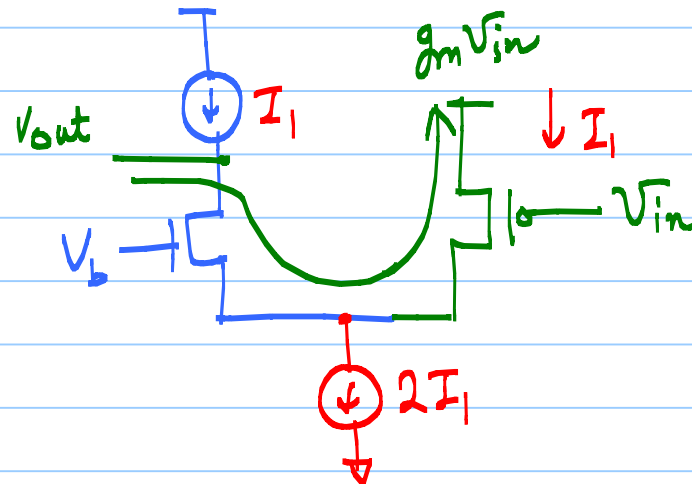
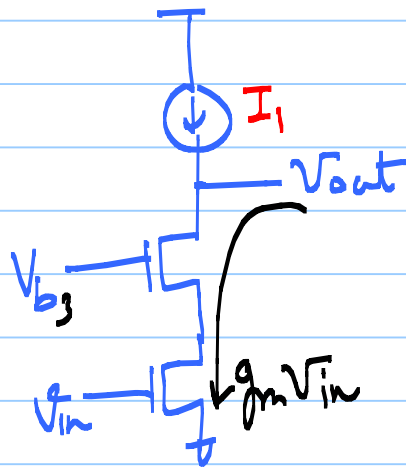


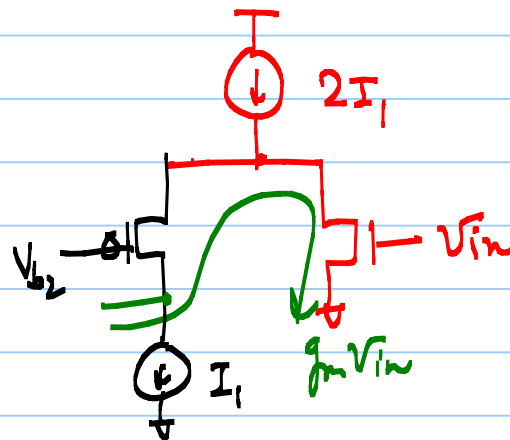
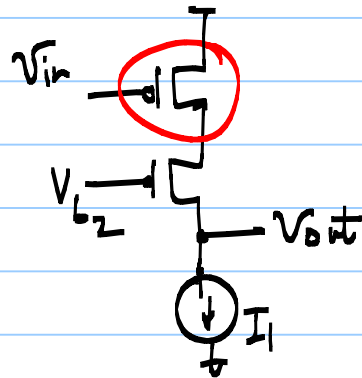
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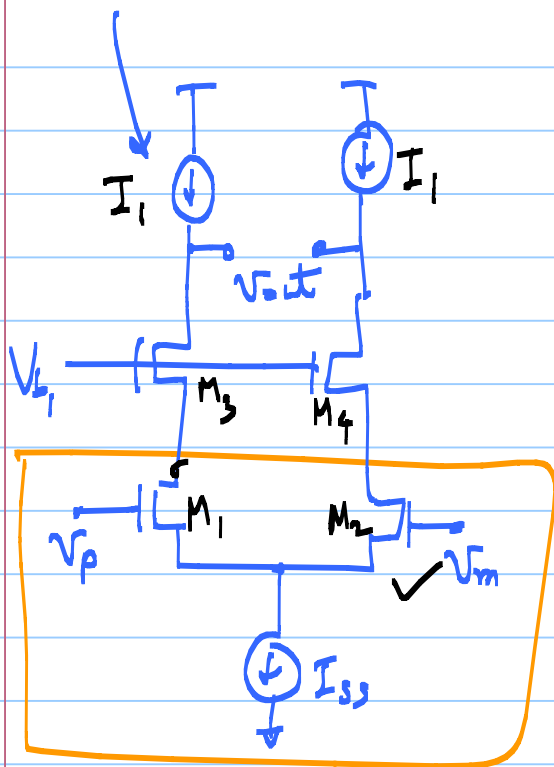
Note Title

4/25/2012

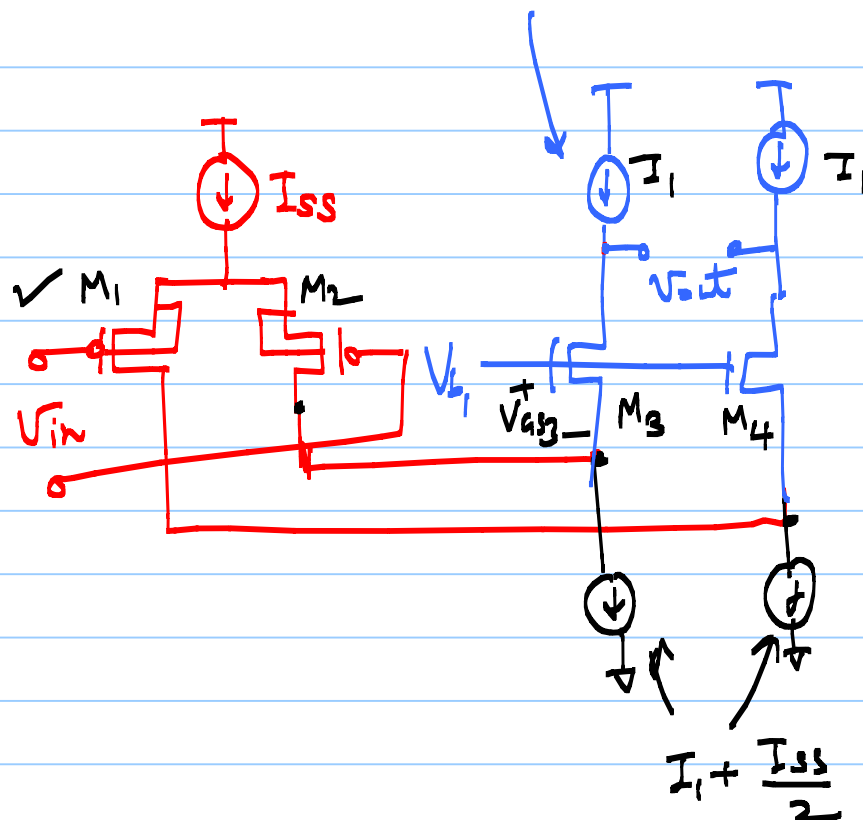


Folded Cascode

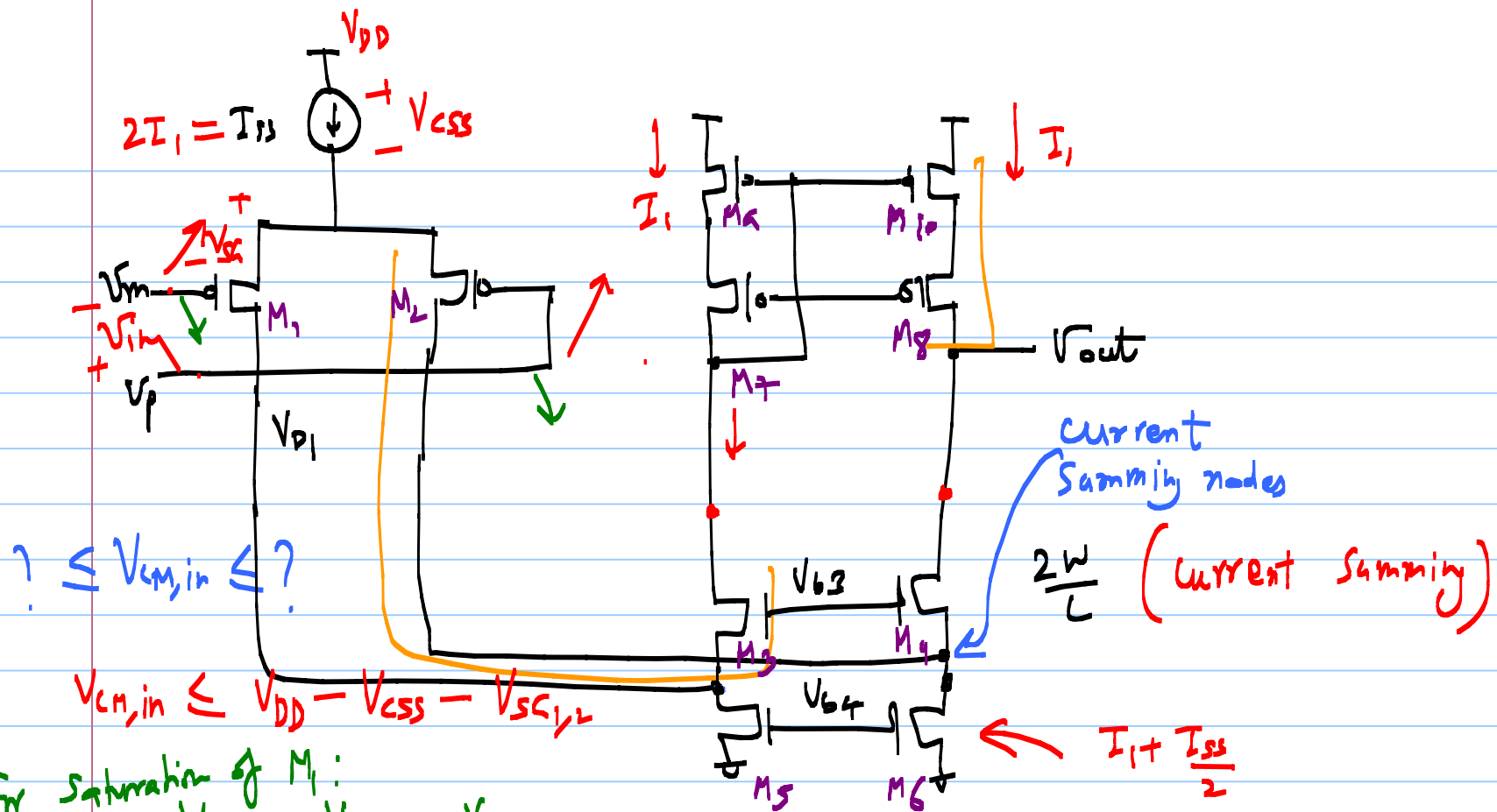




$$V_{cm,in} \leq V_{b1} - \underbrace{V_{gs} + V_{TH1}}_{\text{tail current source voltage}}$$



$$V_{cm,in} \geq \underbrace{V_{b1} - V_{gs3} - V_{TH1}}_{V_{gs3} + V_{ds,sat}} \leq 0$$



$$? \leq V_{cm,in} \leq ?$$

$$V_{cm,in} \leq V_{DD} - V_{CSS} - V_{GS1,2}$$

For saturation of M_1 :

$$V_{SD1} > V_{SG1} - V_{THP}$$

$$\cancel{V_S} - V_{D1} > \cancel{V_S} - V_{G1} - V_{THP}$$

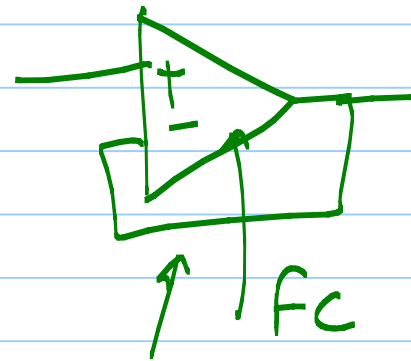
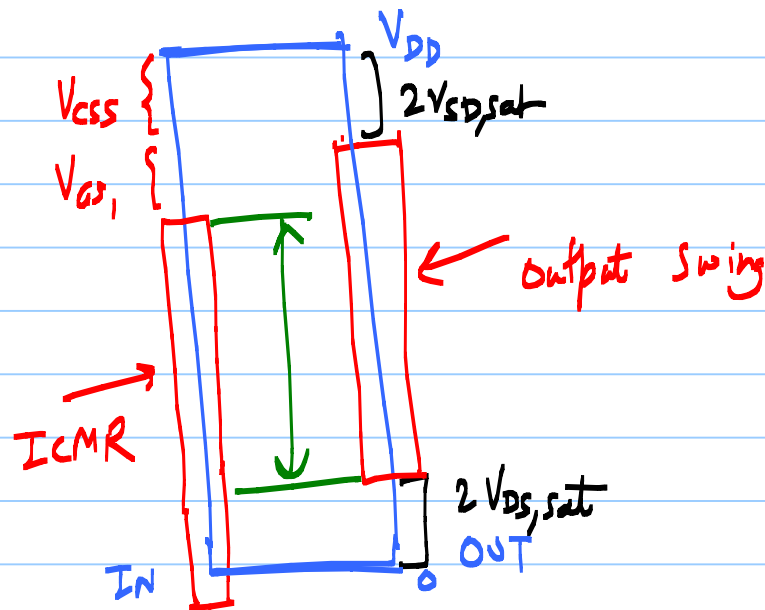
$$V_{G1} > V_{D1} - V_{THP}$$

$$V_{D1} \geq V_{DS,sat}$$

$$V_{G1} \geq \underbrace{V_{DS,sat}}_{100mV} - \underbrace{V_{THP}}_{350mV} = -250mV$$

* wider ICMR

* good overlap of
ICMR and the
output swing



Biasing from Fig. 20.47.
 Sizes given in Table 9.2.

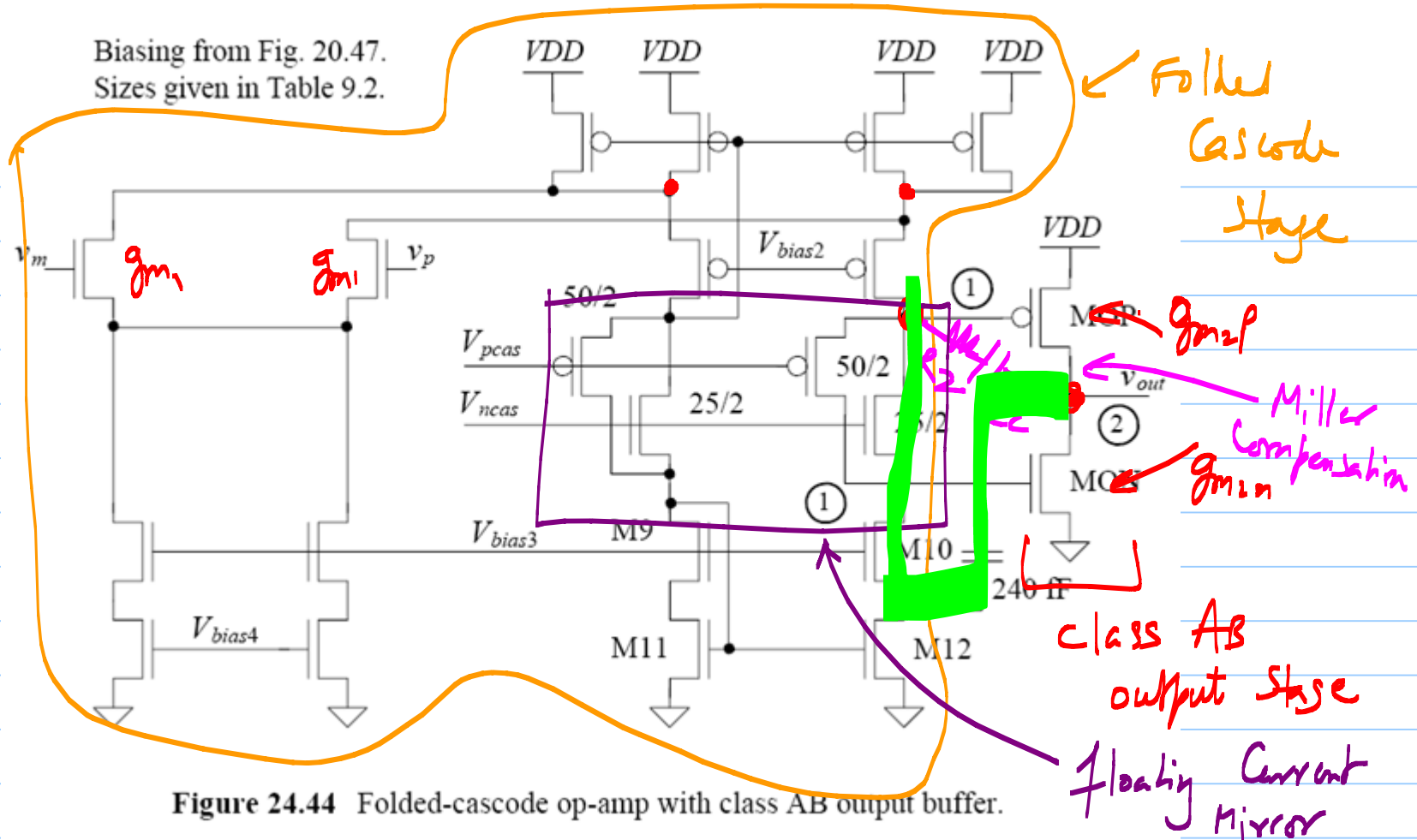
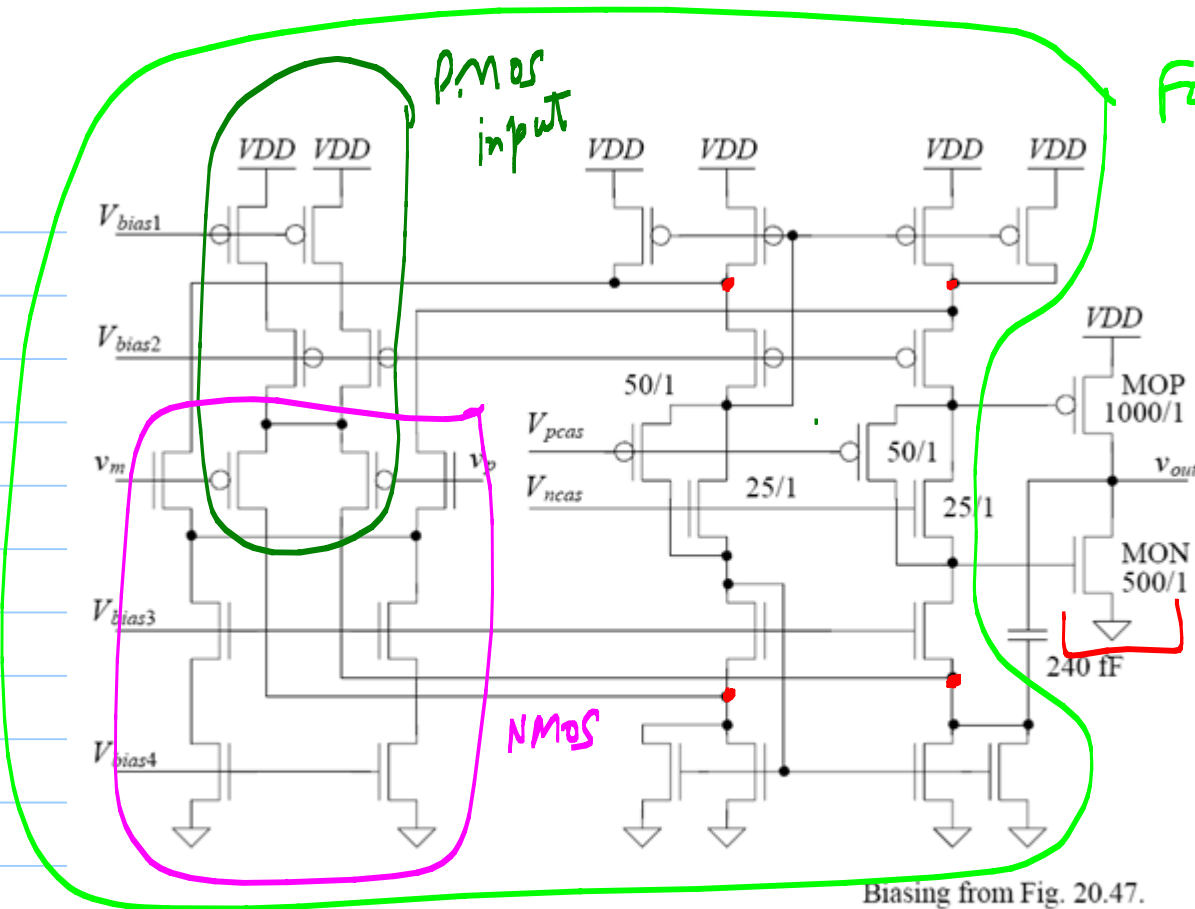


Figure 24.44 Folded-cascode op-amp with class AB output buffer.



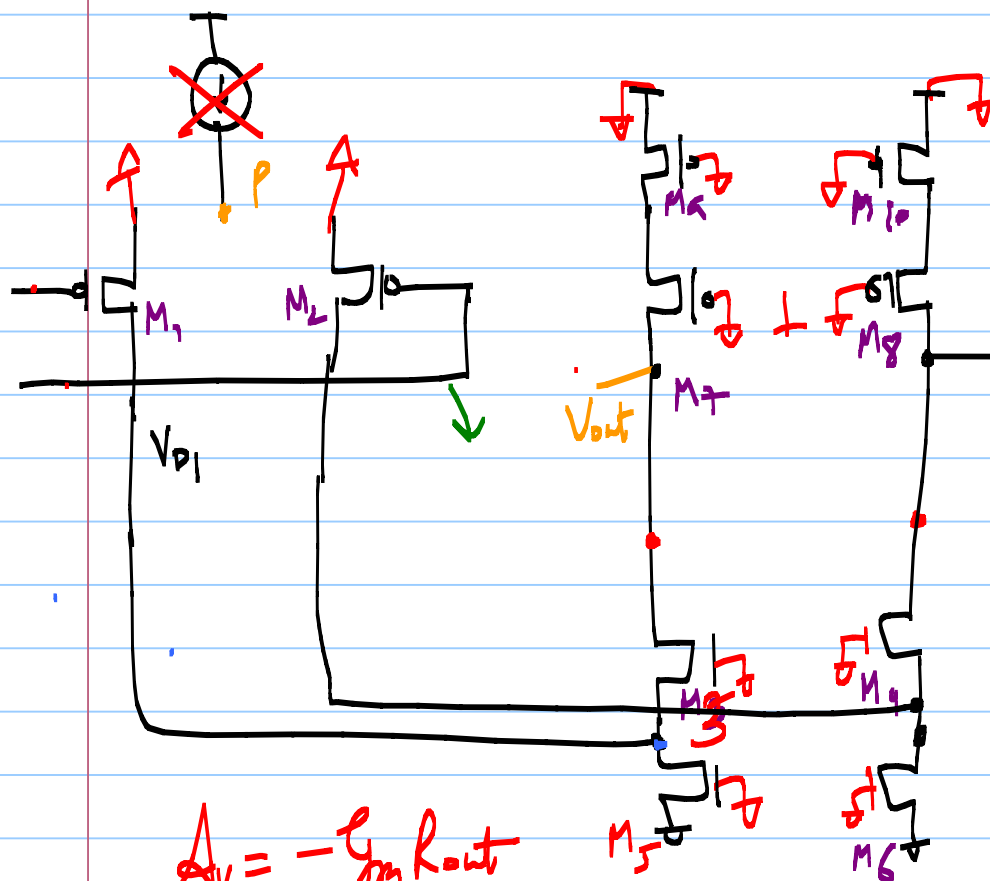
Folded Cascode

rail-to-rail

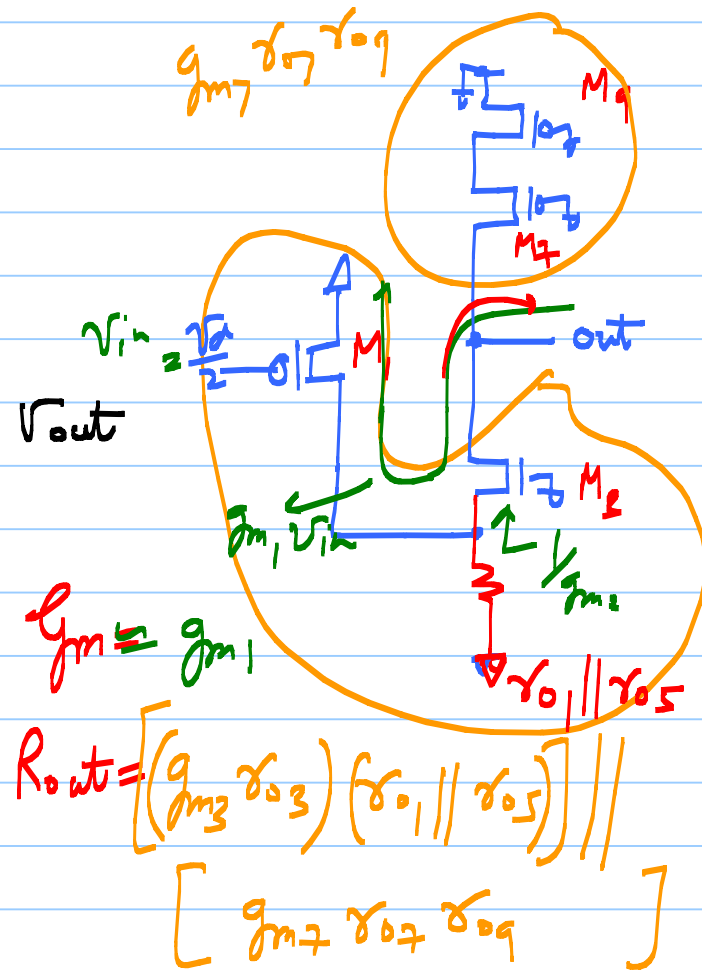
ICMR

Figure 24.48 An op-amp with an input common-mode range that extends beyond the power supply rails and that can drive heavy loads.

Biased from Fig. 20.47.
Unlabeled NMOS are 50/1.
Unlabeled PMOS are 100/1.



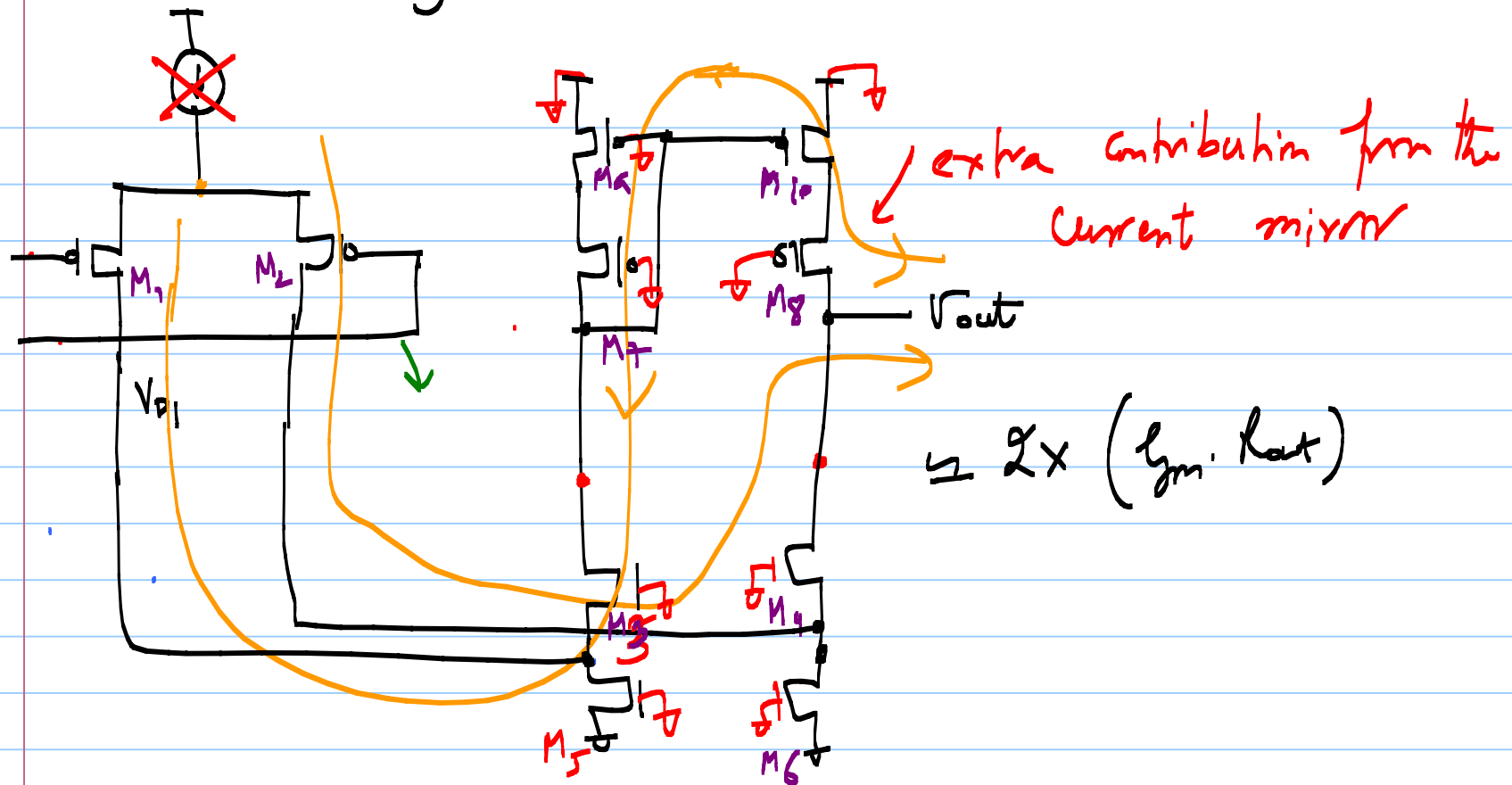
$$A_{v_{DM}} = -g_m R_{out}$$

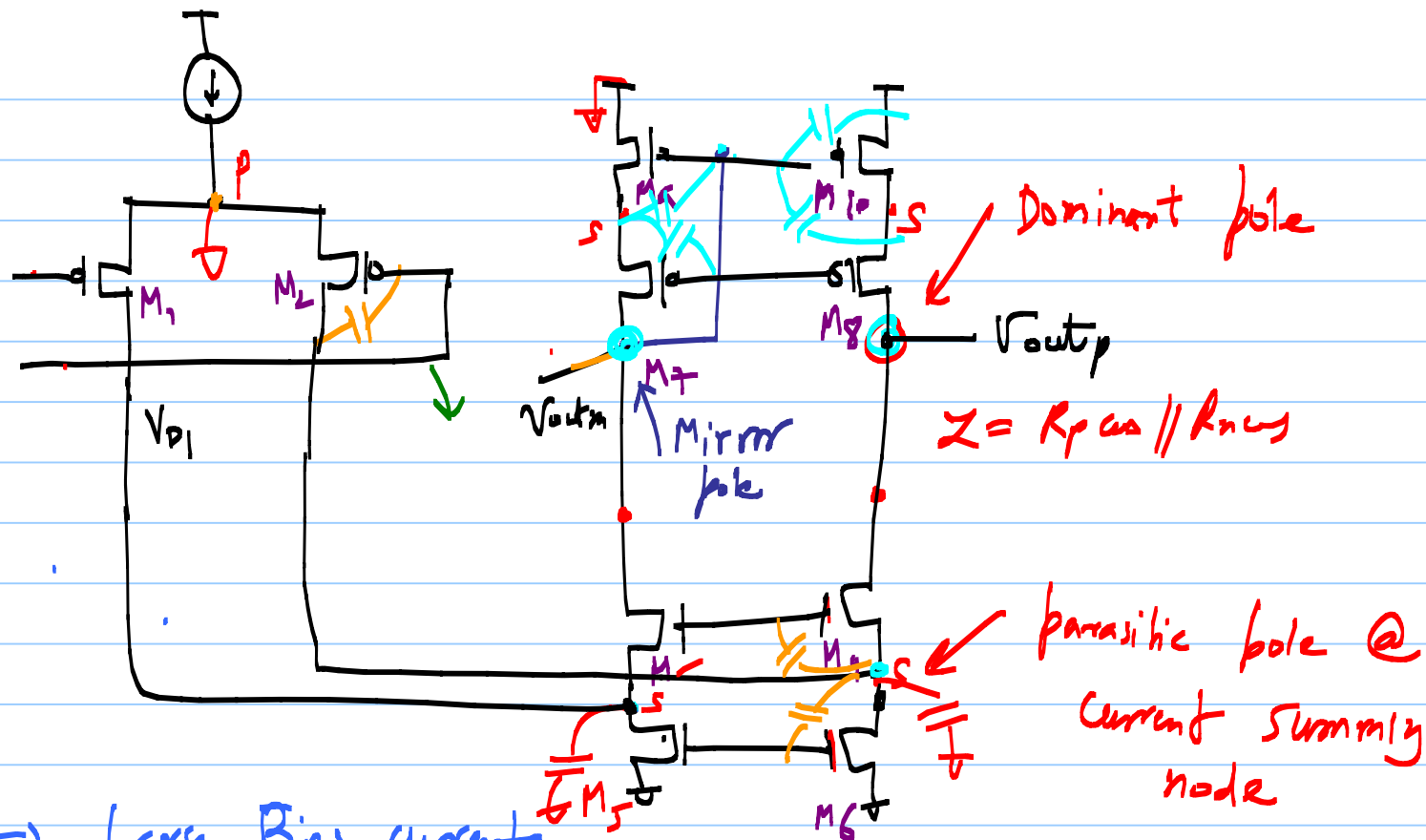


$$= -g_{m1} \cdot R_{p\text{ cas}} \parallel \frac{R_{n\text{ cas}}}{2}$$

HW:
Do CM mode Analysis

Single-ended folded cascode





- (-) Large Bias currents
- (-) ω_{p2} due to current summing node
- (-) Gain is slightly lower than telescopic

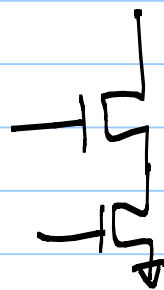
(+) Larger I_{CMR}

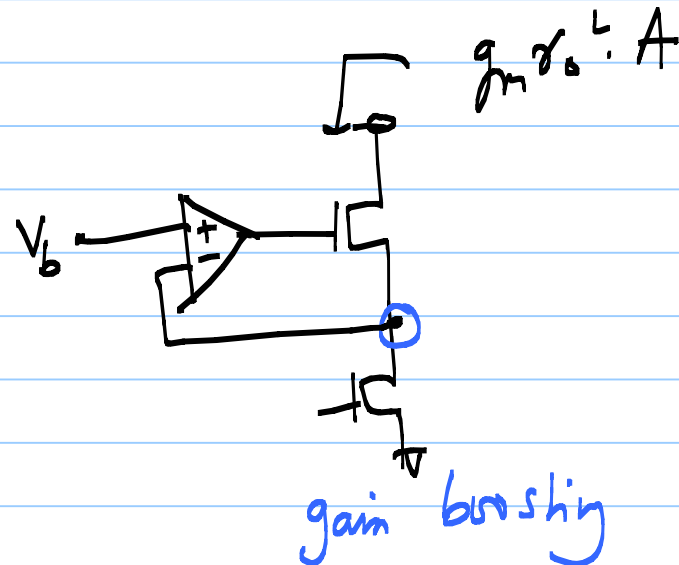
45n CMOS

$$A_v = 100 \text{ dB}$$

$$g_m r_o = 10$$

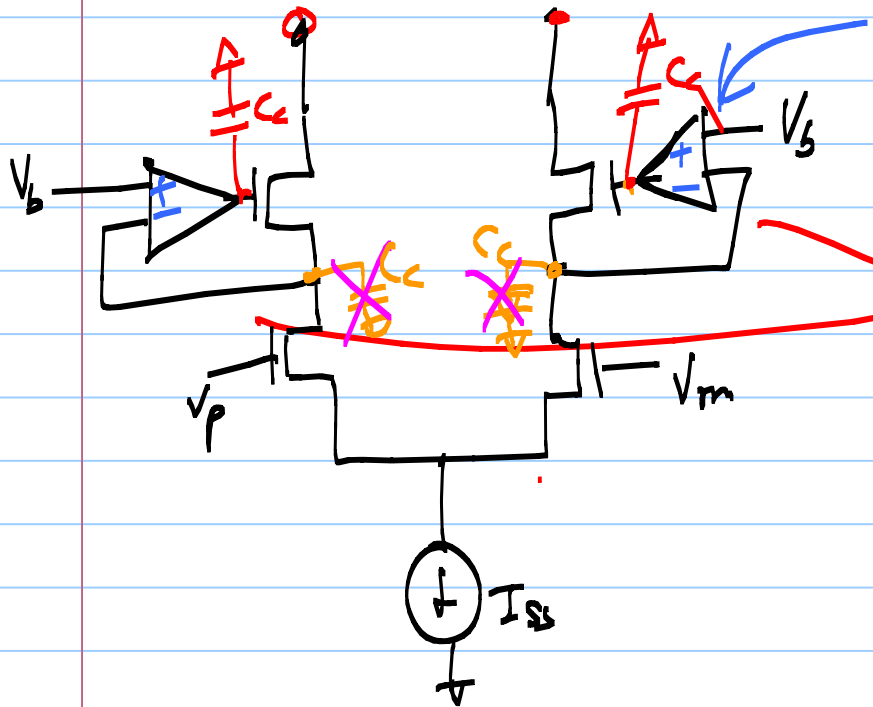
$$r_o = 1 \text{ K}$$


$$g_m r_o^2 \leq 10 \text{ K}$$
$$A = (g_m r_o)^2$$
$$= 100$$
$$40 \text{ dB}$$



Gain-Boosky $A_v = g_m \cdot (g_m r_o \cdot A)$

$$\frac{A_o}{(1 + s/\omega_{p1})}$$



STB analysis
PM

"Compensate all the loops"

Biasing using Fig. 20.47.
 Unlabeled NMOS are 50/1.
 Unlabeled PMOS are 100/1.

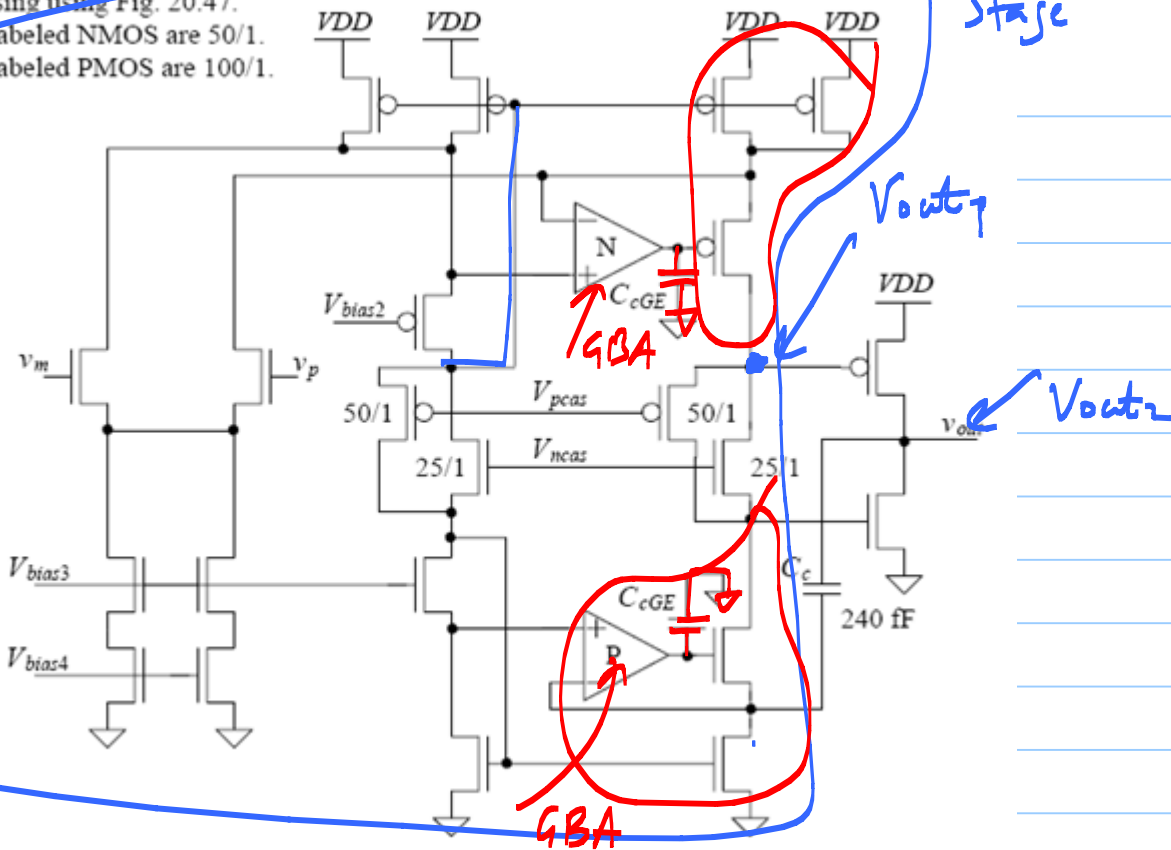


Figure 24.51 Folded-cascode op-amp with class AB output buffer and gain-enhancement.