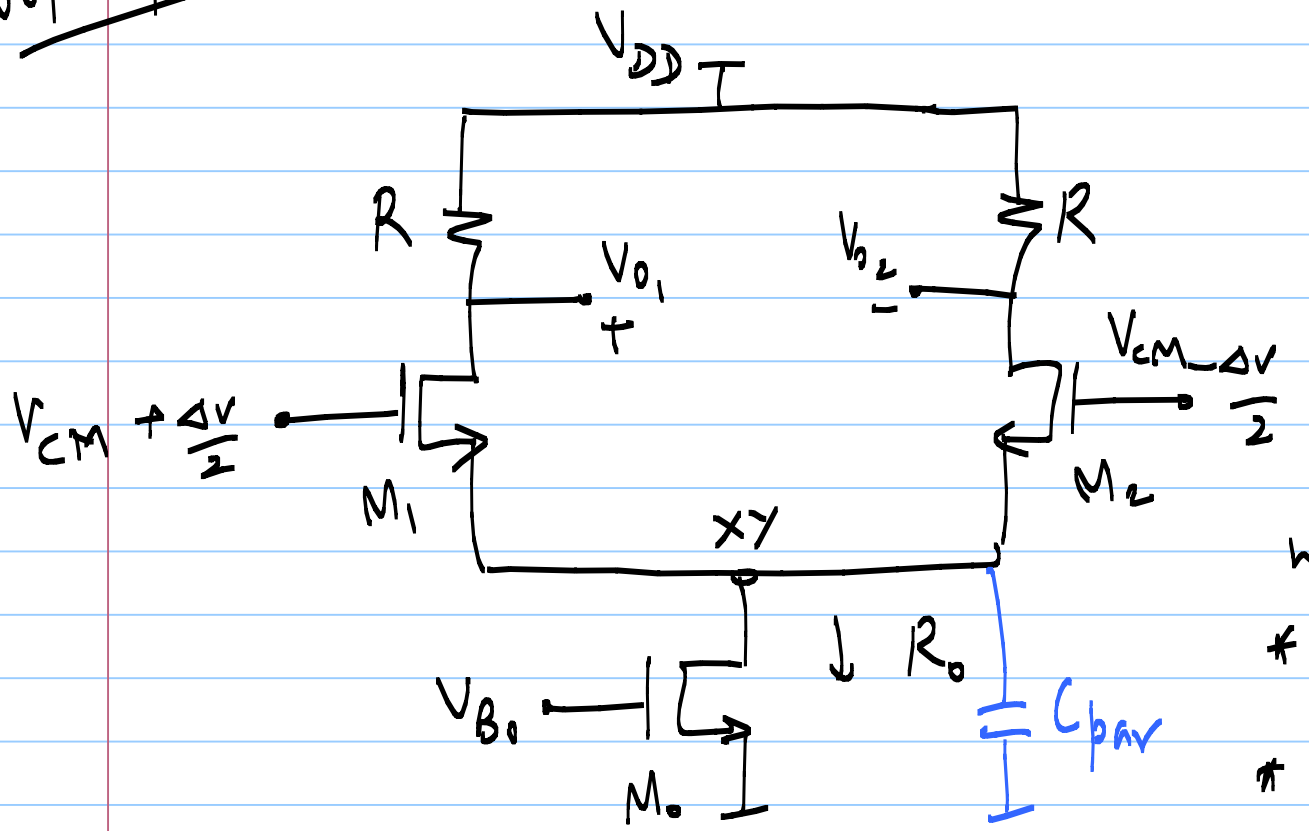
06/10/2020

Lecture 33



A_{DM} is large ($-g_m R$)

A_{CM} is small (dep. on R_0)

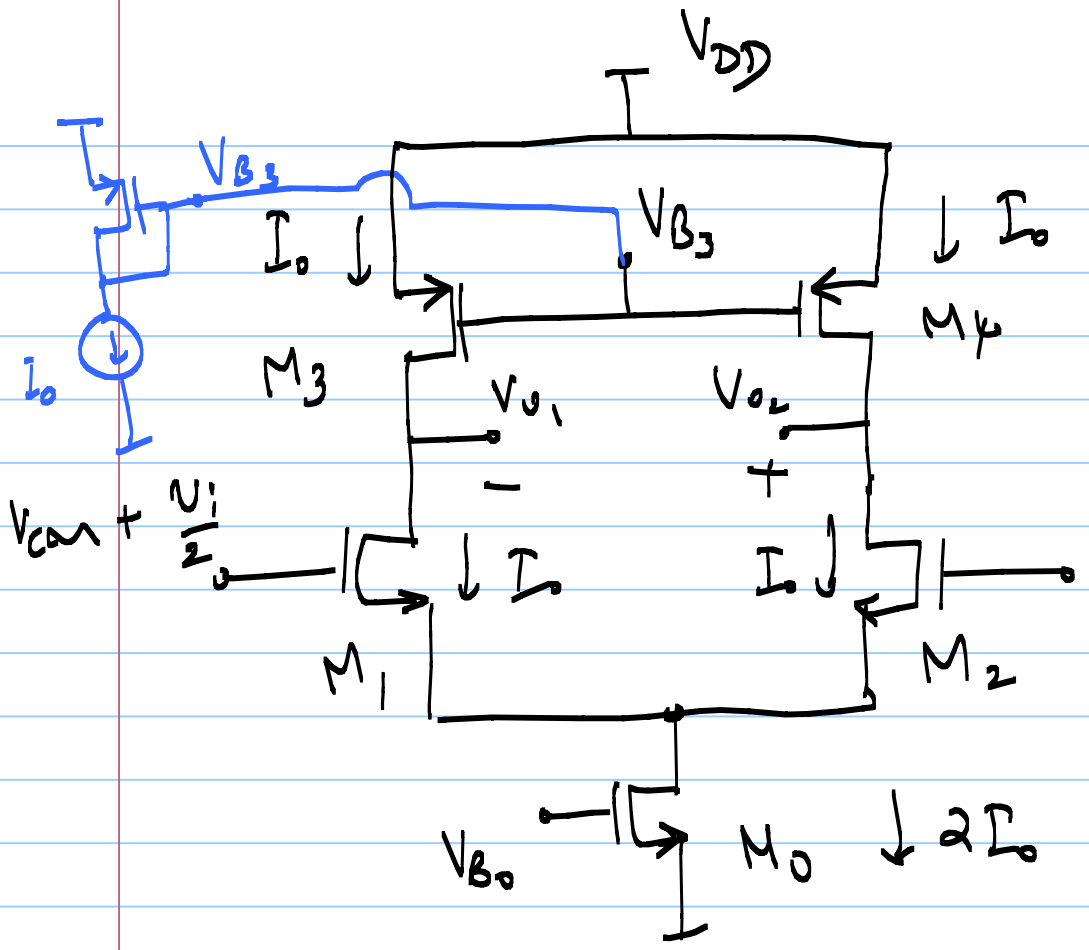
CMRR is large

We want to

* have a single ended o/p
* have more gain
* Ensure C_{par} is as low as possible

Possibilities

* SE o/p – discard V_{O1} or V_{O2} {not good}
* more gain – active load



$$v_{o_1} = -g_{m_1}(r_{ds_1} \| r_{ds_3}) \cdot \left(\frac{v_i}{2}\right)$$

$$v_{o_2} = -g_{m_2}(r_{ds_2} \| r_{ds_4}) \cdot \left(-\frac{v_i}{2}\right)$$

$$= +g_{m_1}(r_{ds_1} \| r_{ds_3}) \cdot \frac{v_i}{2}$$

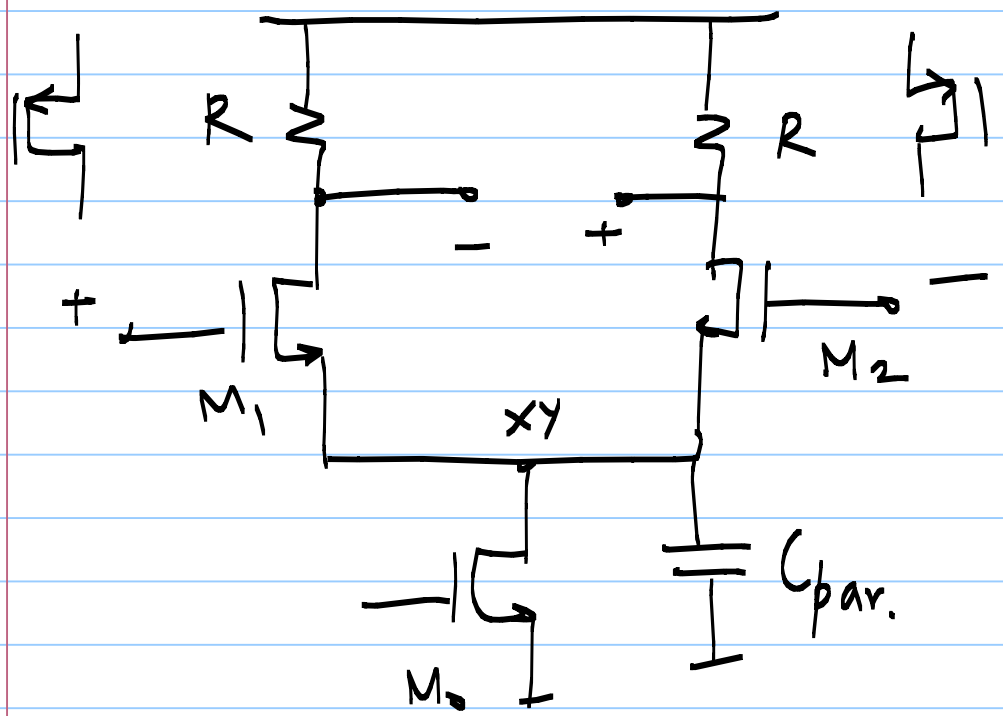
$$v_o = v_{o_2} - v_{o_1}$$

$$= +g_{m_1}(r_{ds_1} \| r_{ds_3}) \cdot v_i$$

gain similar to CSA with active load

* Set V_{B_3} so that

$$I_{D_3} = I_{D_4} = I_o$$



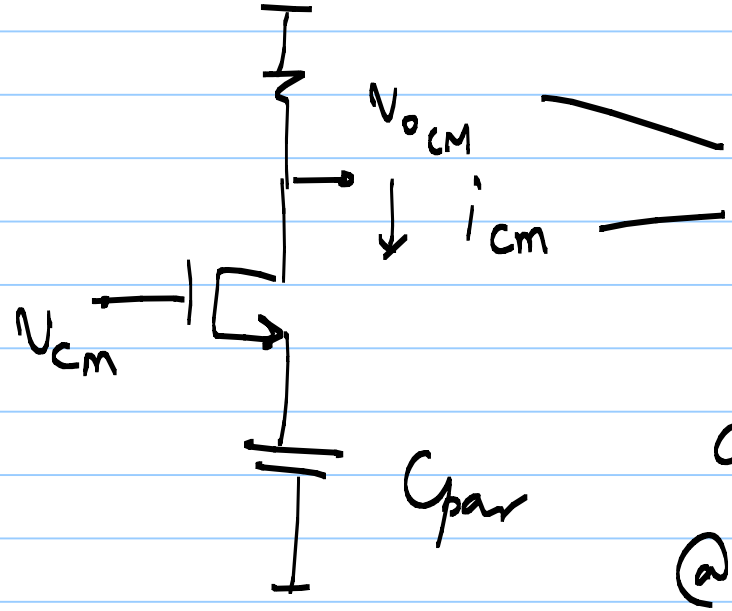
* Cpar = "parasitic" cap
  (undesired cap)
* Normally Cpar @ xy dominated by device cap.
  (M_0, M_1 & M_2)
  (Not M_3 & M_4)

* Cpar does not affect DM performance significantly
* Cpar affect CM performance

  e.g. R_0 (r_{ds_0}) = ∞

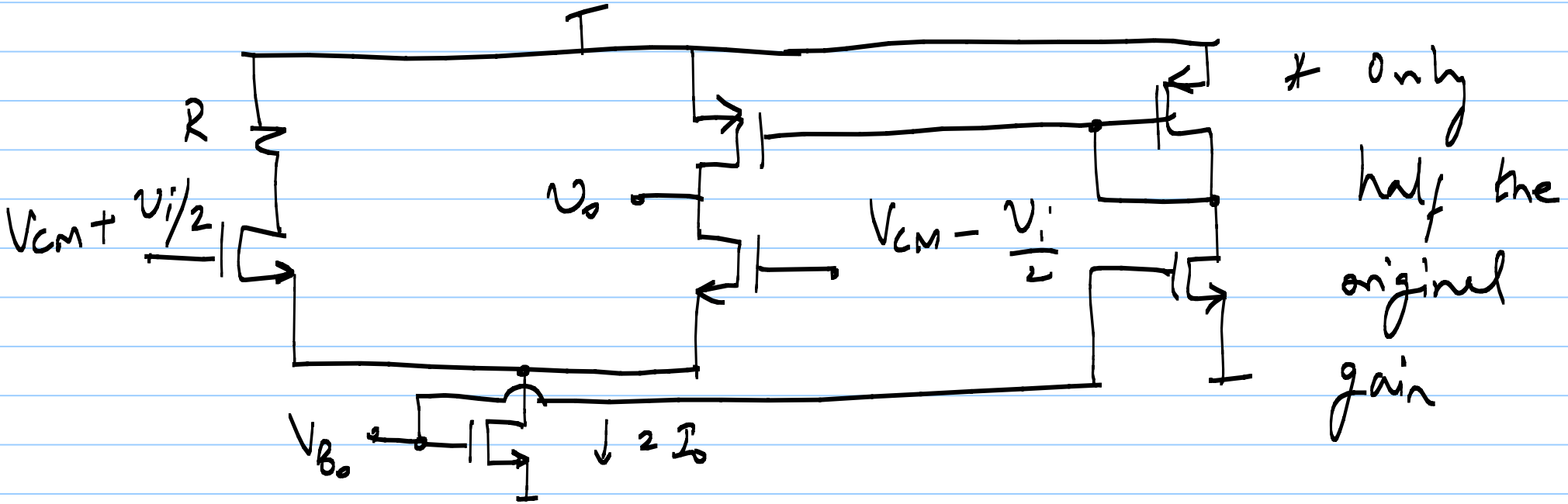
original $A_{CM} = 0$ (without C_{par})

With C_{par}:

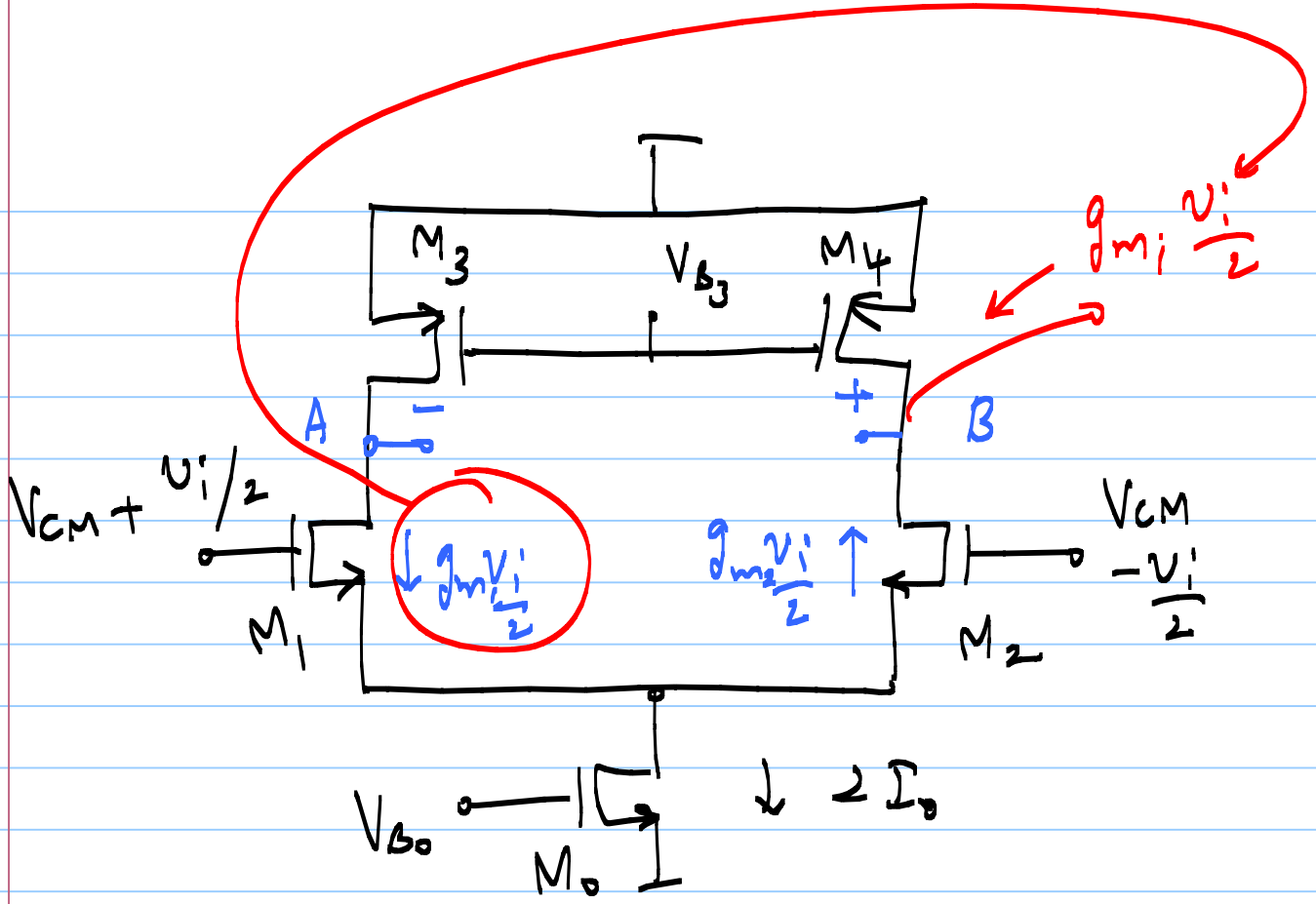


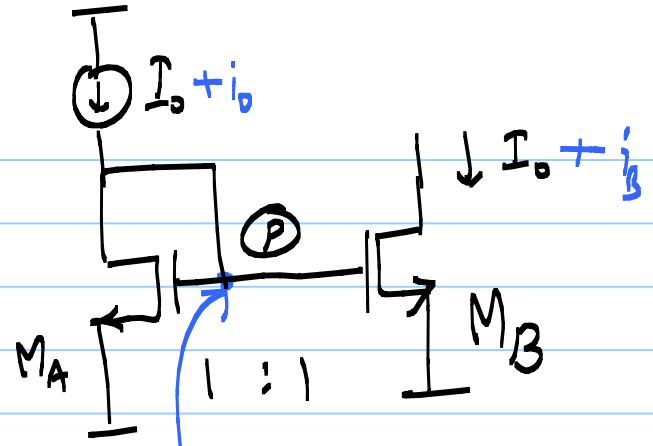
functions of freq.

CMRR is degraded @ high freq.



* only half the original gain



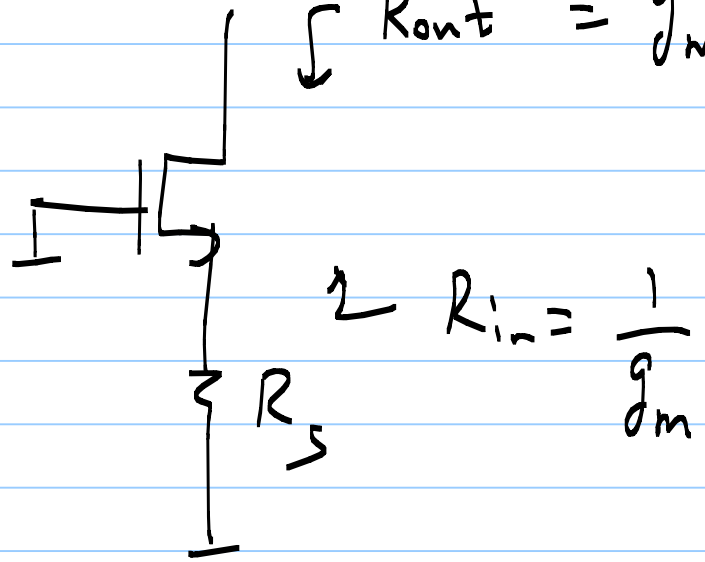


$$V_p = V_{GS_A}\left(I_0 + \frac{i_o}{g_{m_A}}\right)$$

$$I_{D_B} = I_0 + \frac{i_o \cdot g_{m_B}}{g_{m_A}}$$

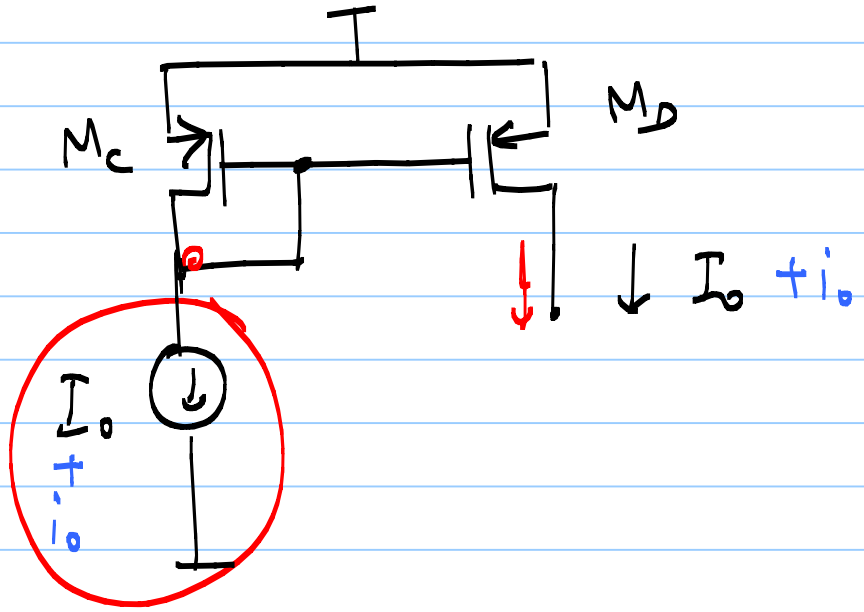
$i_B = i_o$ here (1 : 1 CM)

C.G.A.

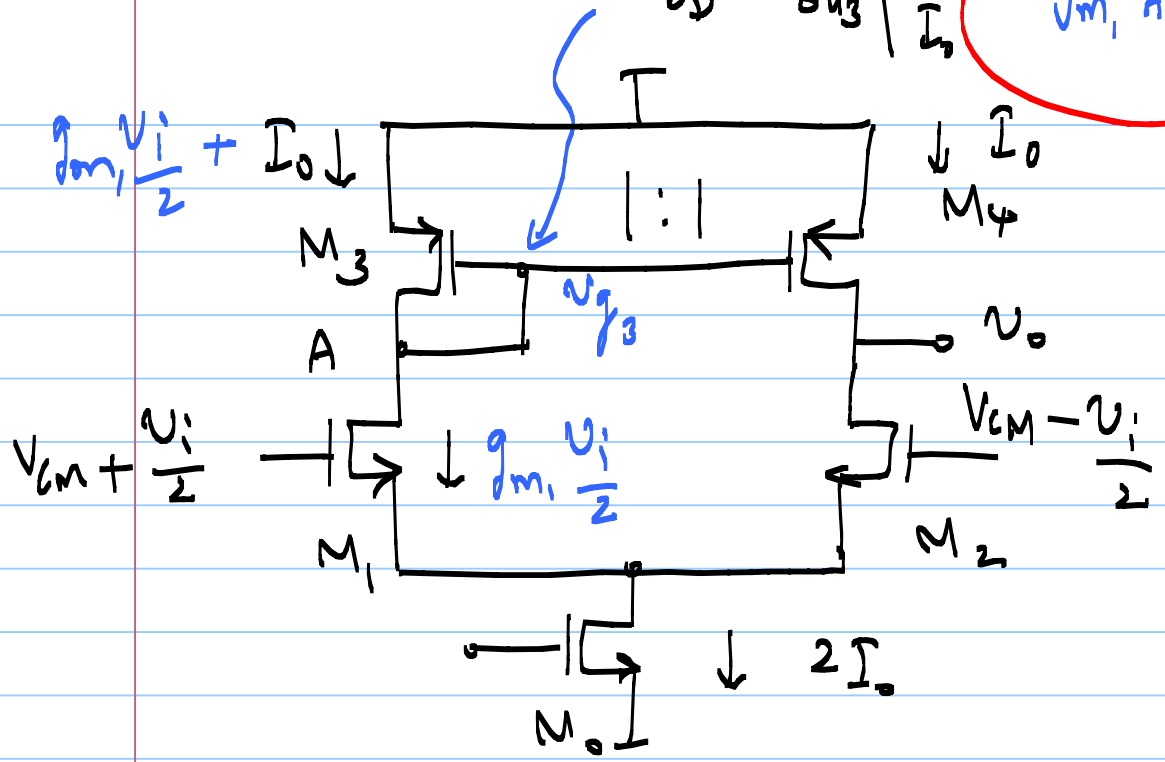


$\Rightarrow R_{out} = g_m r_{ds} \cdot R_s$

$\Rightarrow R_{in} = \frac{1}{g_m}$



* Repurpose M_3 & M_4 to form $M_C - M_D$ C.M.



$g_{m_1}\frac{v_i}{2} + I_0$

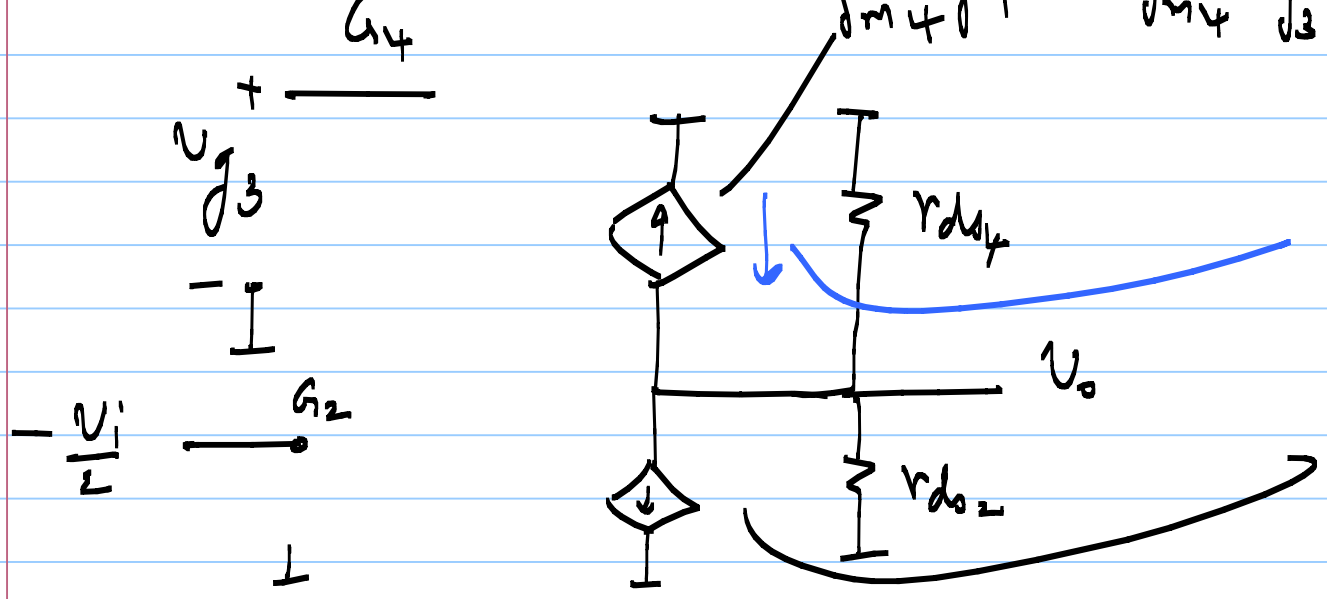
$-g_{m_1} r_A \frac{v_i}{2} \approx -\frac{g_{m_1}}{g_{m_3}} \cdot \frac{v_i}{2}$ {i.e. $g_{m_1} >> g_{ds_1}, g_{ds_3}$}

$r_A = r_{ds_1} \,||\, \frac{1}{g_{m_3}} \,||\, r_{ds_3}\left(\begin{matrix}\text{low}\\ \text{imp}\end{matrix}\right)$

$\approx \frac{1}{g_{m_3}}$

(originally high imp.)

$v_{g_3} = -\frac{g_{m_1}}{g_{m_3}} \cdot \frac{v_i}{2}$



$-g_{m_4} v_{g_3} = -\cancel{g_{m_4}} \cdot \frac{-g_{m_1}}{\cancel{g_{m_3}}} \frac{v_i}{2}$

$= +g_{m_1}\frac{v_i}{2}$