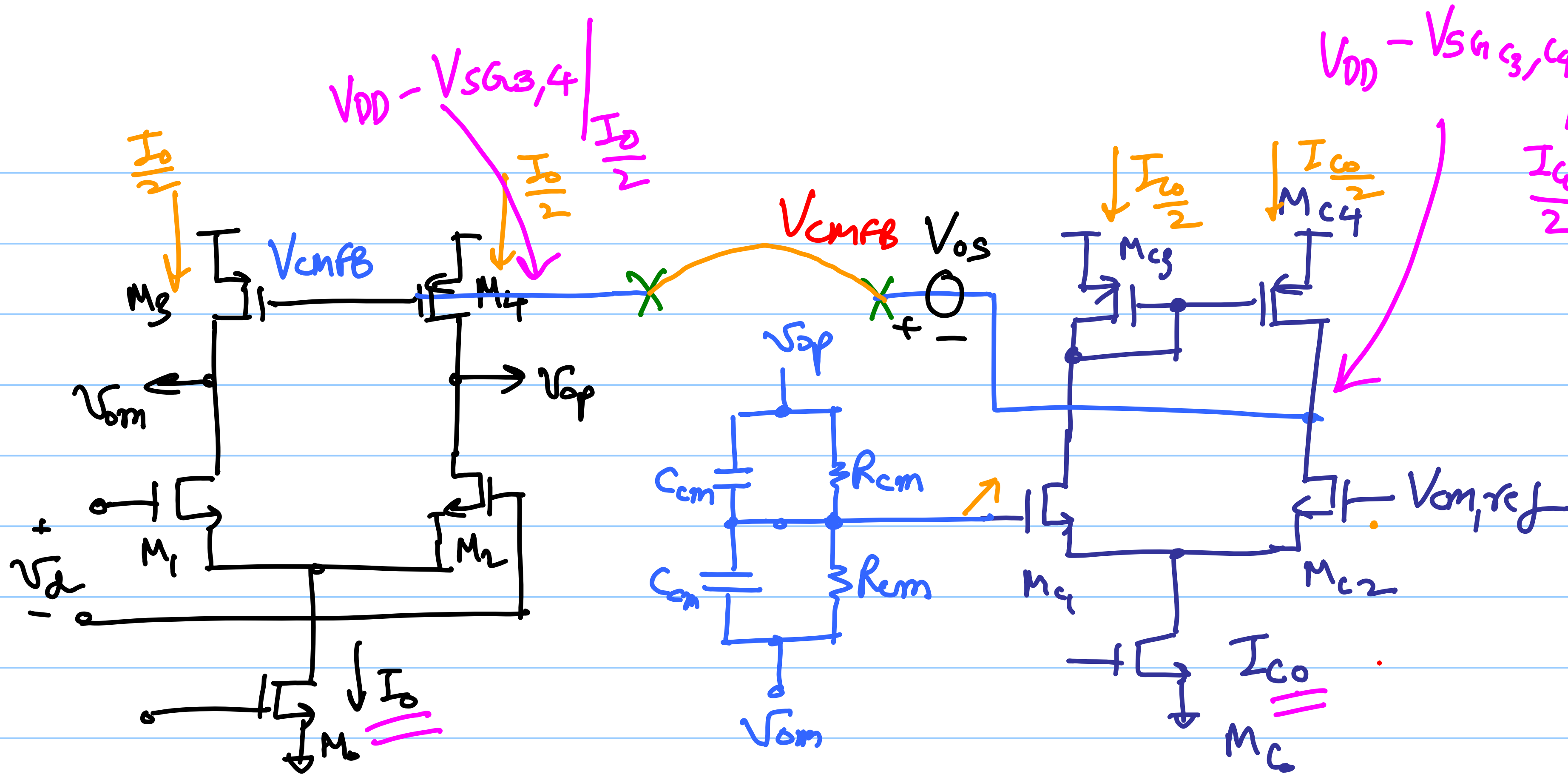
Typical $C_{cm} \simeq C_1$







V_{CMFB}
M_3
M_4
v_{om}
v_{op}
$\frac{C_{c,cm}}{2}$
$\frac{C_{c,cm}}{2}$
M_1
M_2
v_d
I_0
M_0
v_{op}
C_{cm}
R_{cm}
C_{cm}
R_{cm}
v_{om}
cM- detector
$C_{c,cM}$
$V_{cm,ref}$



When the CMFB loop stabilizes the node V_{CMFB} goes from

$$\left(V_{DD} - V_{SG_{C3,C4}}\Big|_{\frac{I_{C0}}{2}}\right) \text{ to } \left(V_{DD} - V_{SG_{3,4}}\Big|_{\frac{I_0}{2}}\right)$$

$$\left| \underbrace{\left(\frac{V_{op}+V_{om}}{2}\right) - V_{CM,ref}}_{} \right| \rightarrow \underbrace{\frac{\left(V_{DD} - V_{SG_{C3,C4}}\Big|_{\frac{I_o}{2}}\right) - \left(V_{DD} - V_{SG_{3,4}}\Big|_{\frac{I_o}{2}}\right)}{}}_{\text{loop-gain}}$$

↑ "system offset"