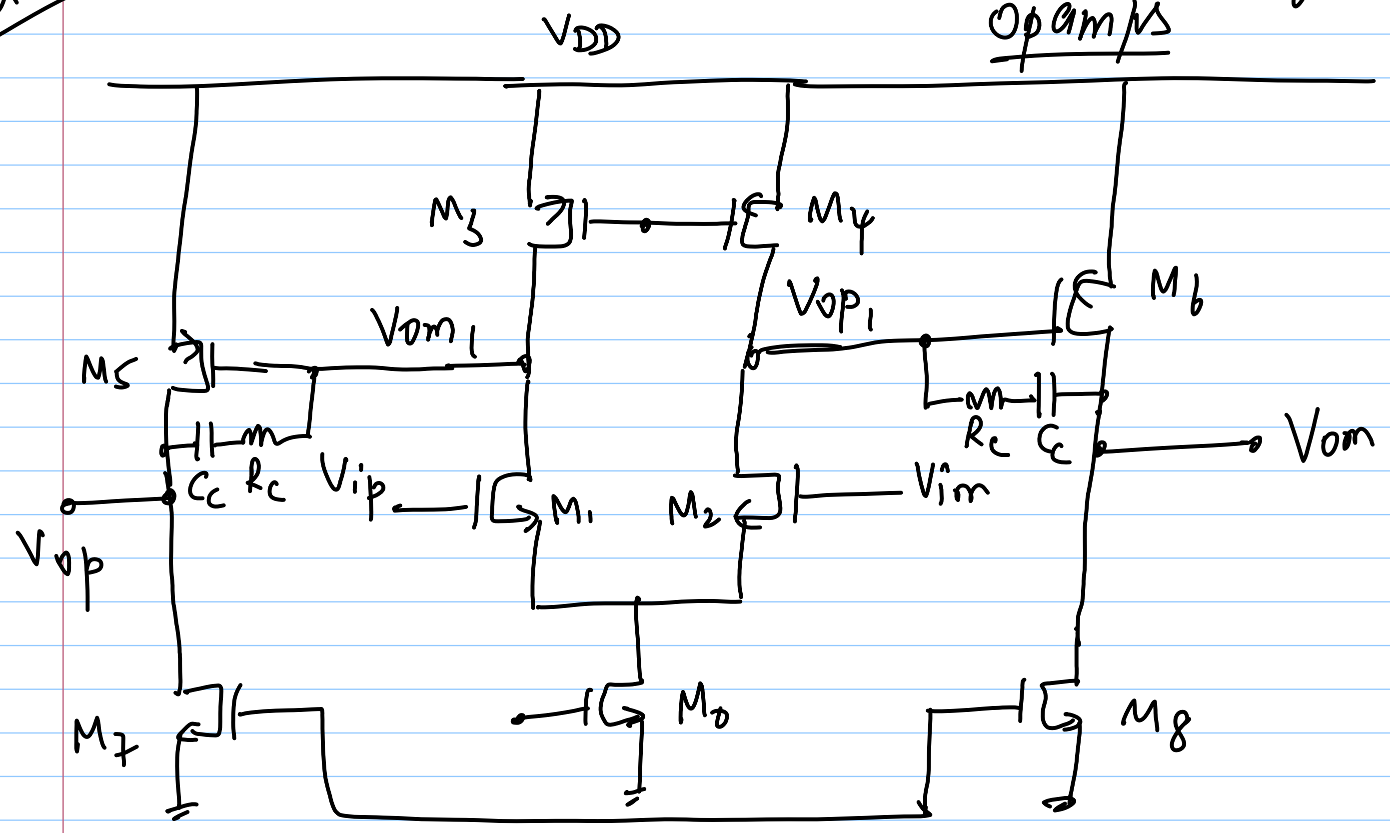
28-03-2012

Lec 34 – Two-stage, fully diff. opamps

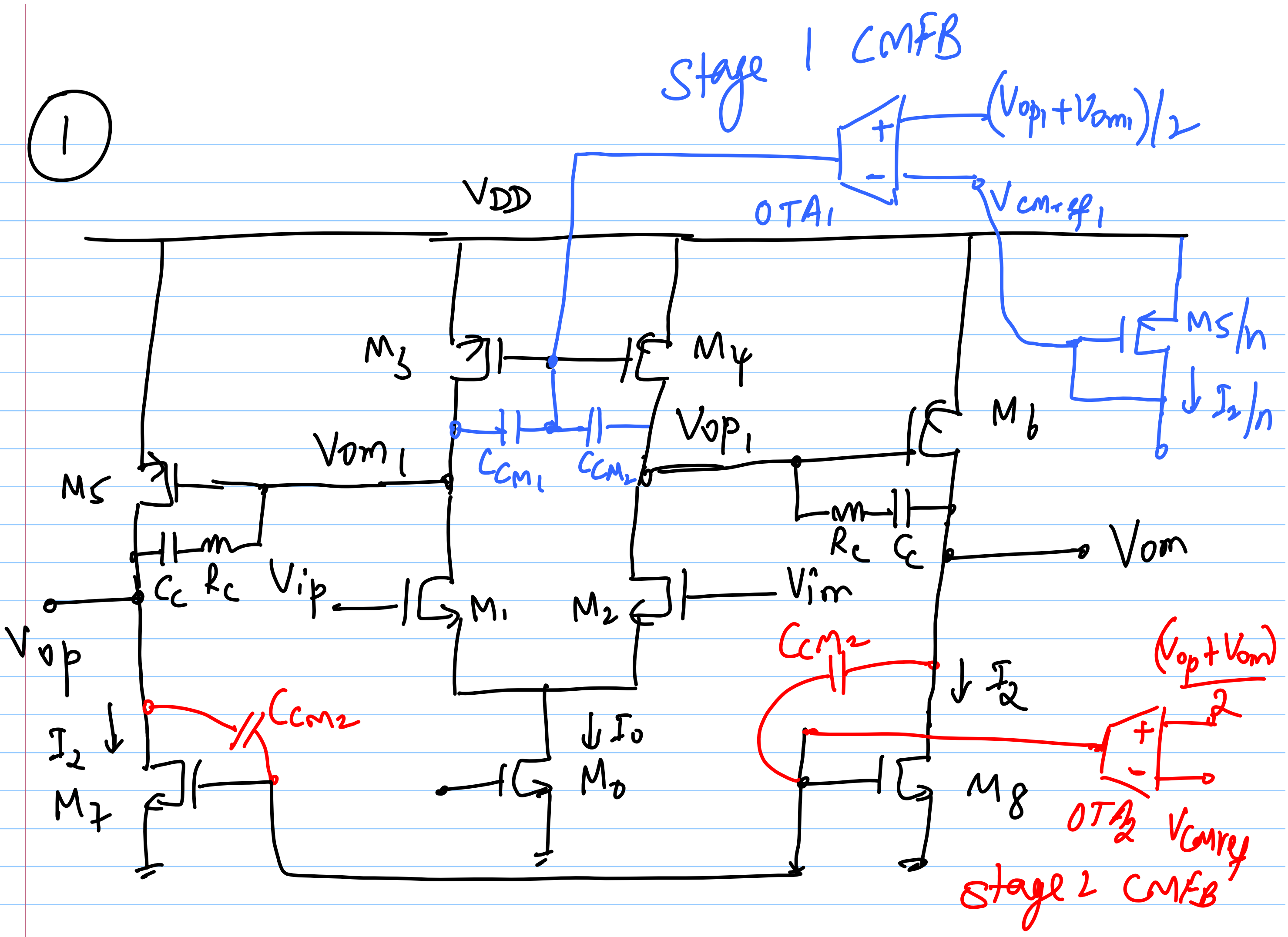


* V_{ocm_1} ← control M_0 or M_3/M_4 gates through CMFB $(V_{op_1}+V_{om_1})/2$

* V_{ocm_2} ← control gate of M_7/M_8, or M_0 or M_3/M_4 through V_{op_1}/V_{om_1} & M_5–M_6

⇒ M_5 & M_6 are pseudo differential ampl. ⇒ non-zero CM gain

(1)



* How do you choose $V_{CM,ref1}$?

→ $V_{CMref_1} = V_{DD} - V_{SG5}\big|_{I_2}$

→ cannot be chosen independently (e.g. @ $V_{DD}/2$)

→ M7 & M8 gates get adjusted automatically through $CMFB_2$

* Generate V_{CMref_1} through <u>replica</u>

* How to choose $V_{cm,ref}$?
  → choose to maximize swing
  i.e. $V_{cm,ref} = V_{DD}/2$

__Separate CMFB for stages 1 & 2__

__stage 1__ : * control gates of $M_{3,4}$
* set $\frac{V_{op_1} + V_{om_1}}{2}$ to $V_{DD} - V_{SG_{5}}/I_2$
$(= V_{CM,ref_1})$
→ derive from a replica branch

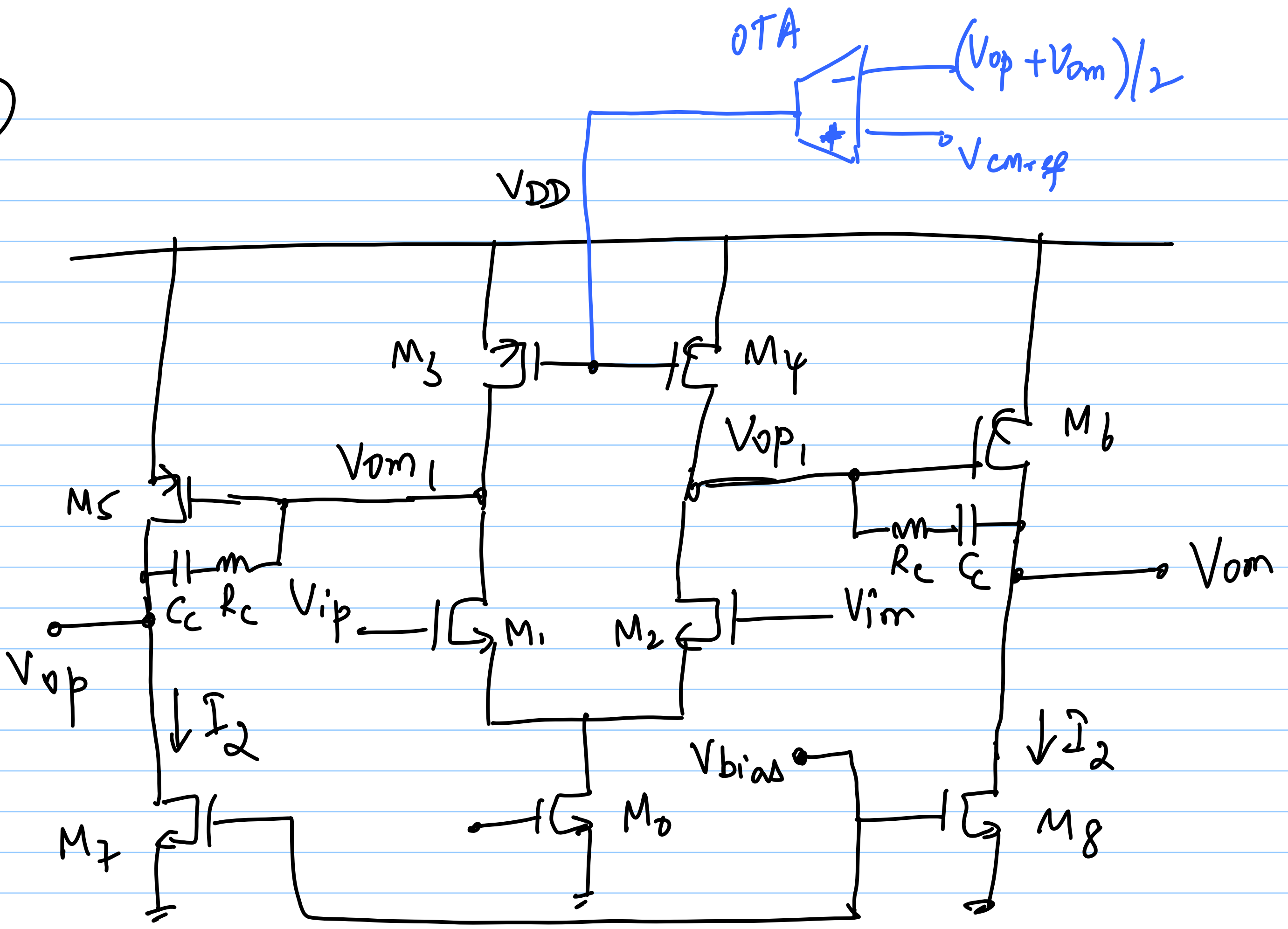
* Use a CM detector w/o resistive loading @ the input (maintain gain)

__Stage 2__ : * $V_{CM,ref} \simeq V_{DD}/2$ to maximize swings
* resistive CM detector (high swings)

* Use single-stage opamps to complete CM feedback
* Do compensation for CMFB loops
→ C_{CM_1}, C_{CM_2} (can also have R_{CM_1}, R_{CM_2})

* OTA$_1$ ← nmos i/p pair with pmos loads (M_3/M_4 replica)
* OTA$_2$ ← pmos i/p pair with nmos loads (M_7/M_8 replica)

(2)



* Single f.b. loop
  → stages 1 & 2 are both in f.b. loop
* fundamentally possible because M_5 & M_6 have CM gain
* V_{bias} such that I_2 in M_7, M_8
* Once CMFB loop settles,
  → $V_{op} = V_{om} = V_{CM,ref}$
  → $I_{M_5} = I_{M_6} = I_2$
  → $V_{op_1} = V_{om_1} = V_{DD} - V_{SG_{5,6}}\big|_{I_2}$

Stability

* 3 stages in f.b. ⇒ harder to stabilise
* Make OTA low-gain
  e.g. use diode loads instead of mirror so that gain ~ 1
* C_c – can be designed to stabilise CM loop as well (difficult)