Lecture 9 ECG 720

Advanced Analog

L → speed L↑ speed↓

gain L↑ gain↑

$V_{ov} = V_{GS} - V_{THN}$

V_{ov}↑ speed↑

gain↓

width → needed currents

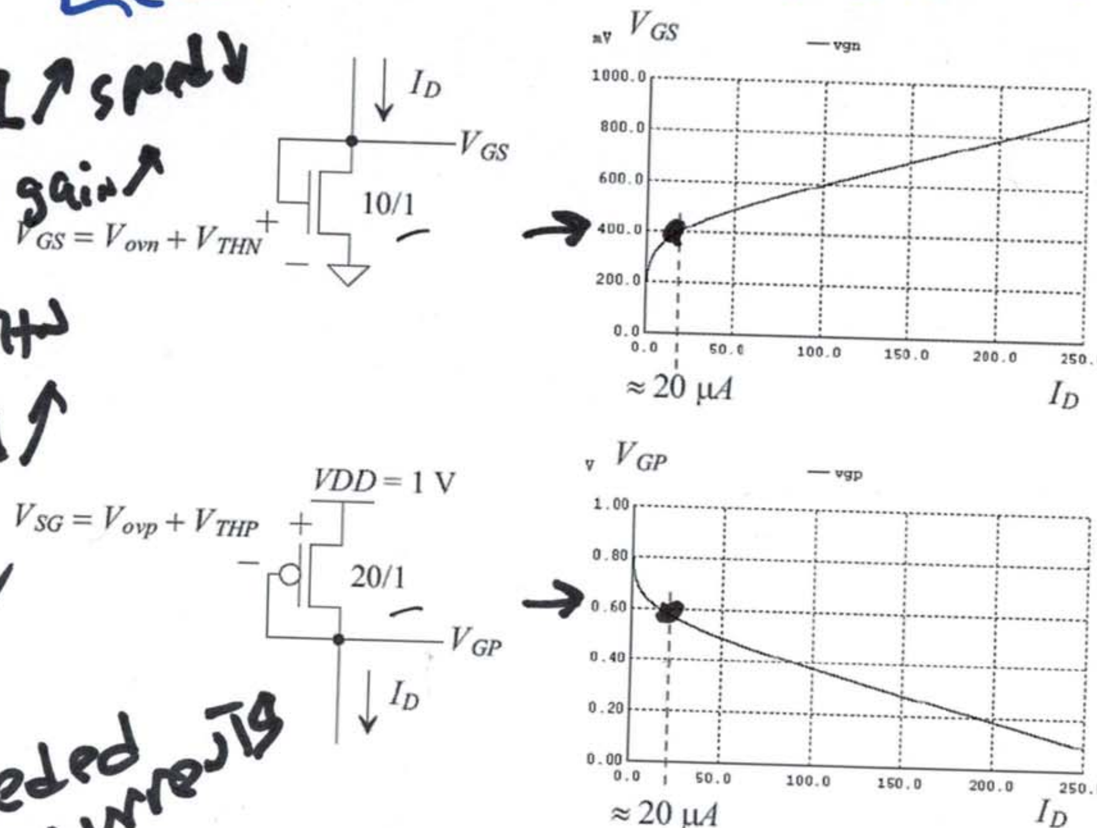


Figure 26.1 Gate-source voltages plotted against drain currents.

High-speed minimum L

$$I = C\frac{dV}{dT} = C \cdot \frac{VDD}{T_{clk}/2}$$

$$\Rightarrow \sqrt{\frac{KT}{C}} << 1\ LSB$$

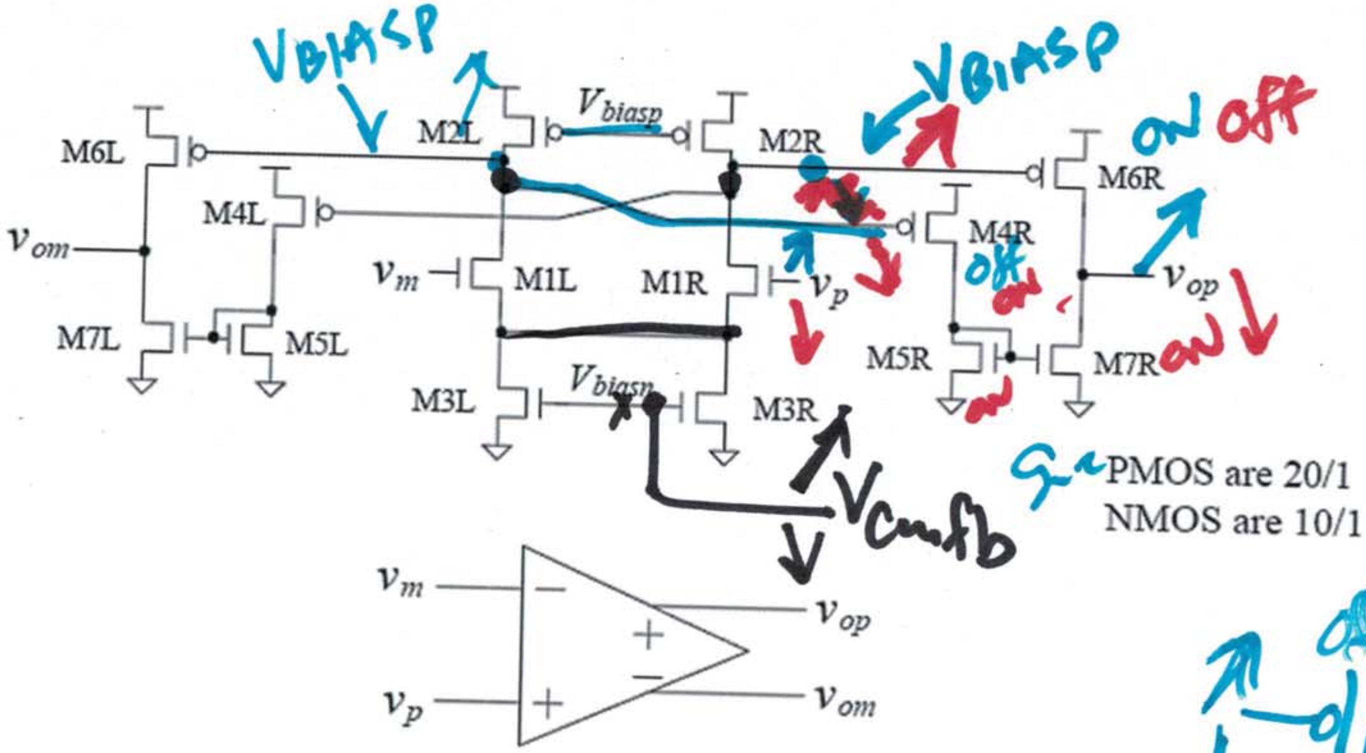
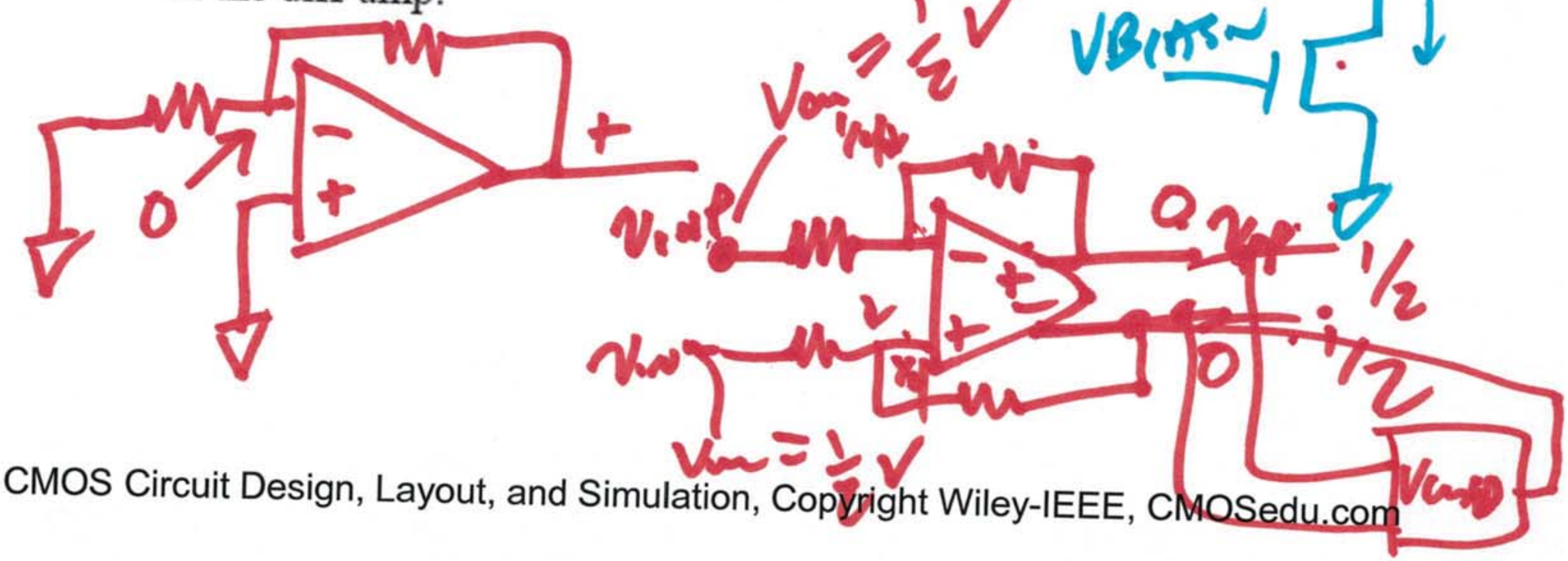


Figure 26.2 A two-stage fully-differential op-amp. Compensation and CMFB are not shown. Output stage operates class AB. See discussion in the next section concerning the output voltage of the diff-amp.



2)

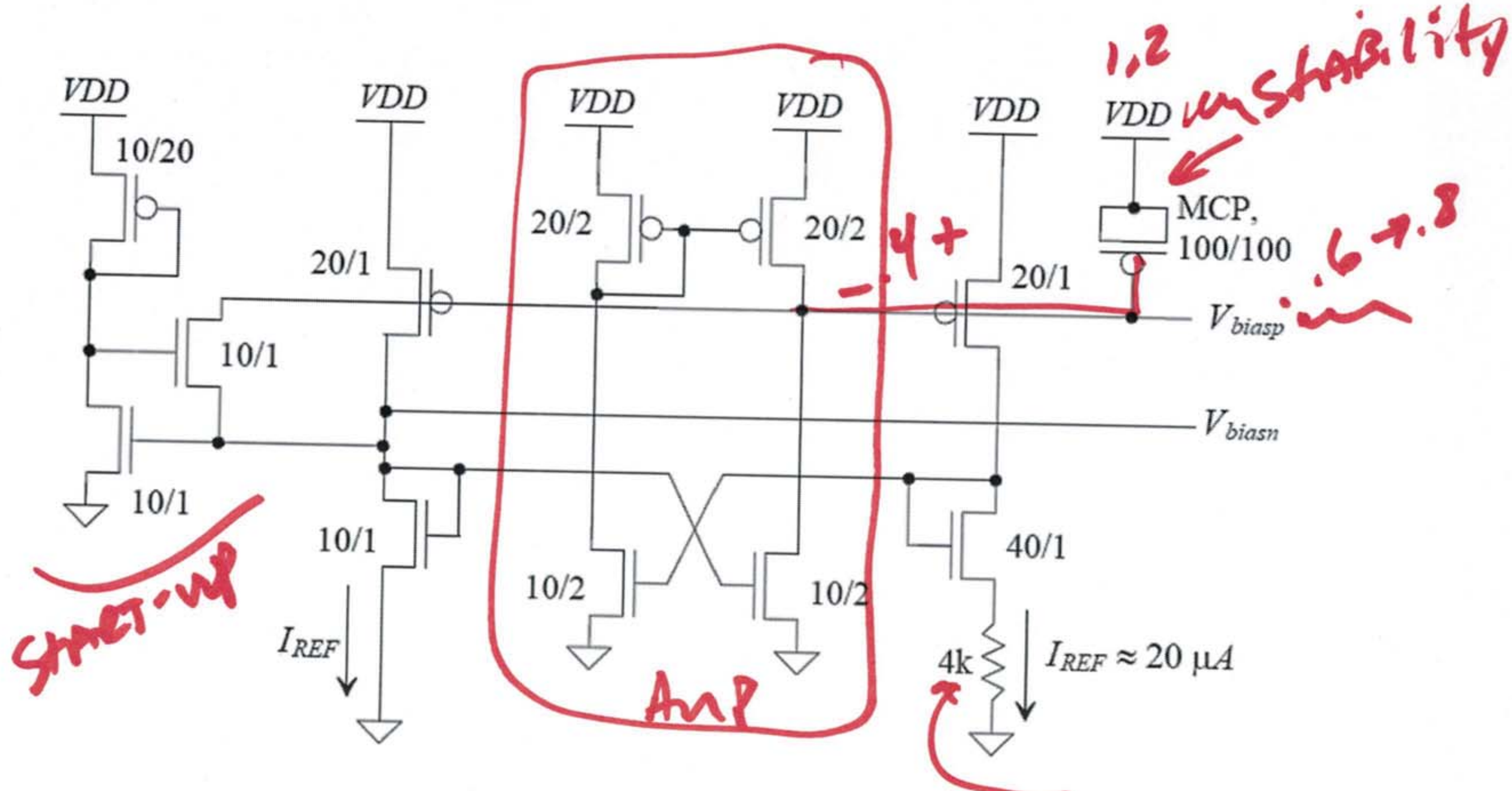
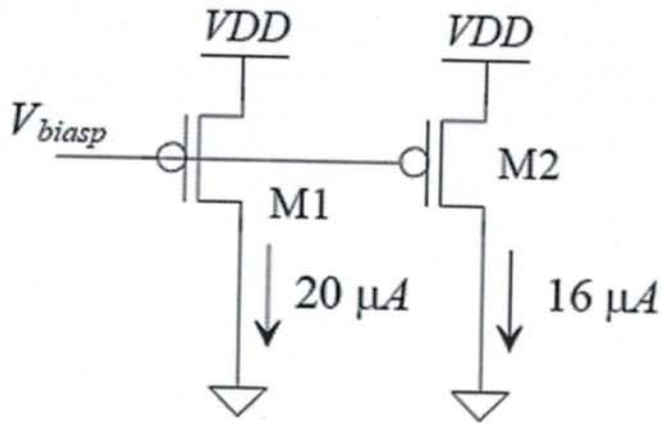
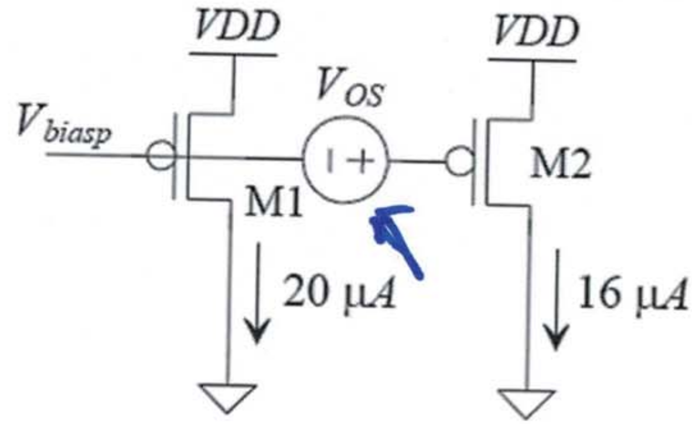


Figure 26.3 Biasing circuit used in this chapter. This bias circuit pulls approximately 50 microamps.



(a) M1 and M2 are mismatched.



(b) M1 and M2 are perfectly matched (as in a SPICE simulation).

Figure 26.5 How we add an offset into the circuit to model mismatch.

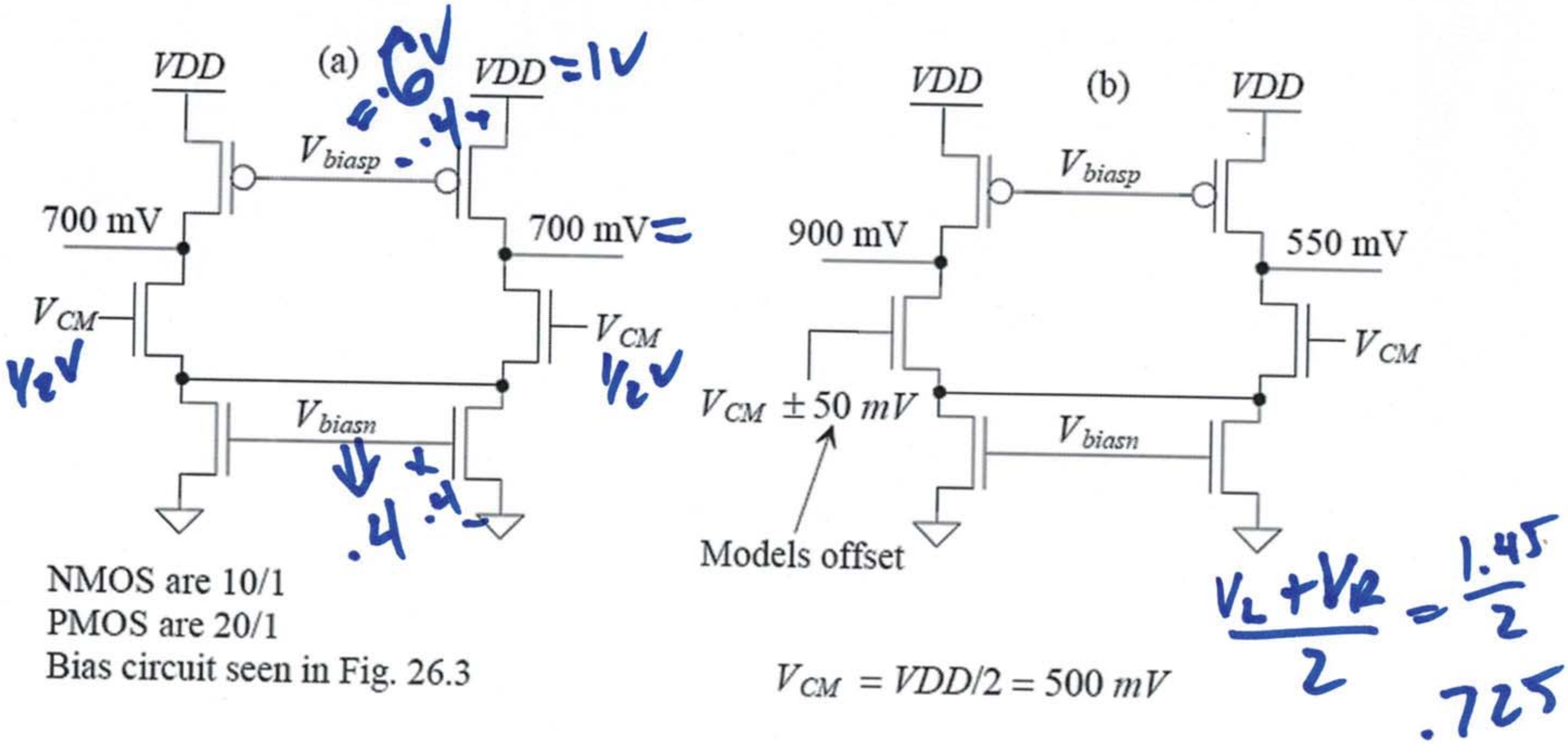


Figure 26.6 Comparing the diff-amp's output voltages with and without an offset.

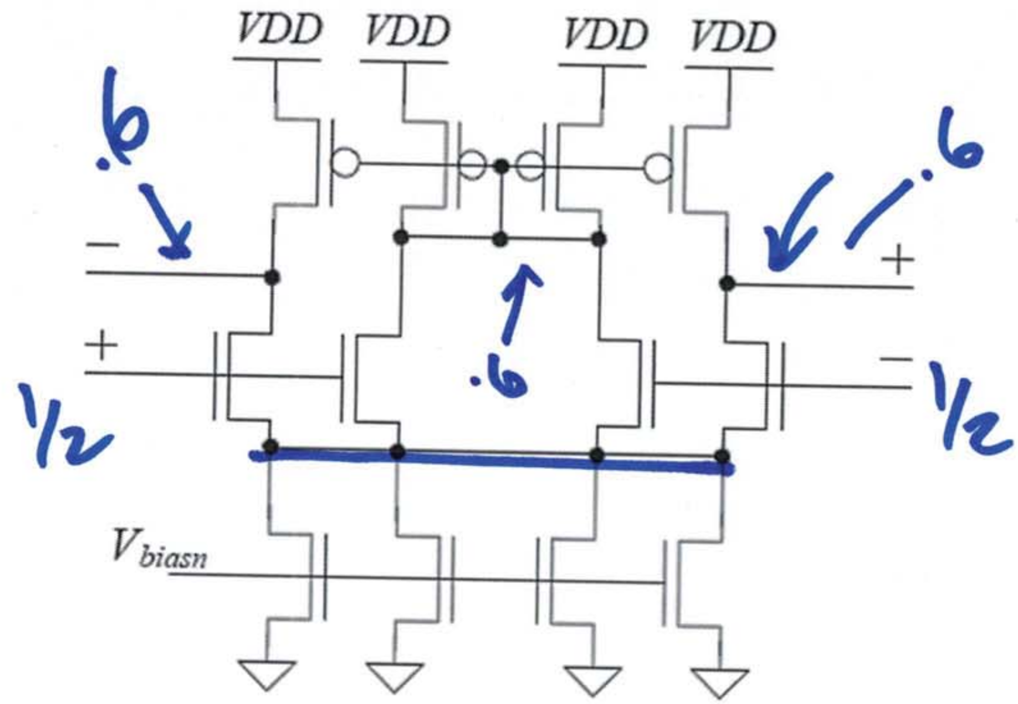


Figure 26.7 A fully-differential diff-amp that generates its own bias for the PMOS.

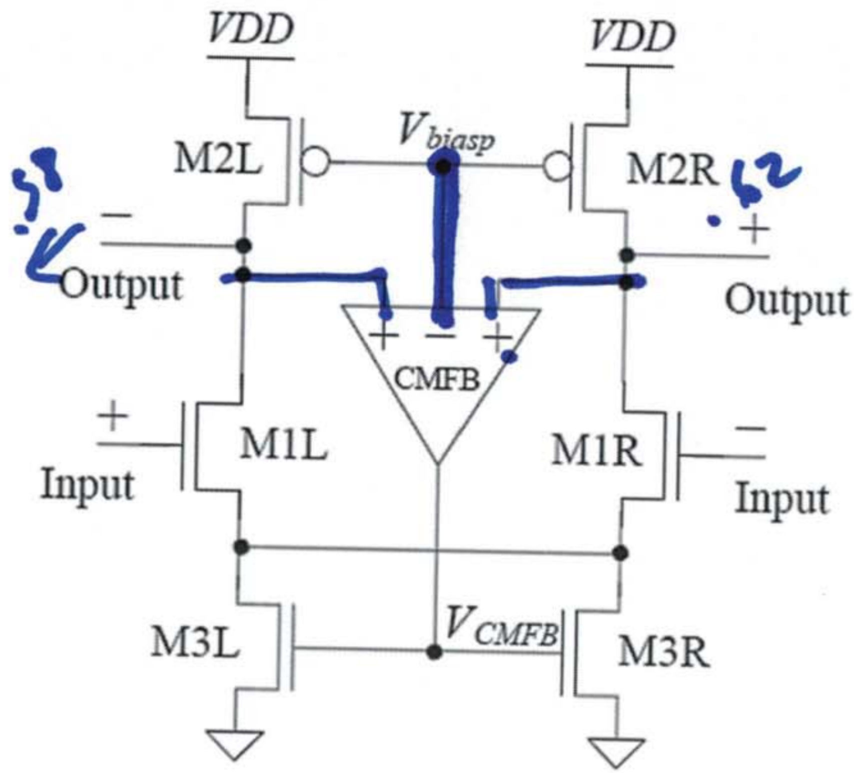
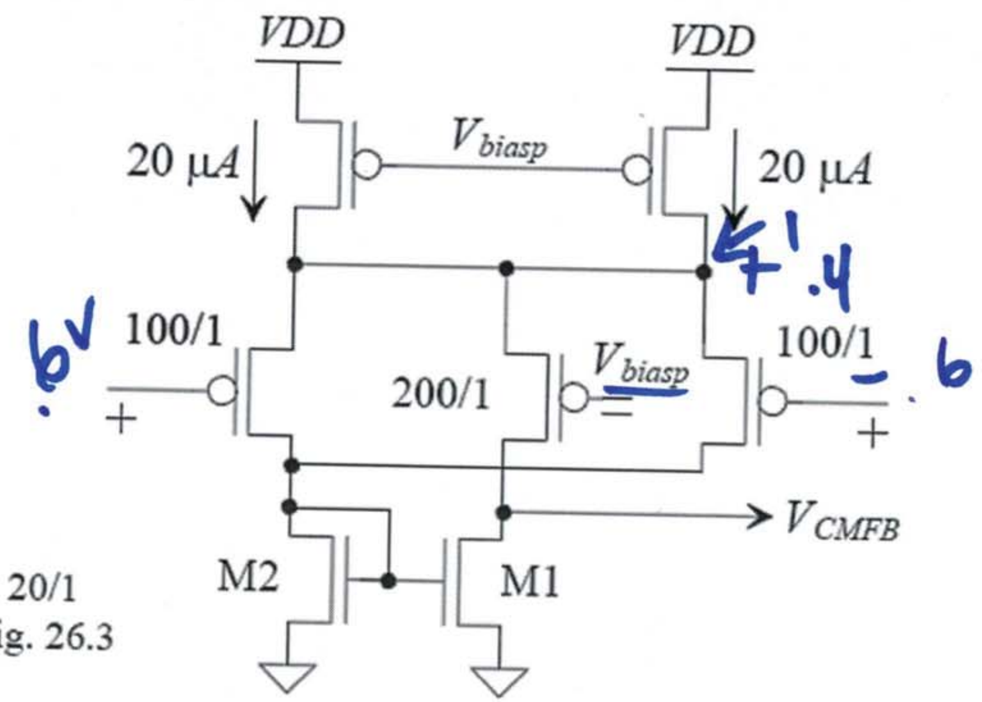


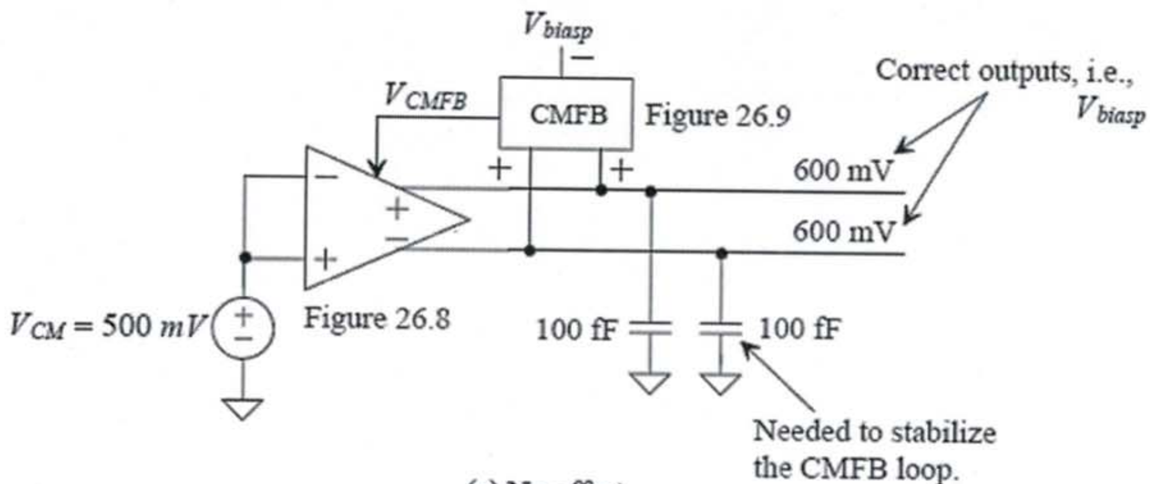
Figure 26.8 Using a common-mode feedback (CMFB) amplifier to set the output voltages.



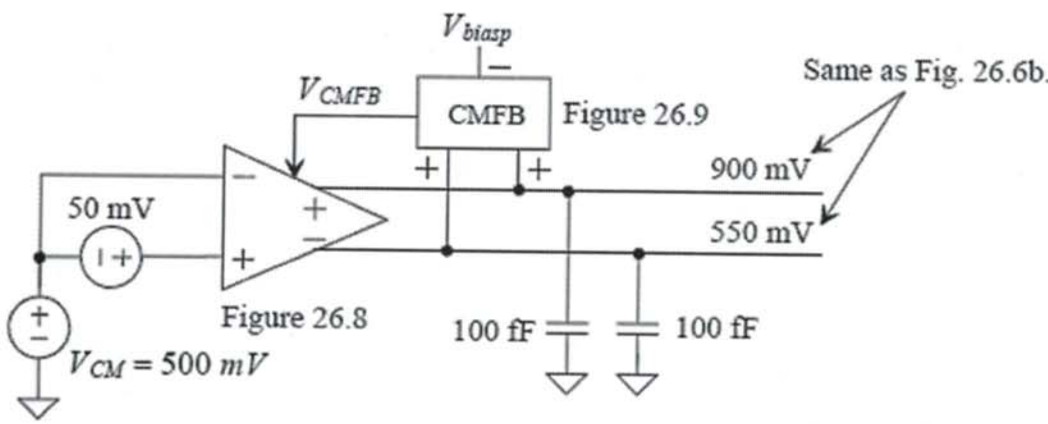
NMOS are 10/1
Unlabeled PMOS are 20/1
Bias circuit seen in Fig. 26.3

Figure 26.9 Implementation of the CMFB amplifier in Fig. 26.8.

b)

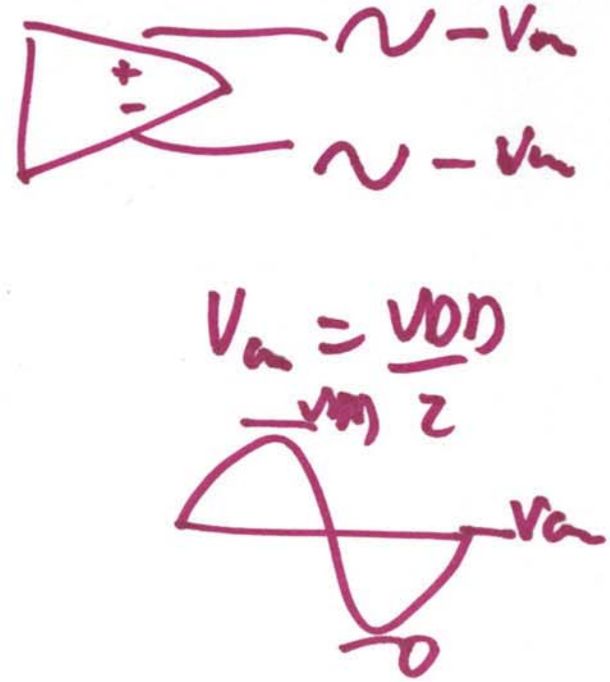


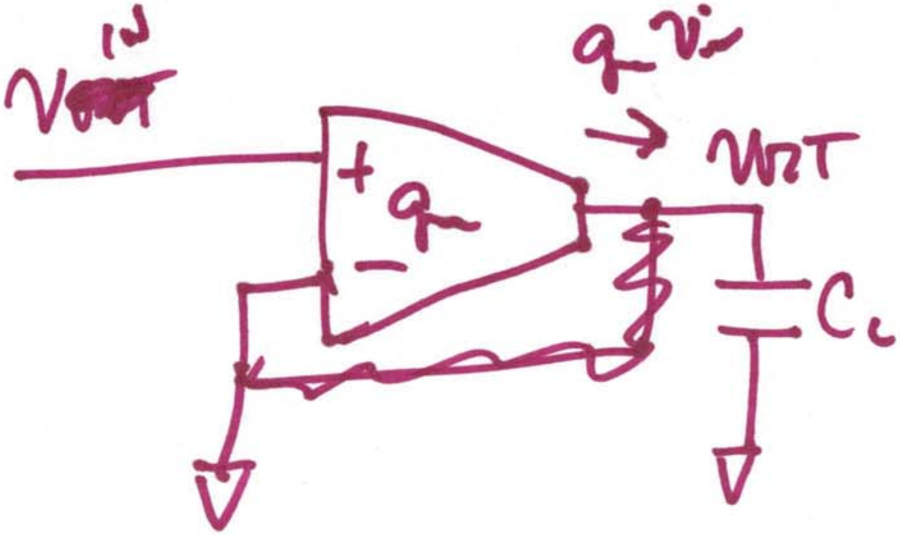
(a) No offset



(b) With a 50 mV offset. Note how the CMFB isn't doing anything.

Figure 26.10 Simulating the operation of the CMFB circuit in Fig. 26.9.





$\beta = 1$

$$A_{CL} = \frac{A_{OL}}{1 + A_{OL} \cdot \beta}$$

-1 UNSTABLE

$|A_{OL}| = 1$

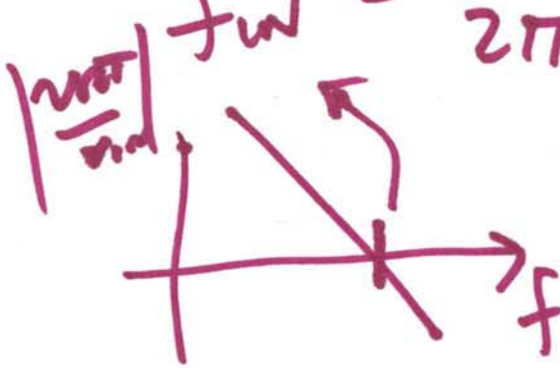
$\angle A_{OL} = \underline{180°}$

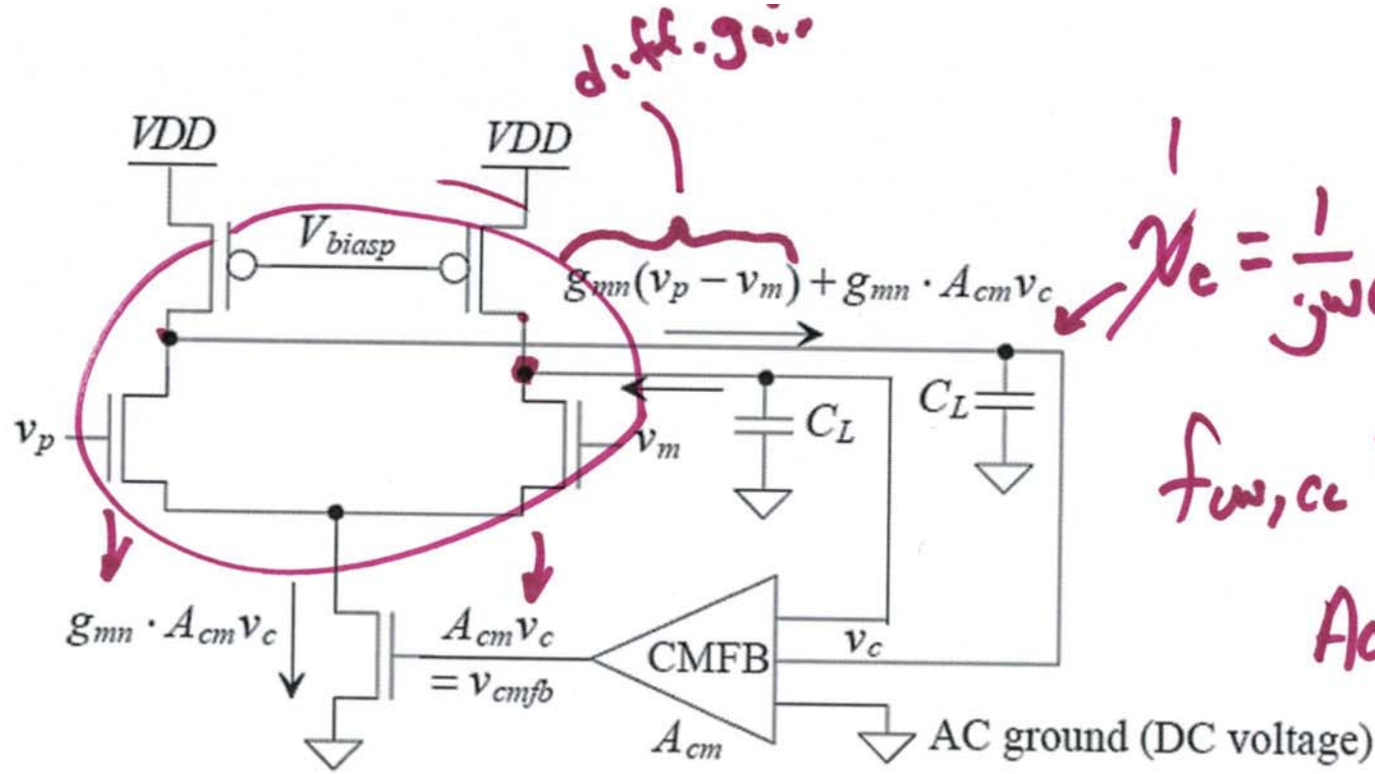
$$v_{OUT} = \frac{1}{j\omega C_L} \cdot g_m v_{in}$$

$$\left|\frac{v_{OUT}}{v_{IN}}\right| = \frac{g_m}{2\pi f \cdot C_L}$$

$$\angle \frac{v_{OUT}}{v_{in}} = -90°$$

$$f_{UN} = \frac{g_m}{2\pi C_L}$$



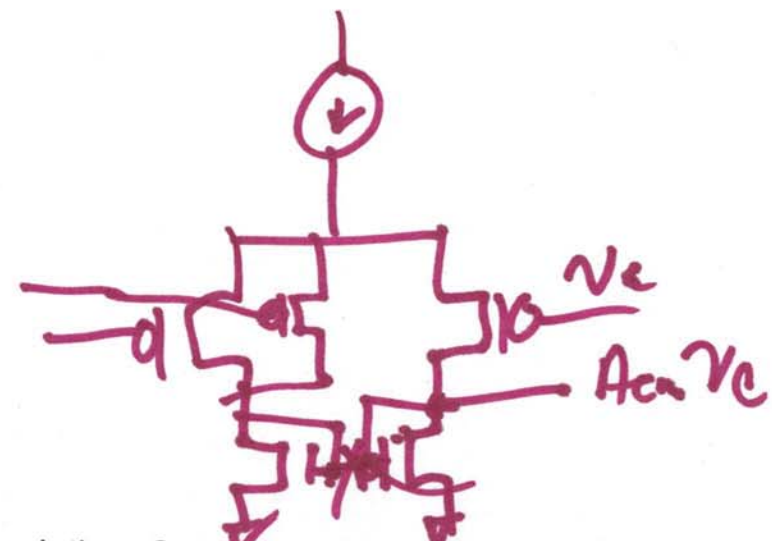


$v_c = \frac{1}{j\omega C_L} \cdot g_{mn} \cdot A_{cm} \cdot v_c$

$f_{un,cc} = \frac{A_{cm} \cdot g_m}{2\pi C_L}$

$A_{cm} < 1$

Figure 26.11 Schematic view of differential and CM feedback.



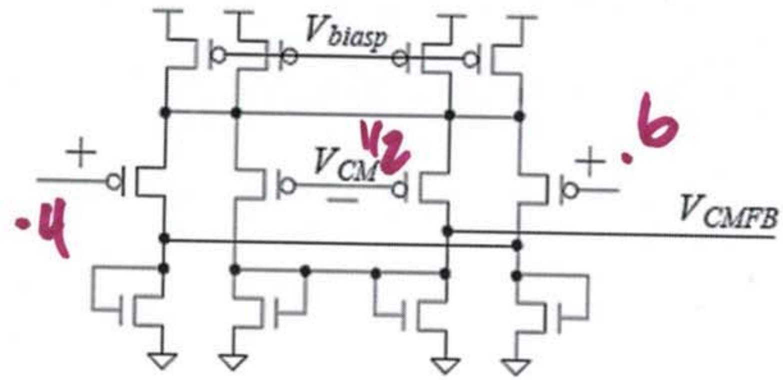
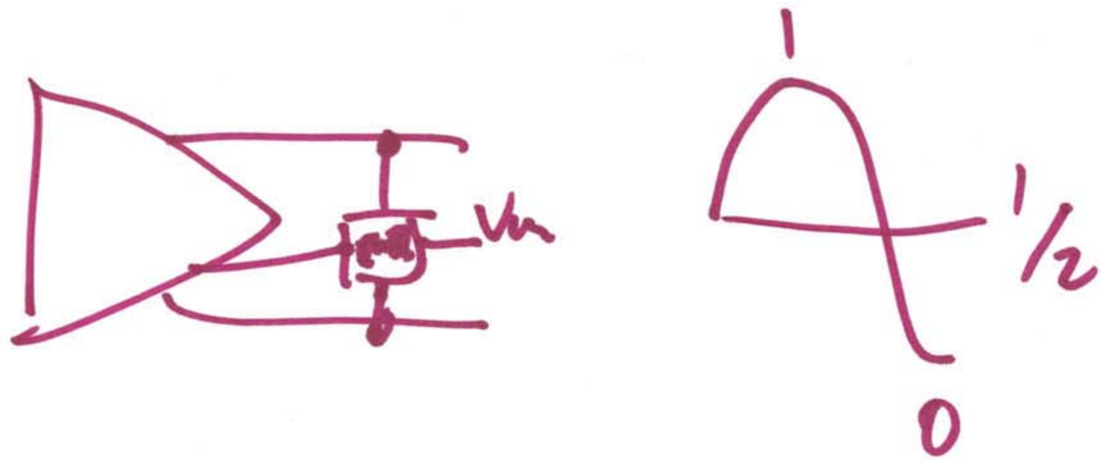


Figure 26.12 A CMFB amplifier with a gain of nominally unity.



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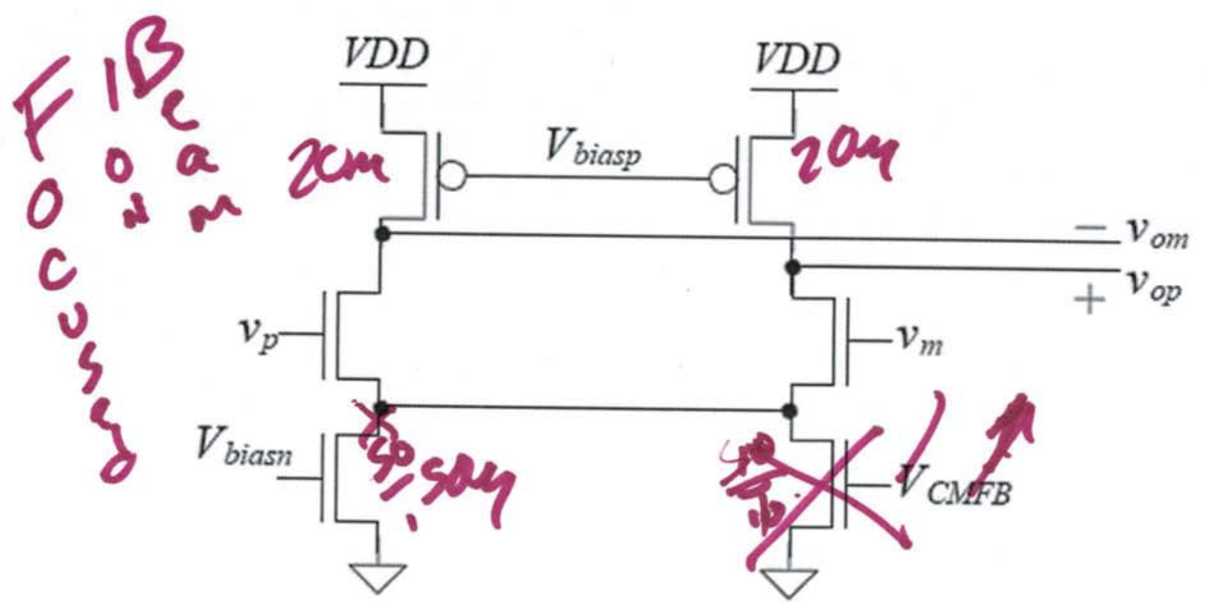

Figure 26.13 Reducing the forward gain of the CMFB loop.