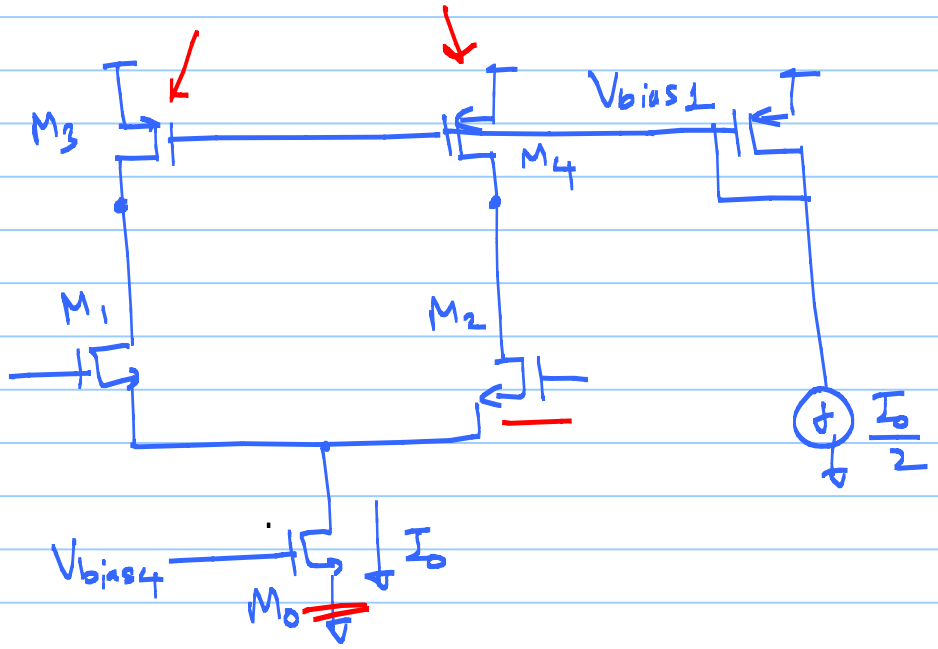
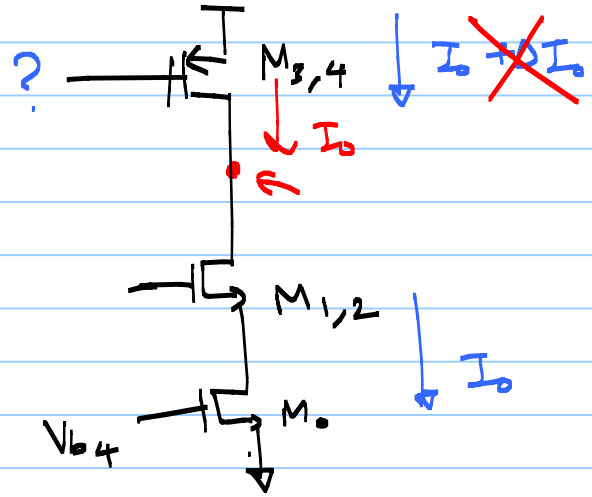
ECE 614 – Lecture 2

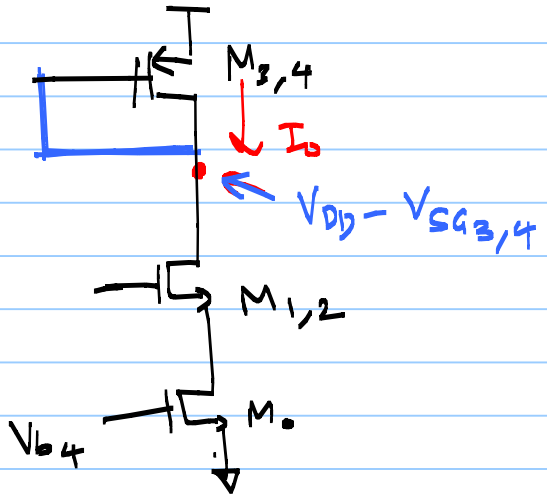
Note Title 8/31/2012

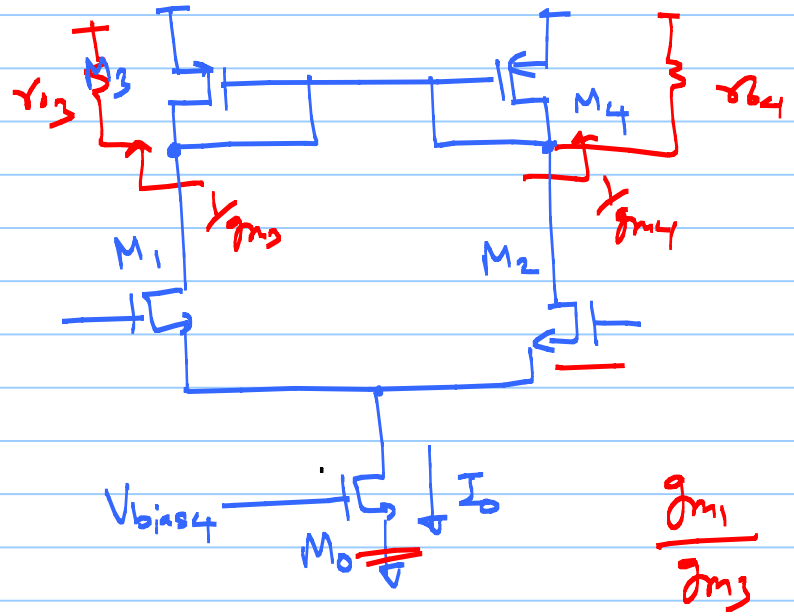


CM equivalent



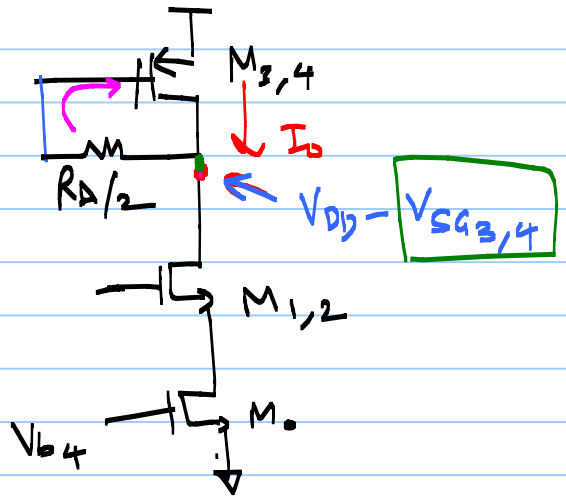
CM picture

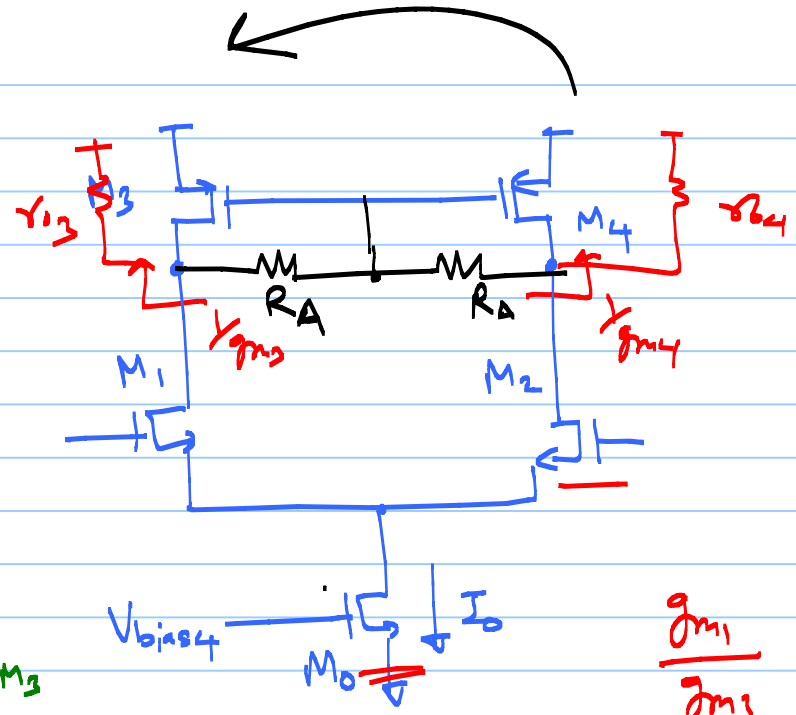




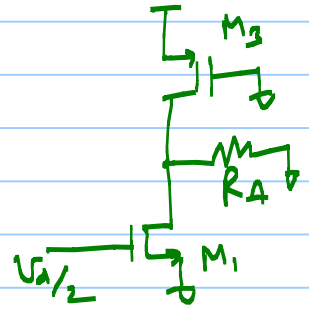
$\frac{g_{m1}}{g_{m3}}$

CM picture

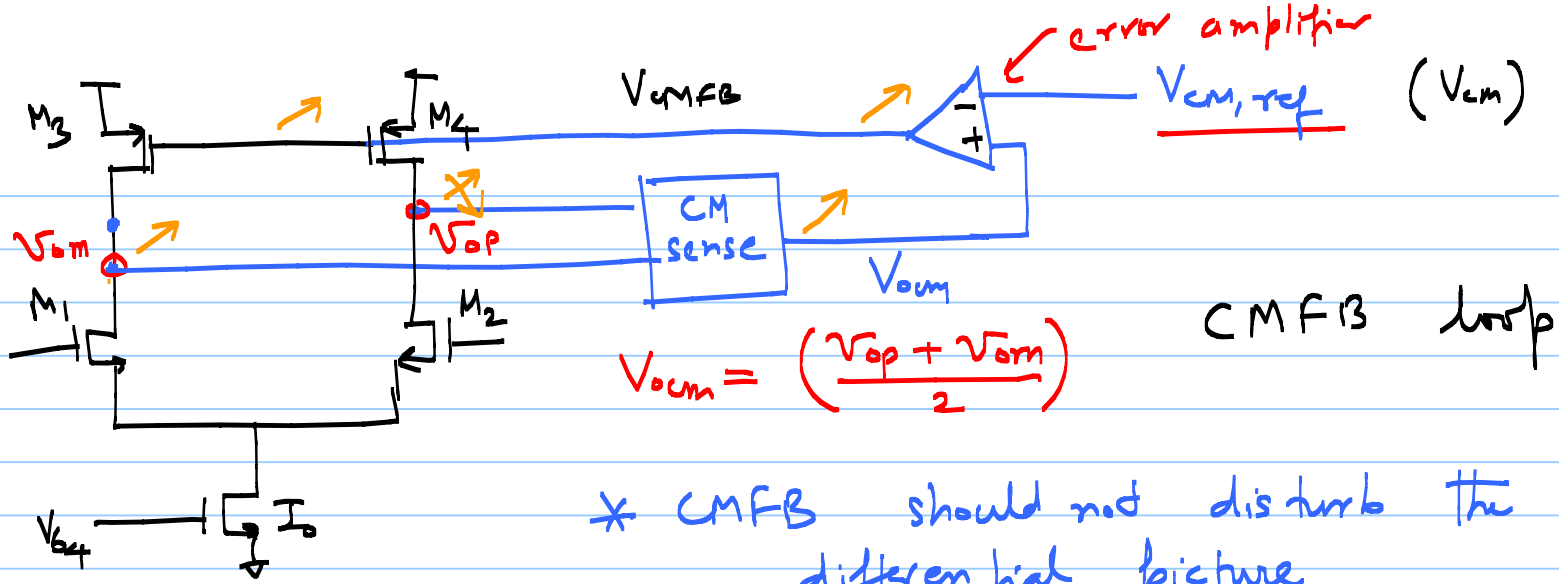




$\frac{g_{m1}}{g_{m3}}$



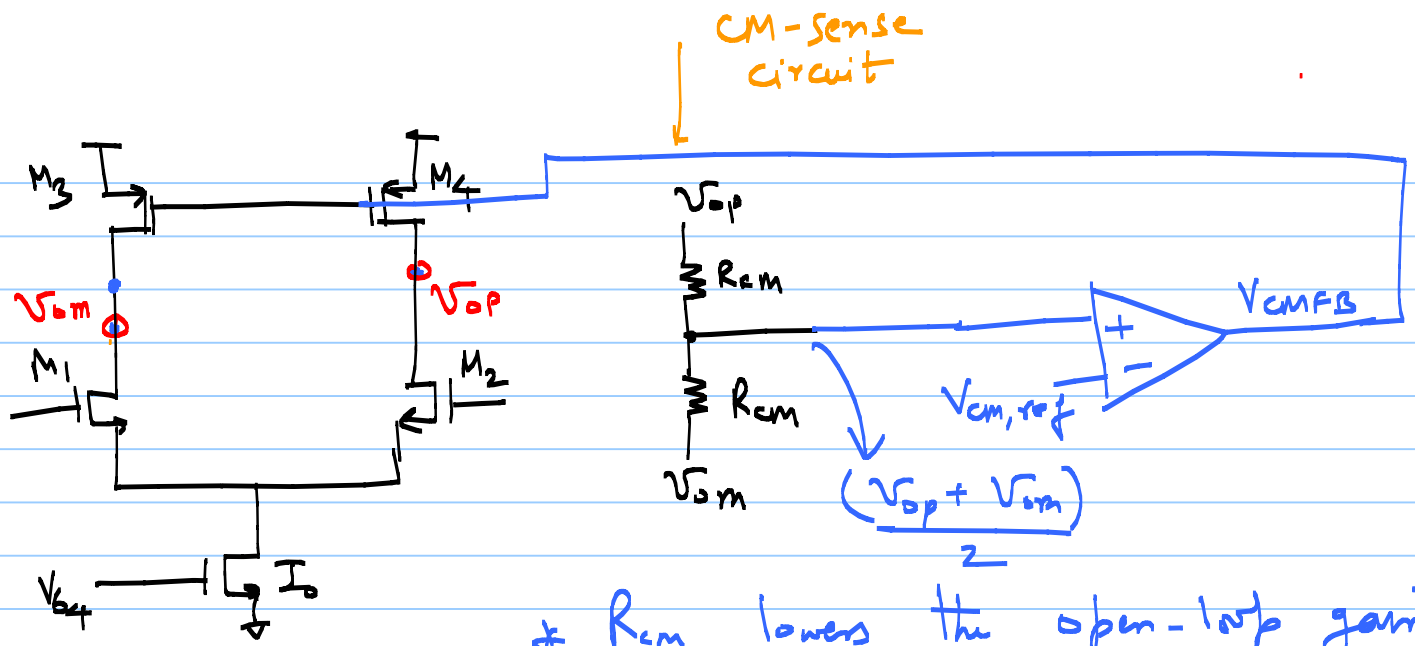
$-g_{m1}(r_{o1} \| r_{o3} \| R_A)$



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

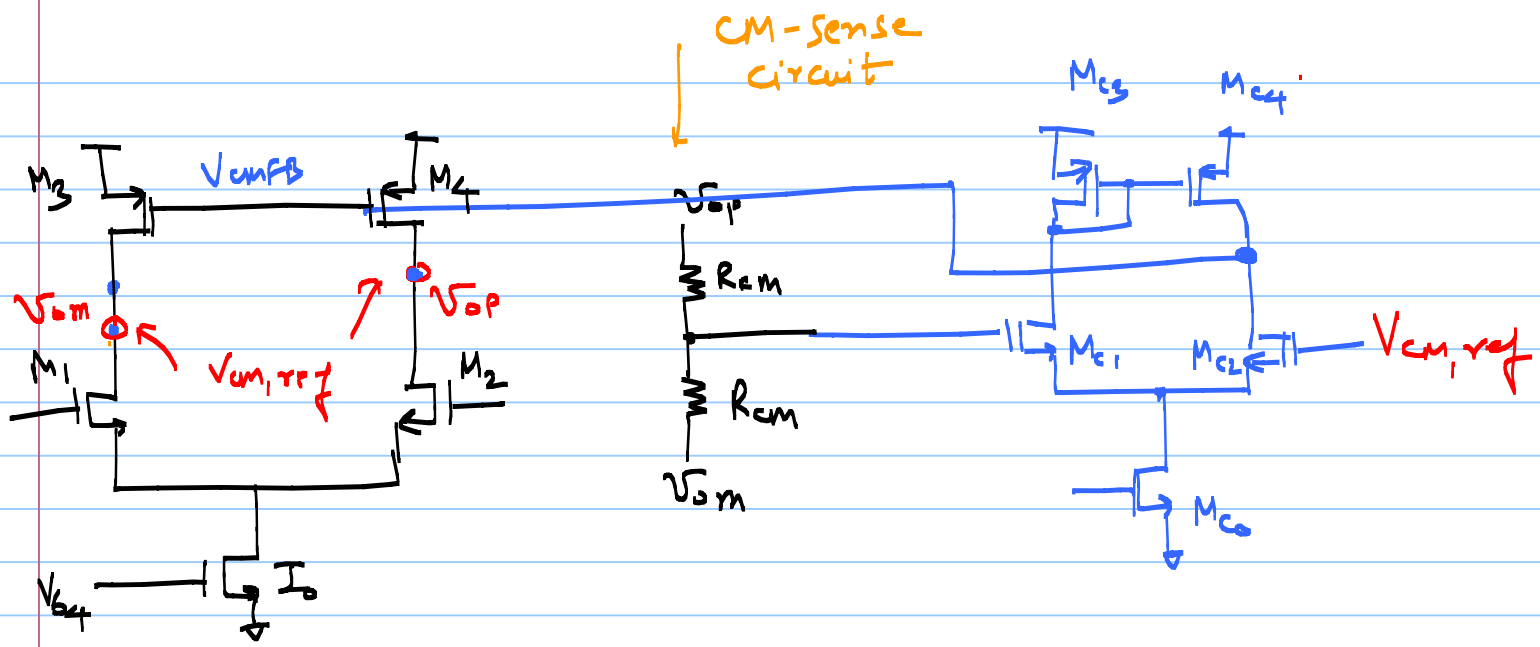
CMFB loop

* CMFB should not disturb the differential picture

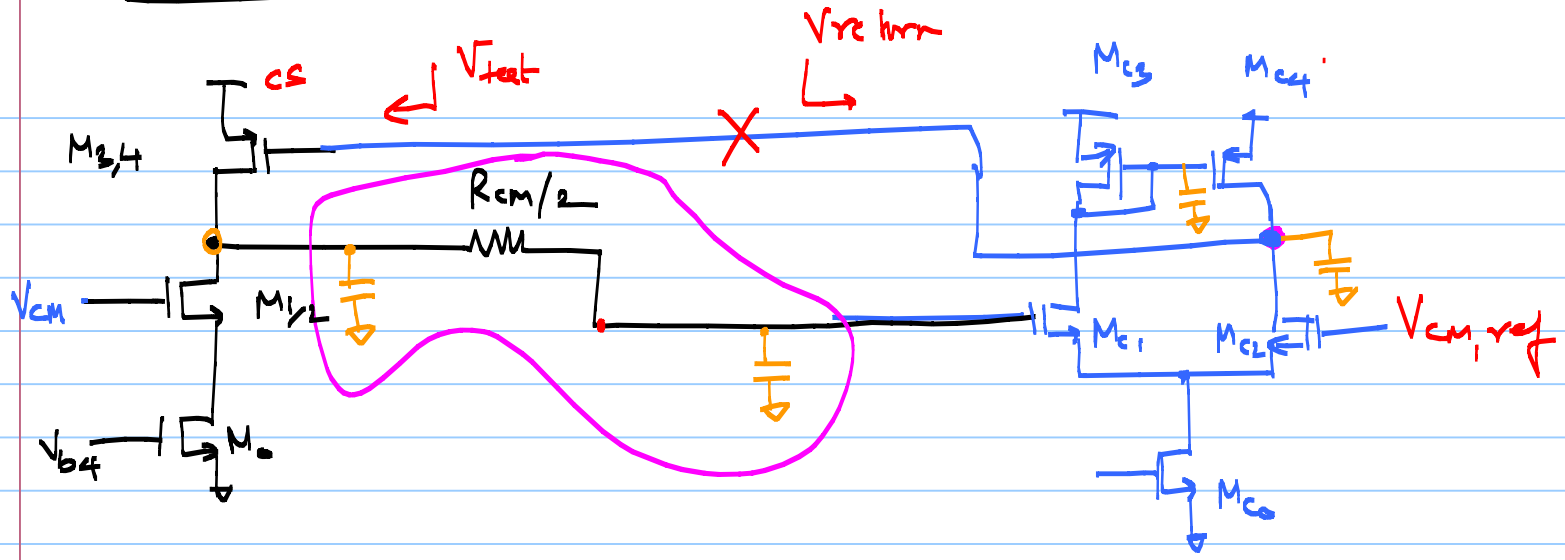


* R_{cm} lowers the open-loop gain

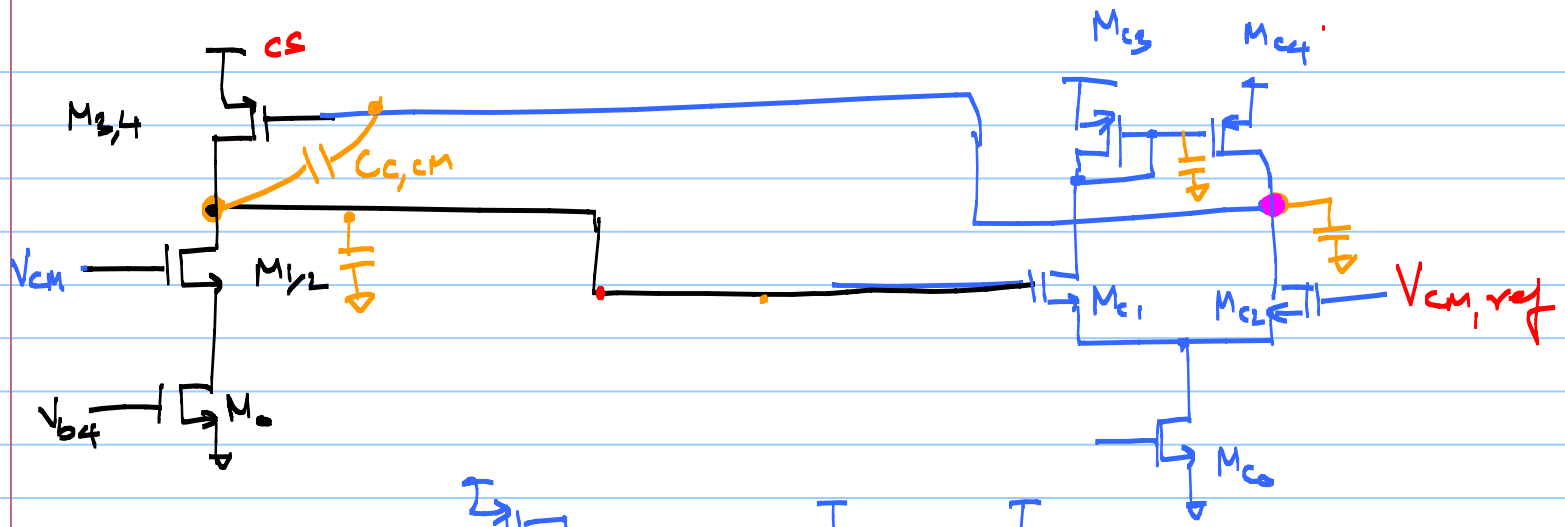
↳ can't use it for single-stage opamps


CM-sense circuit
M_3
V_{cmFB}
M_4
V_{om}
$V_{cm,ref}$
V_{op}
M_1
M_2
V_{GG}
I_0
V_{op}
R_{cm}
R_{cm}
V_{om}
M_{c3}
M_{c4}
M_{c1}
M_{c2}
$V_{cm,ref}$
M_{c0}

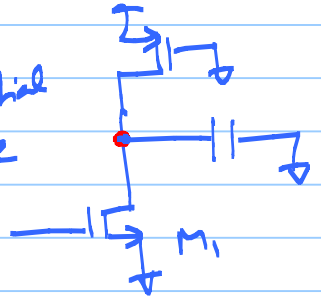
CM picture

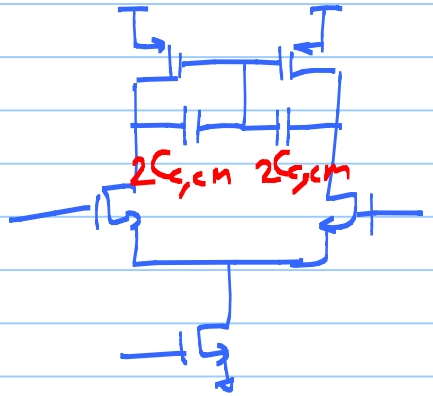

CS
V_{feat}
V_{return}
$M_{3,4}$
$R_{CM}/2$
V_{CM}
$M_{1,2}$
V_{b4}
M_0
M_{c3}
M_{c4}
M_{c1}
M_{c2}
$V_{CM,ref}$
M_{c0}

* Let's ignore R_{cm} for now

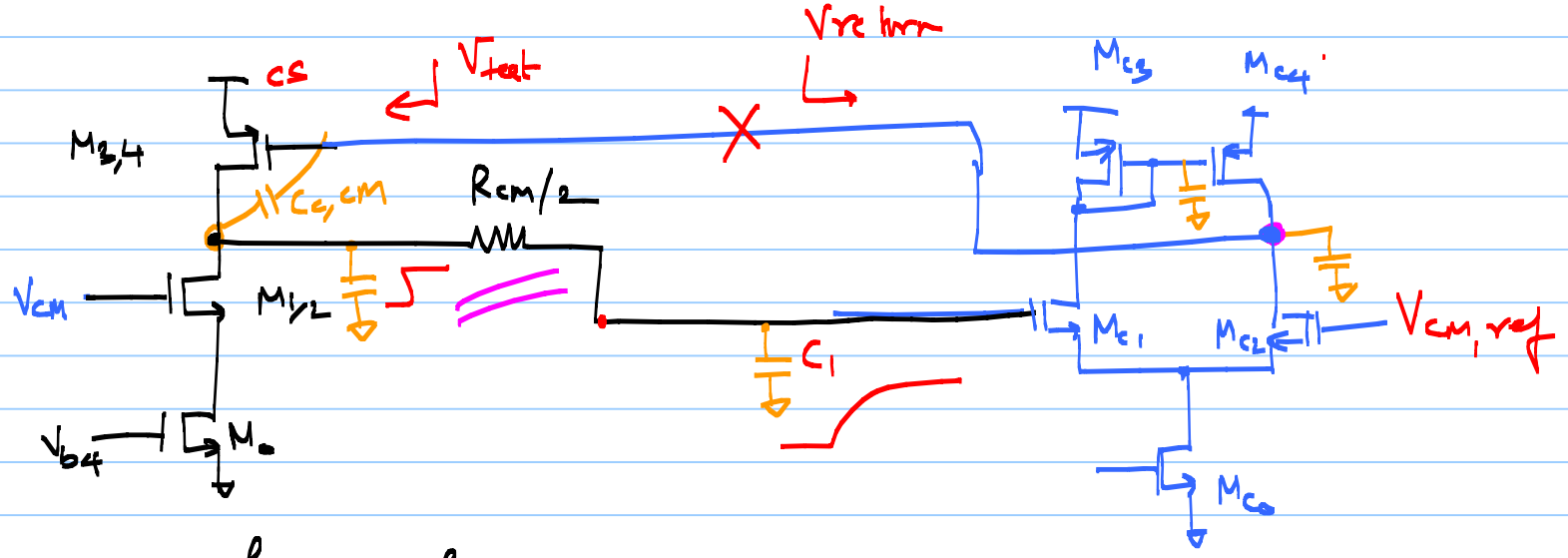


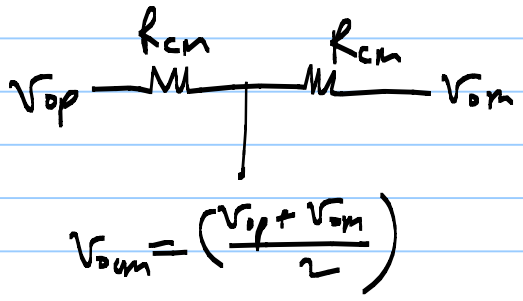
Differential picture

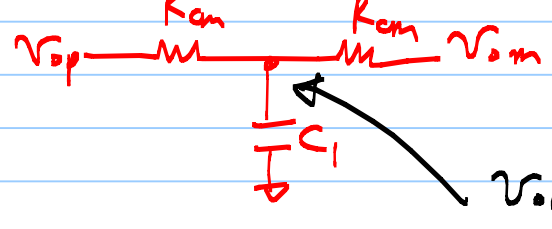




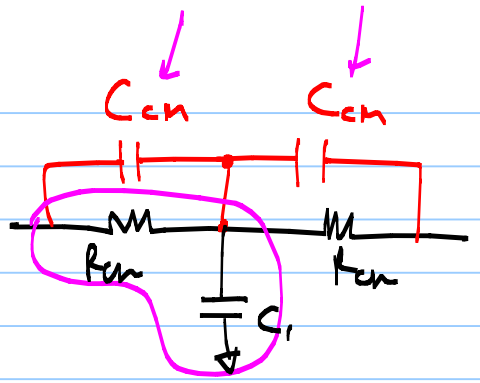
* loading the differential amplifier







* CM-detector doesn't work at high frequencies



at high frequencies:

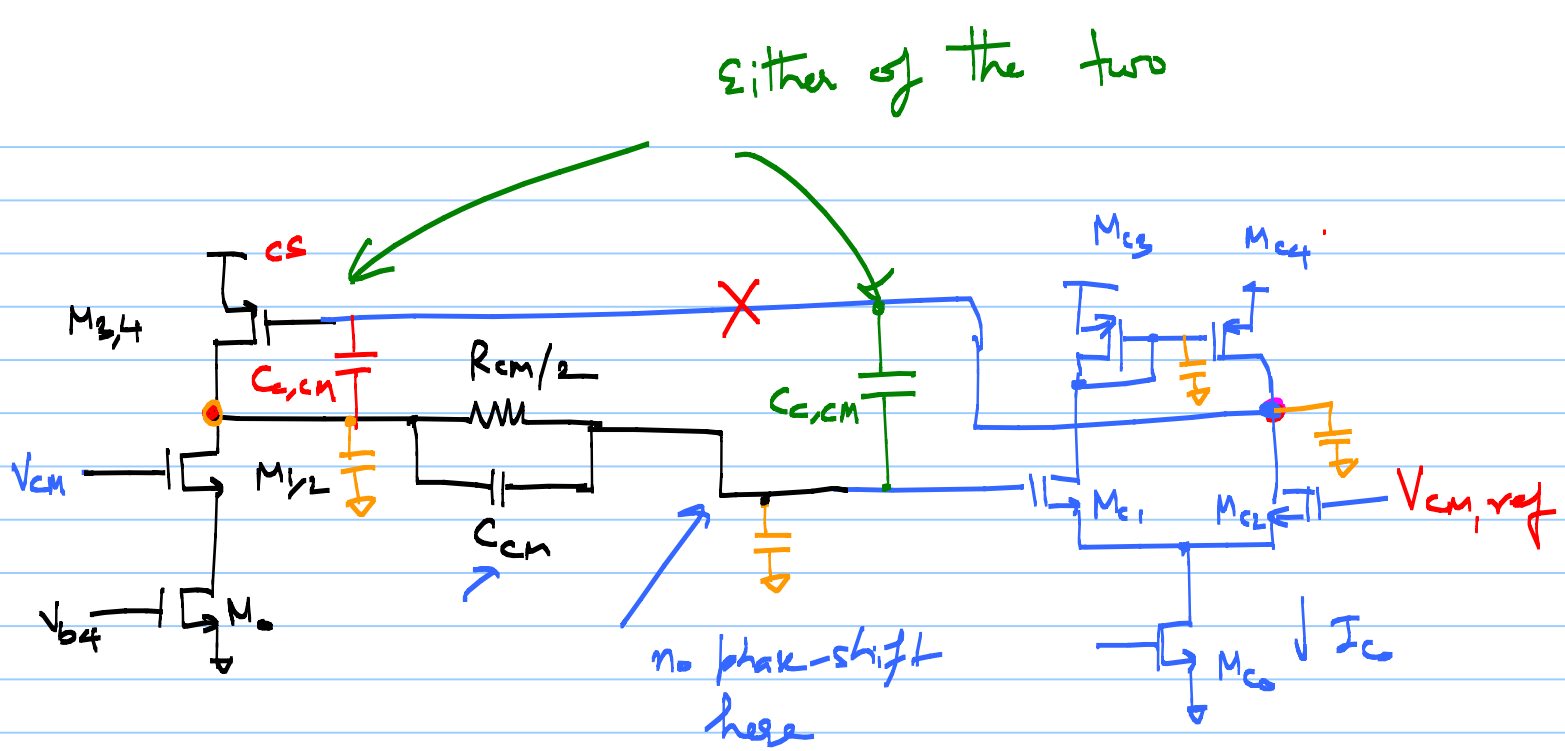
$$V_{ocm} = V_{op}\left(\frac{C_{cm}}{2C_{cm}+C_1}\right) + V_{om}\left(\frac{C_{cm}}{2C_{cm}+C_1}\right)$$

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

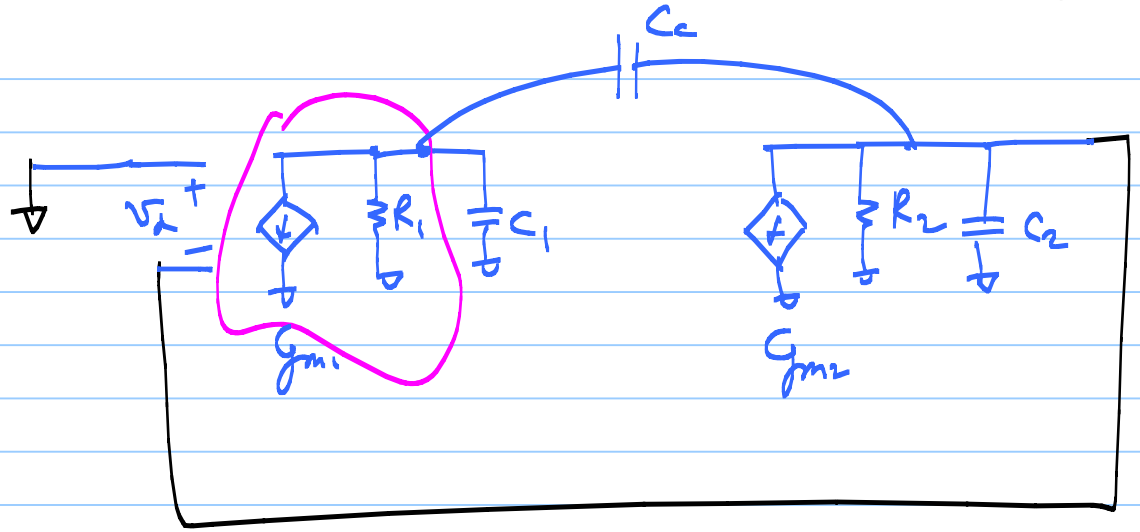
gain < 1

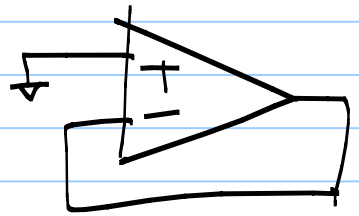
$\Rightarrow C_{cm} \ll C_1$

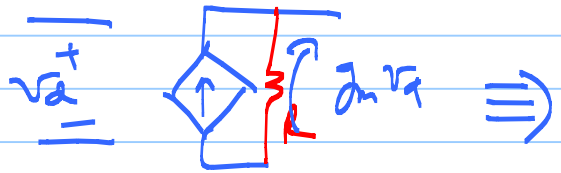
* No lag at high frequencies.


either of the two
CS
M3,4
Ca,cm
Rcm/2
Cc,cm
Vcm
M1,2
Ccm
Vb4
M0
no phase-shift here
Mc3
Mc4
Mc1
Mc2
Vcm,ref
Mc0
Ic

Miller-compensated two-stage amplifier



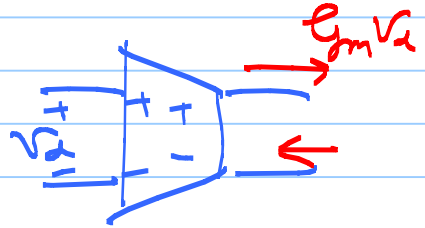


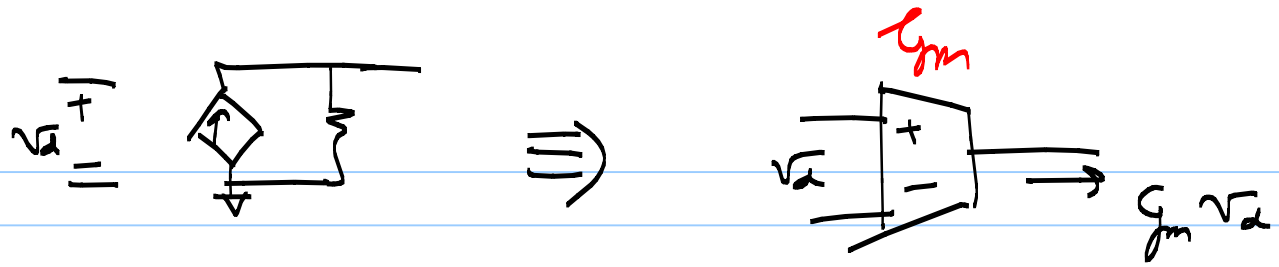


VCCS

$\equiv$

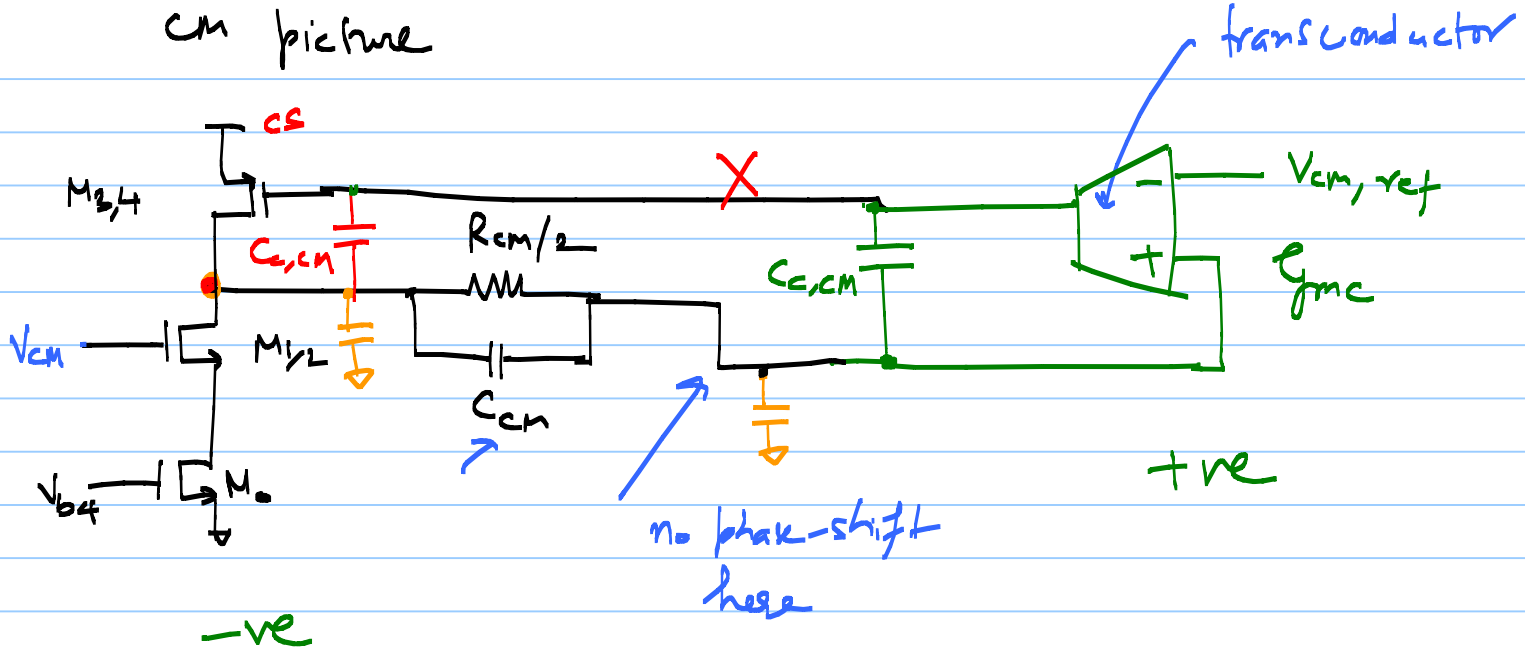
Transconductor

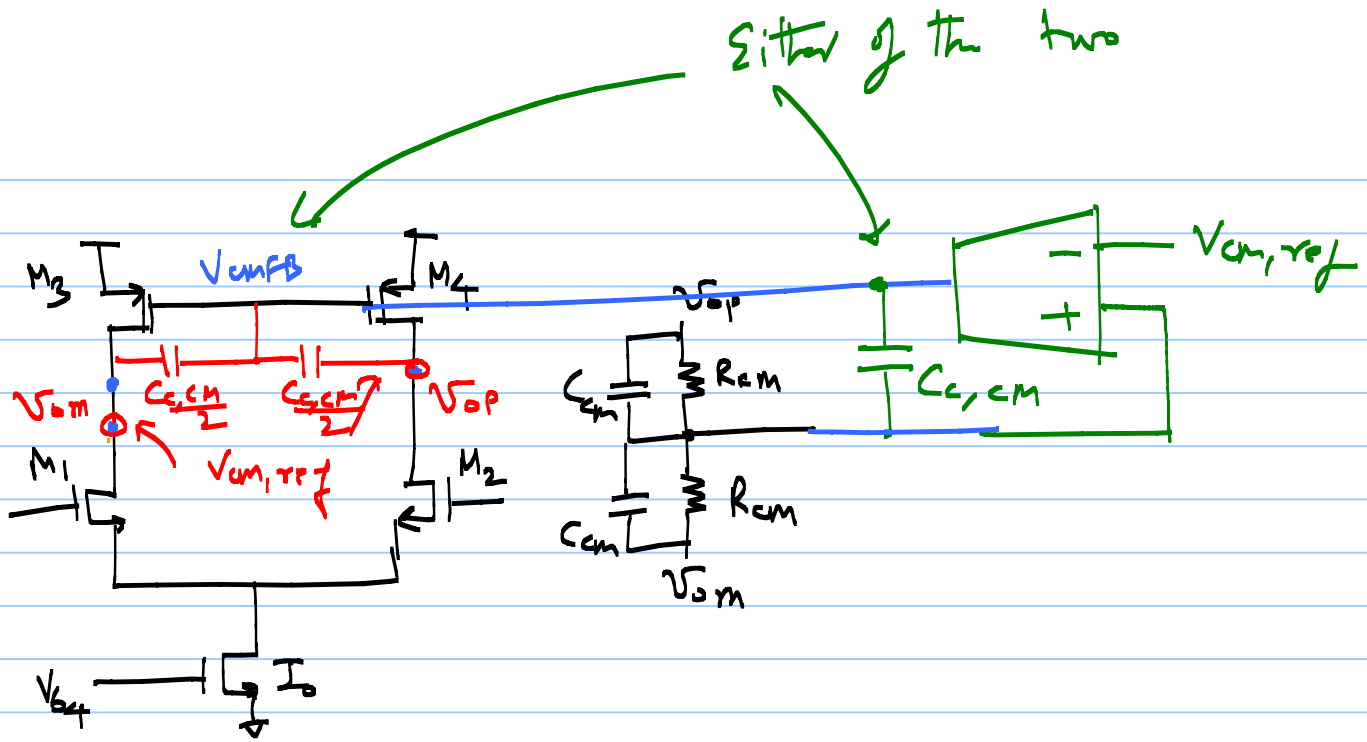



v_d
+
−
G_m
+
v_d
−
$G_m v_d$

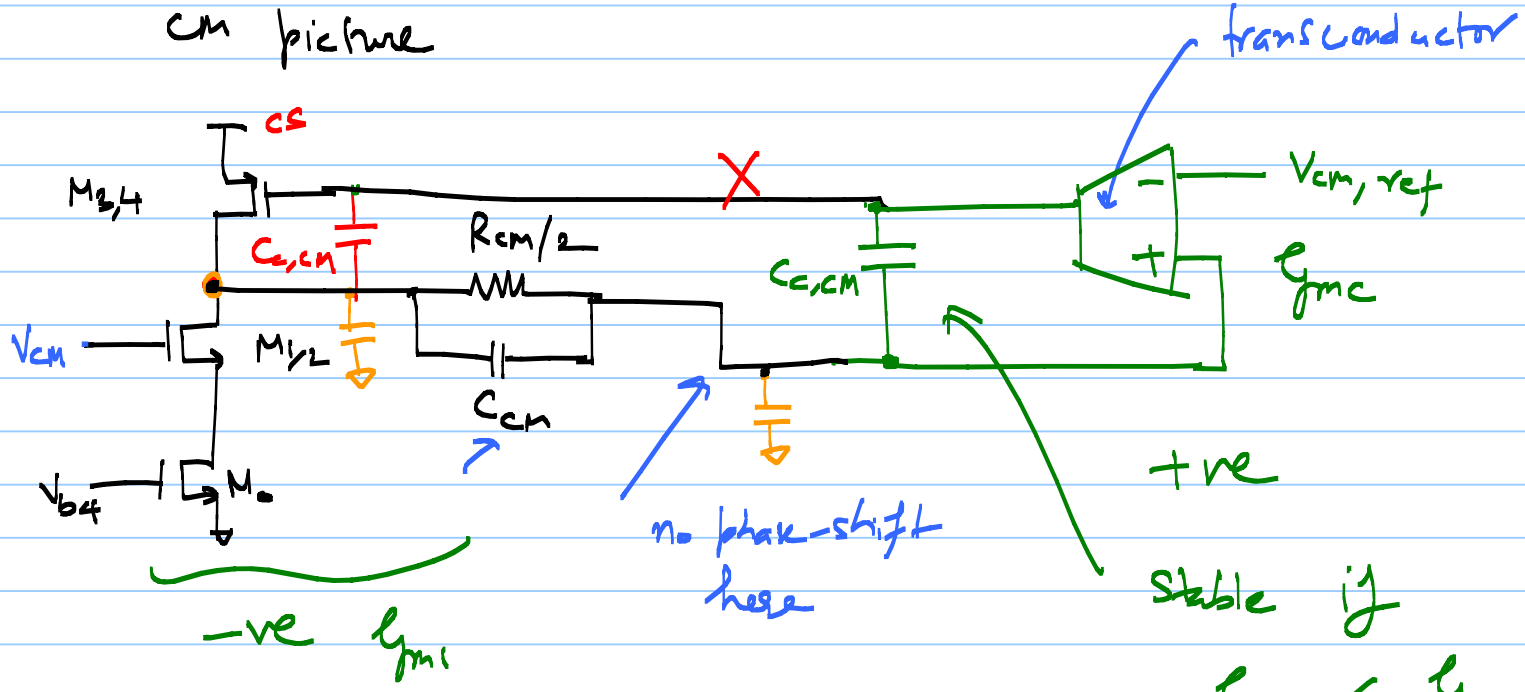
Simplied Schematic

CM picture

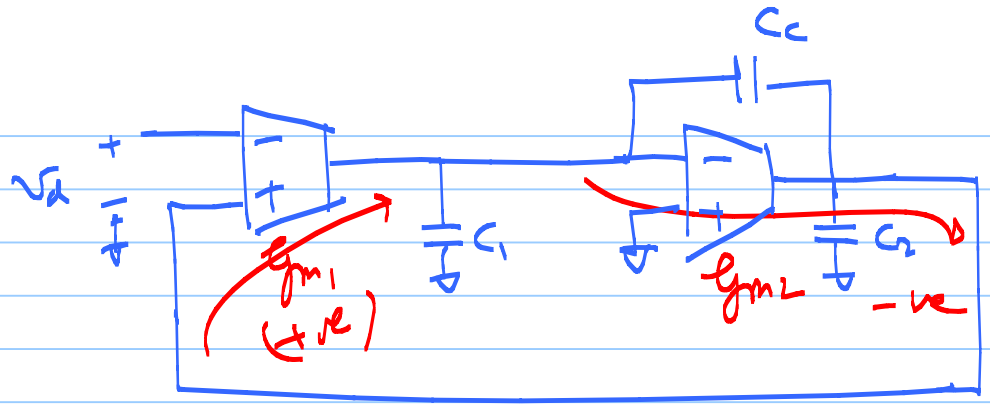



Either of the two
M_3
V_{cmFB}
M_4
V_{op}
V_{om}
$C_{c,cm}/2$
$C_{c,cm}/2$
V_{op}
$V_{cm,ref}$
M_1
M_2
V_{bias}
I_0
C_{cm}
R_{cm}
R_{cm}
C_{cm}
V_{om}
$V_{cm,ref}$
$C_{c,cm}$
−
+

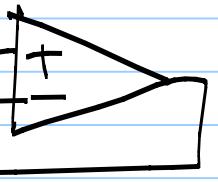
CM picture


CS
$M_{3,4}$
$C_{s,cm}$
$R_{cm}/2$
X
$C_{c,cm}$
transconductor
$V_{cm,ref}$
g_{mc}
V_{cm}
$M_{1/2}$
C_{cm}
V_{b4}
M_0
no phase-shift here
+ve
Stable if
$g_{mc} < g_{m1}$
-ve g_{m1}

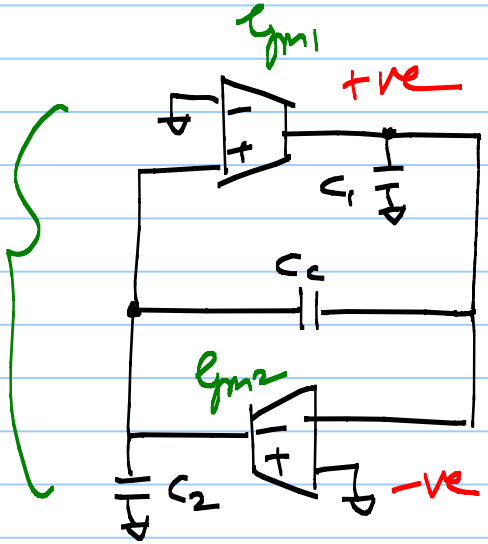
2-Stage Miller Compensated amp/loop

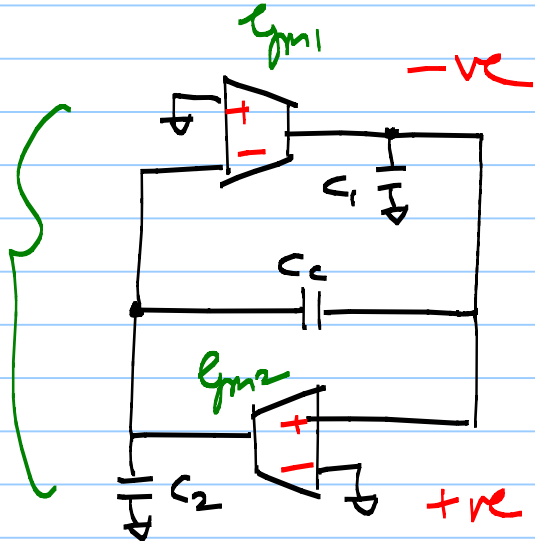


≡



LHP poles if $g_{m2} > g_{m1}$





$g_{m1} > g_{m2}$

g_{m1} ↑ diff amp

g_{m2}

$$w_{u,CMFB} \equiv \frac{q_{mc}}{C_{s,cm}}$$