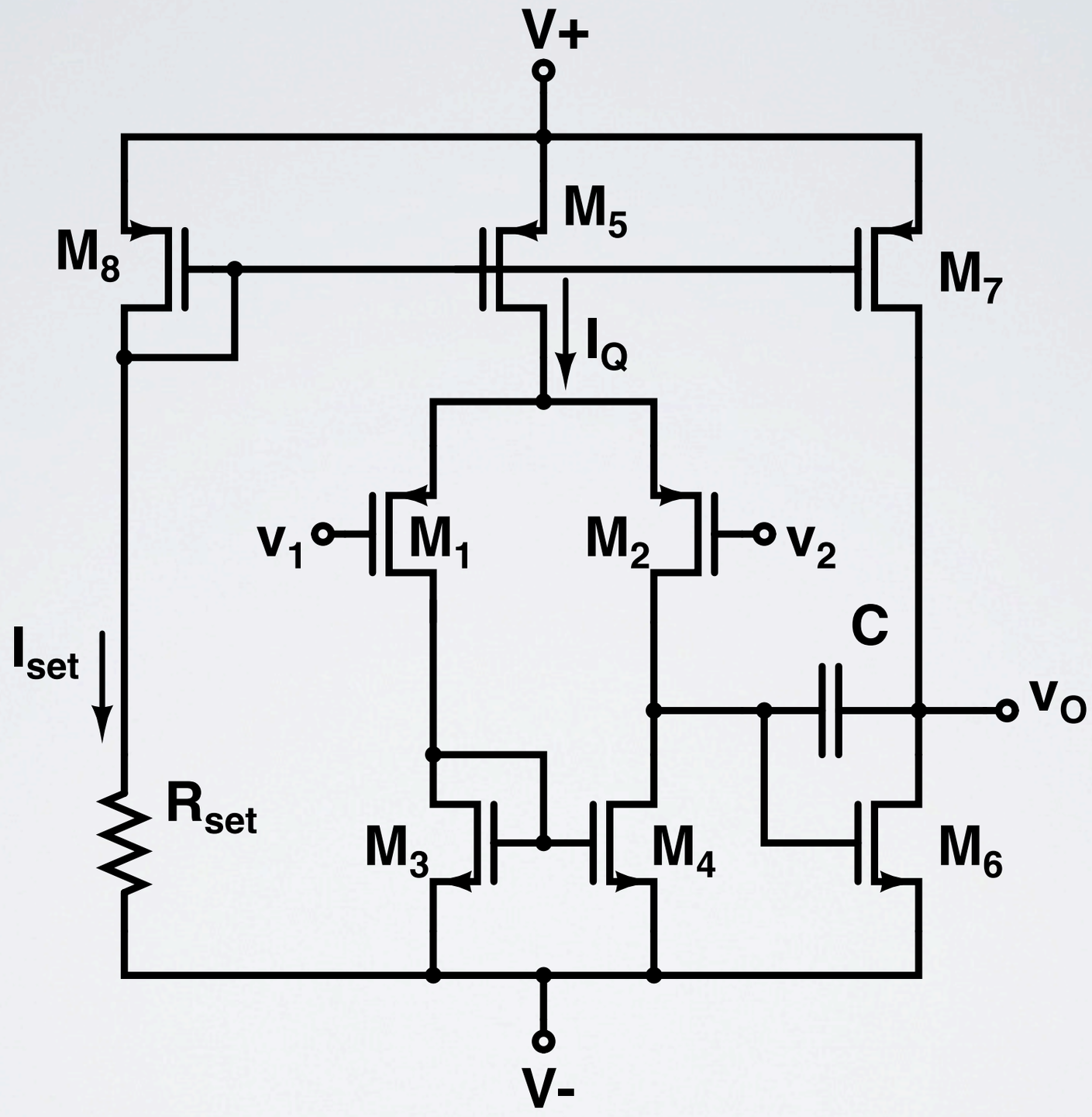
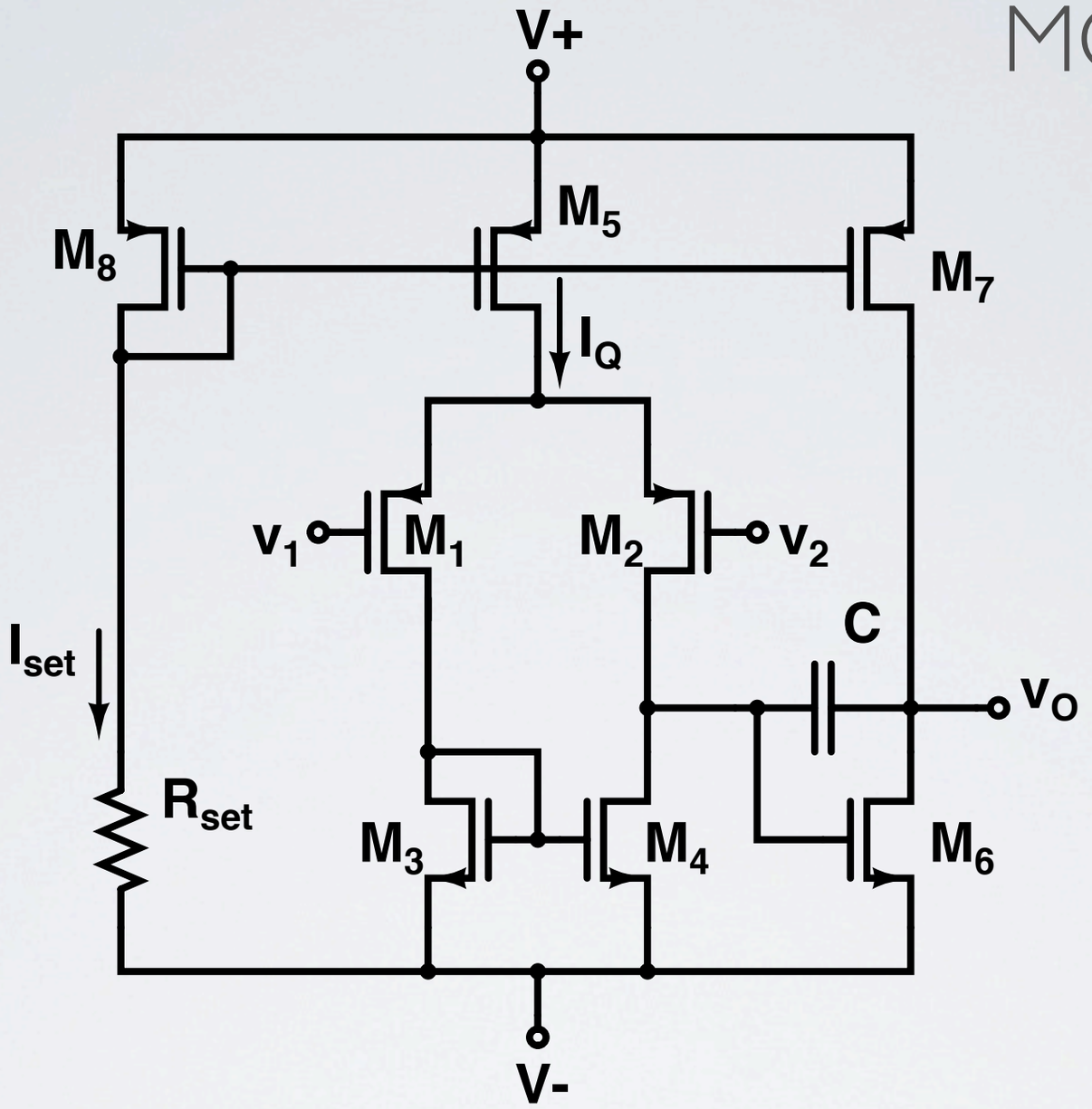
CMOS OPAMPS

INEL4202 Electronics II

MC14573



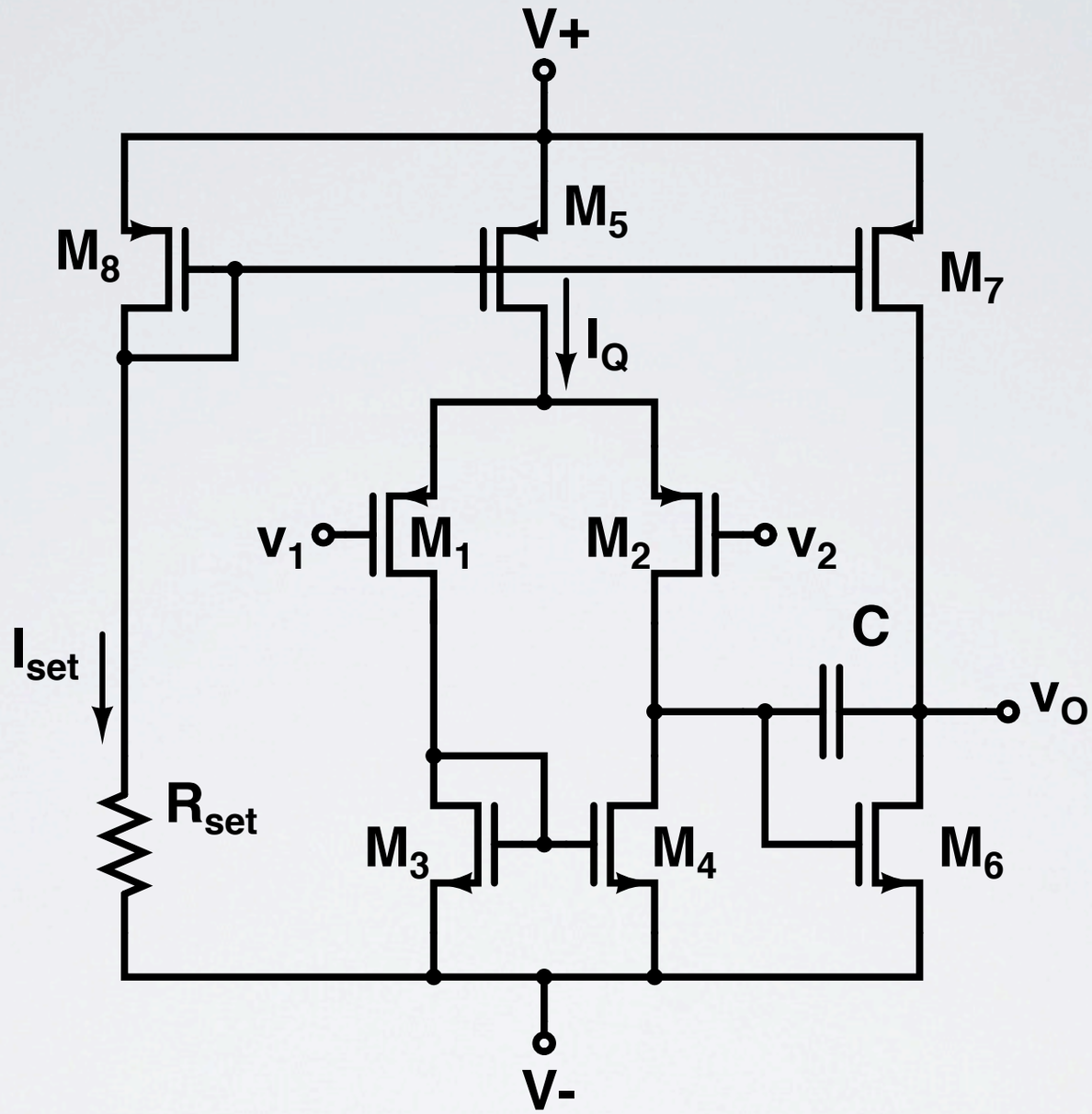
MC14573



Example: Find DC bias current when V_{TN}=0.5V, ½$\mu_n C_{ox}$=20uA/V^2, λ_n=0.02V^{-1}, V_{TP}=-0.5V, ½$\mu_p C_{ox}$=10uA/V^2, λ_p=0.02V^{-1}, R_{SET}=225kΩ,$(W/L)_3$=$(W/L)_4$=6.25, $(W/L)_{OTHER}$=12.5, V+=5V, V-=-5V.

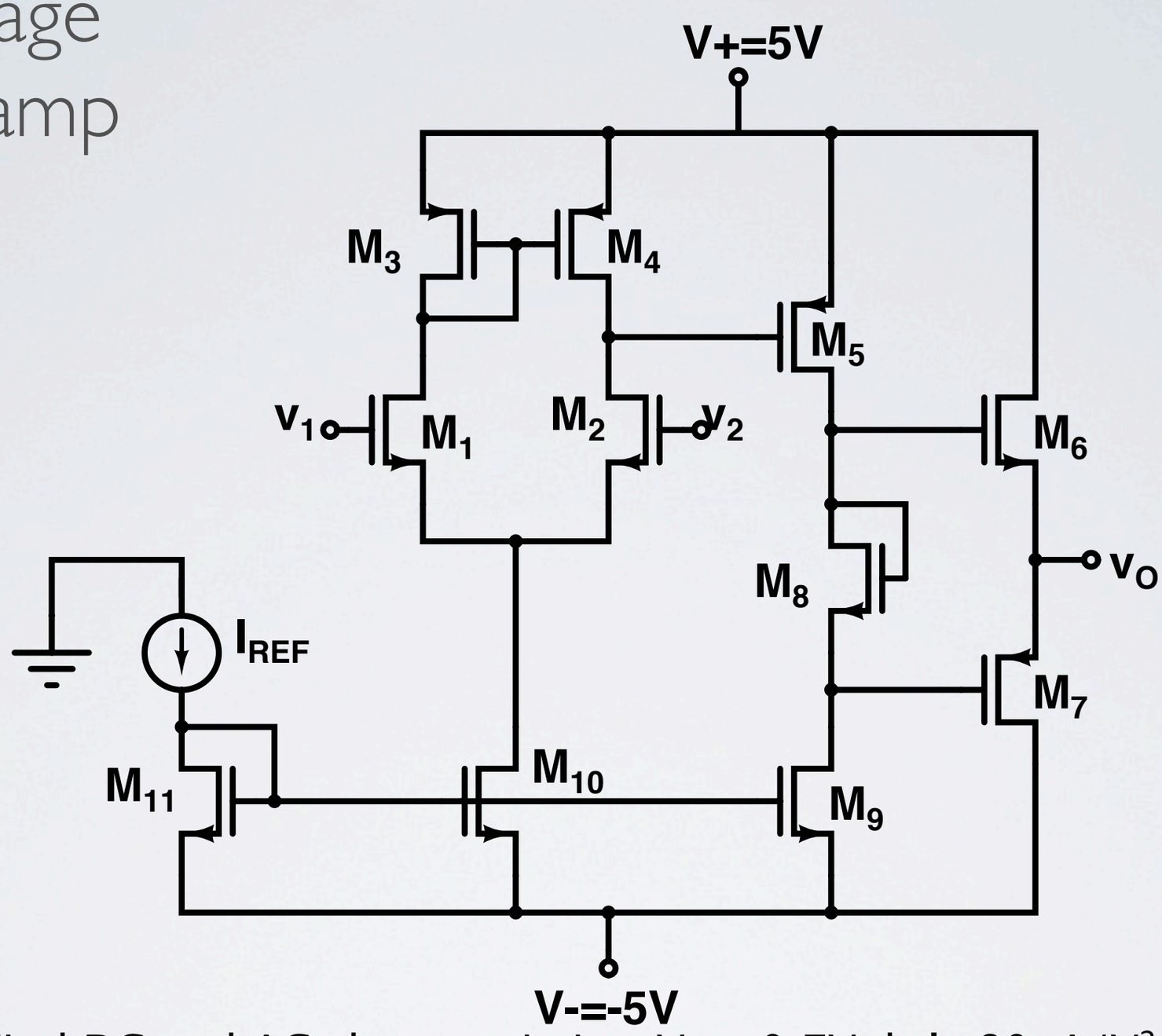
Example: Find gain.

MC14573



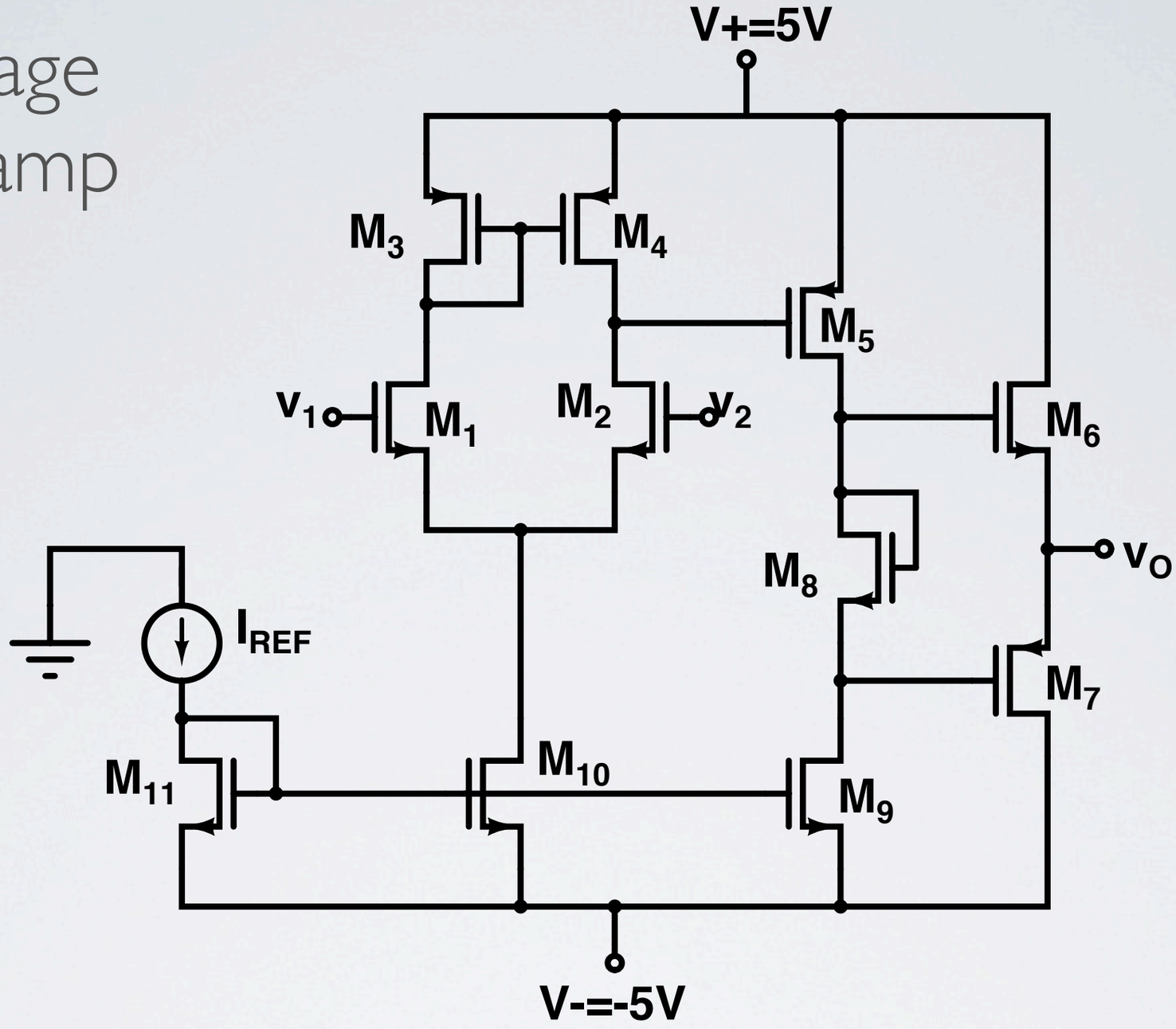
Example 13.8: Find DC bias current when $V_{TN}=0.5V$, $\frac{1}{2}\mu_n C_{ox}=20uA/V^2$, $\lambda_n=0.02V^{-1}$, $V_{TP}=-0.5V$, $\frac{1}{2}\mu_p C_{ox}=10uA/V^2$, $\lambda_p=0.02V^{-1}$, $R_{SET}=225k\Omega$,$(W/L)_3=(W/L)_4=6.25$, $(W/L)_{OTHER}=12.5$, V+=5V, V-=-5V. (ANSWER: $I_{REF}=39.7uA$)
Example 13.9: Find gain. (ANSWER: $A_v=(125)(125)=15{,}625$)

Three-stage cmos opamp

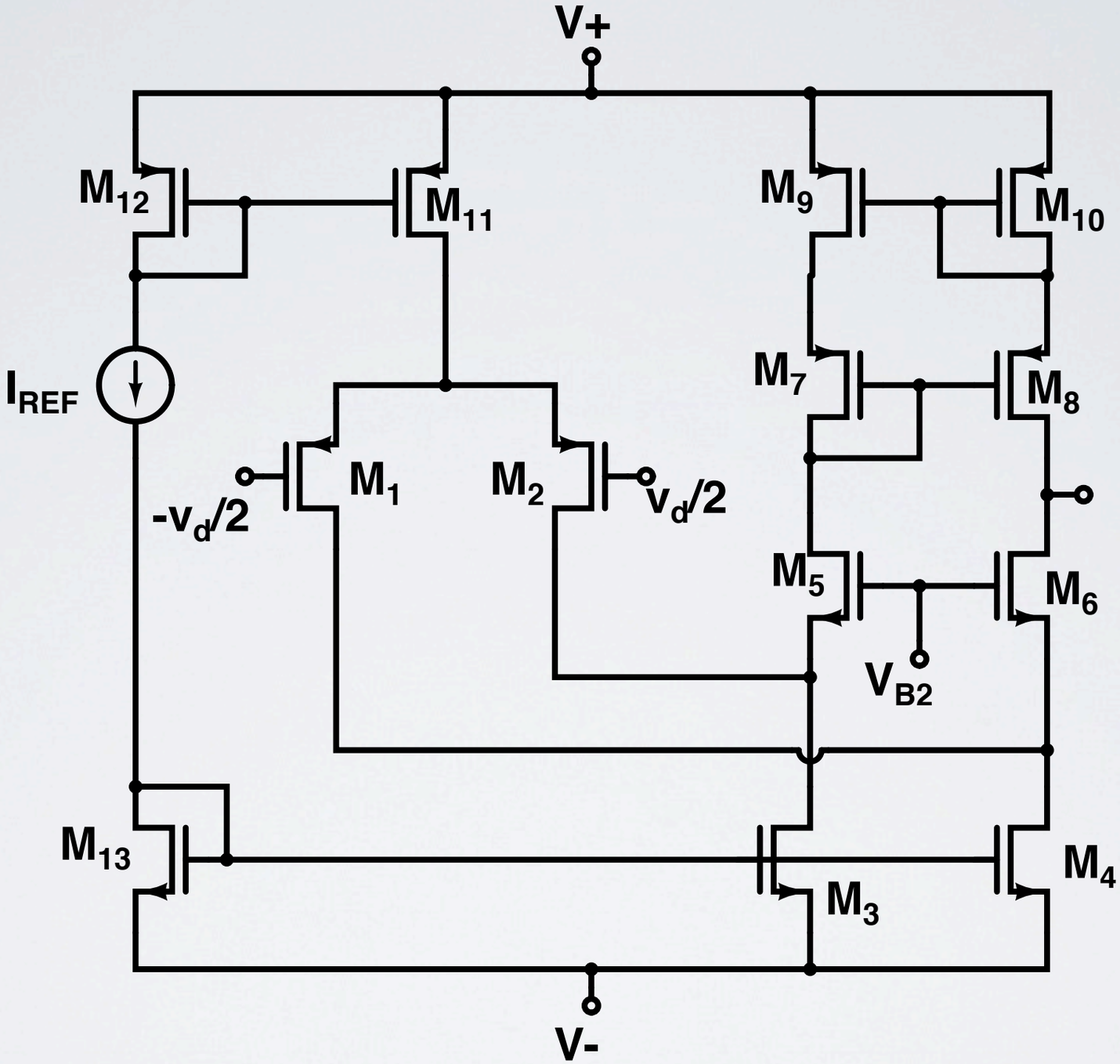


Example 13.10: Find DC and AC characteristics. V_{TN}=0.7V, k_n'=80uA/V^2, λ_n=0.01V^{-1}, V_{TP}=-0.7V, k_P'=40uA/V^2, λ_p=0.015V^{-1}, I_{REF}=160μA, $(W/L)_1=(W/L)_2$=15/1, $(W/L)_3=(W/L)_4$=40/1, $(W/L)_5$=80/1, $(W/L)_6$=25/1, $(W/L)_7$=50/1, $(W/L)_9=(W/L)_{10}=(W/L)_{11}$=20/1. Select $(W/L)_8$ so that $V_{GS6}=V_{GS7}$=0.85V.

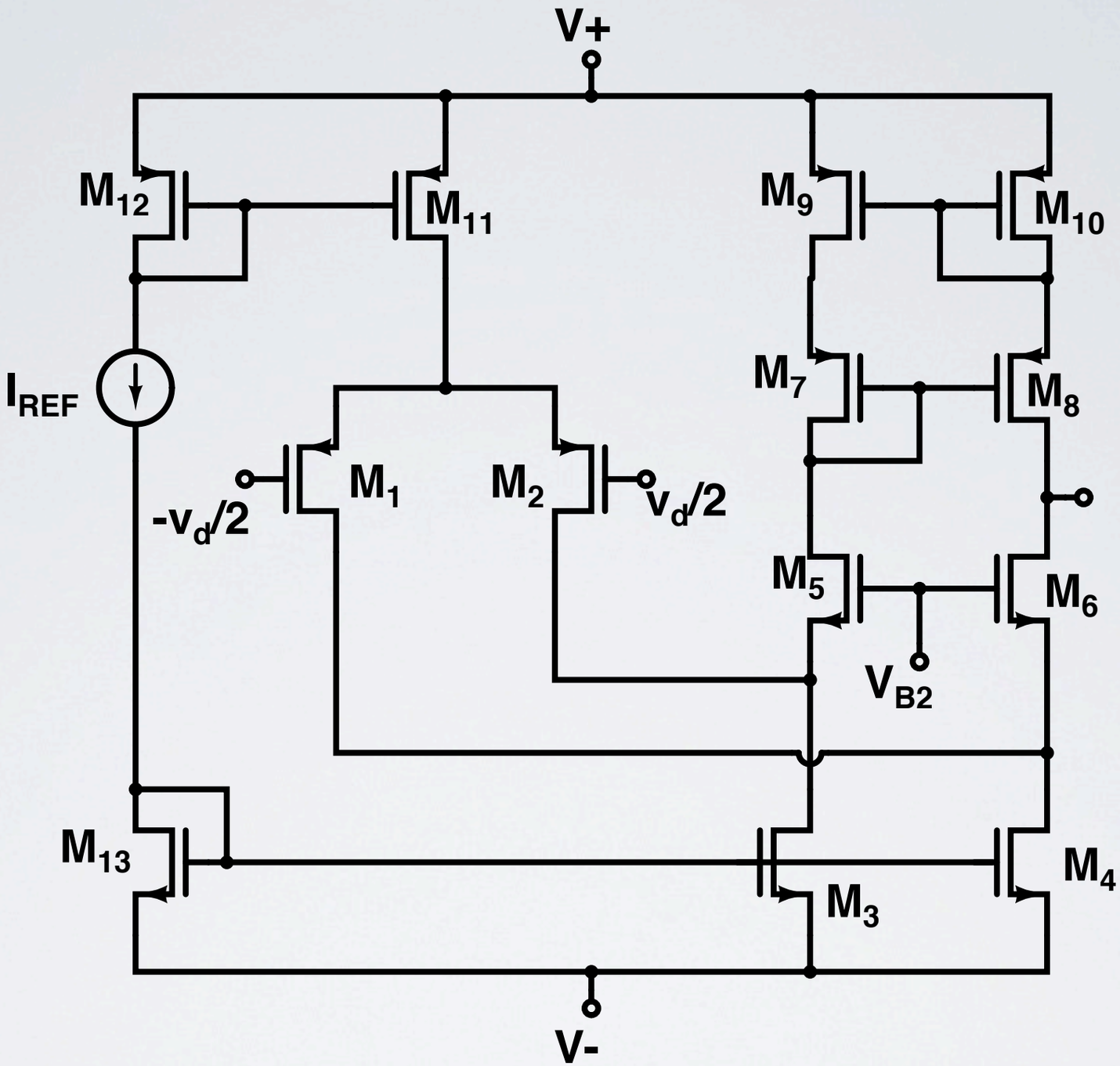
Three-stage cmos opamp



Example: Find DC and AC characteristics. V_{TN}=0.7V, k_n'=80uA/V^2, λ_n=0.01V^{-1}, V_{TP}=-0.7V, k_P'=40uA/V^2, λ_p=0.015V^{-1}, I_{REF}=160μA, $(W/L)_1=(W/L)_2$=15/1, $(W/L)_3=(W/L)_4$=40/1, $(W/L)_5$=80/1, $(W/L)_6$=25/1, $(W/L)_7$=50/1, $(W/L)_9=(W/L)_{10}=(W/L)_{11}$=20/1. Select $(W/L)_8$ so that $V_{GS6}=V_{GS7}$=0.85V.
ANSWER: $(W/L)_8$ = 4; $I_{D6}=I_{D7}$=22.5uA; A_v=(219)(-253)=-55407 V/V.



Example: I_{REF}=100uA, k_n'=80uA/V^2, K_p'=40uA/V^2,(W/L)=25, y $\lambda_n=\lambda_p=0.02V^{-1}$.
Find voltage gain.

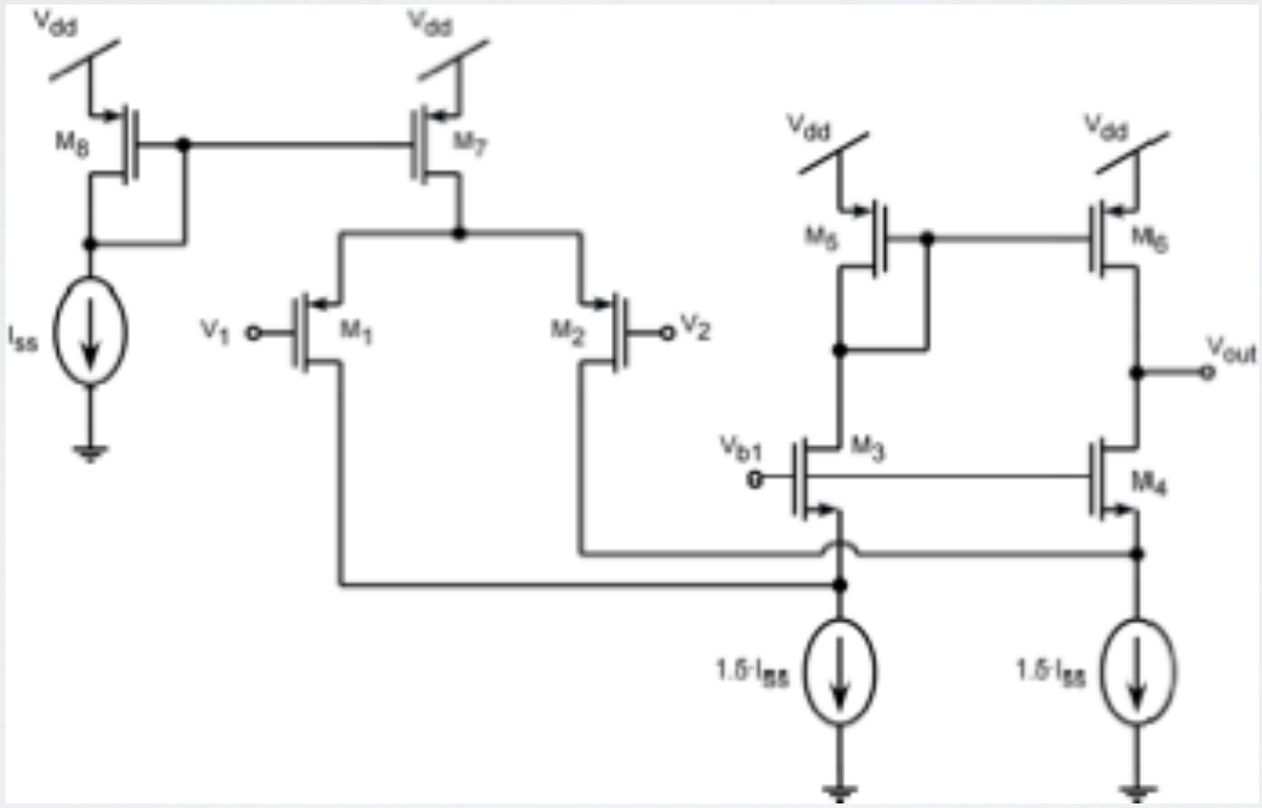


Example: I_{REF}=100uA, k_n'=80uA/V^2, K_p'=40uA/V^2,(W/L)=25, y $\lambda_n=\lambda_p=0.02V^{-1}$.
Find voltage gain. (ANSWER: A_d=32000)

For the following CMOS amplifier, where V_{b1} and V_{b2} are DC voltages for proper operation of the circuit:

a) identify the negative and the positive terminals
b) find the expression for the differential gain $A_{id}=V_{out}/V_{id}$
c) find the expression for the differential input resistance R_{ind}
d) find the expression for the output resistance R_{out}

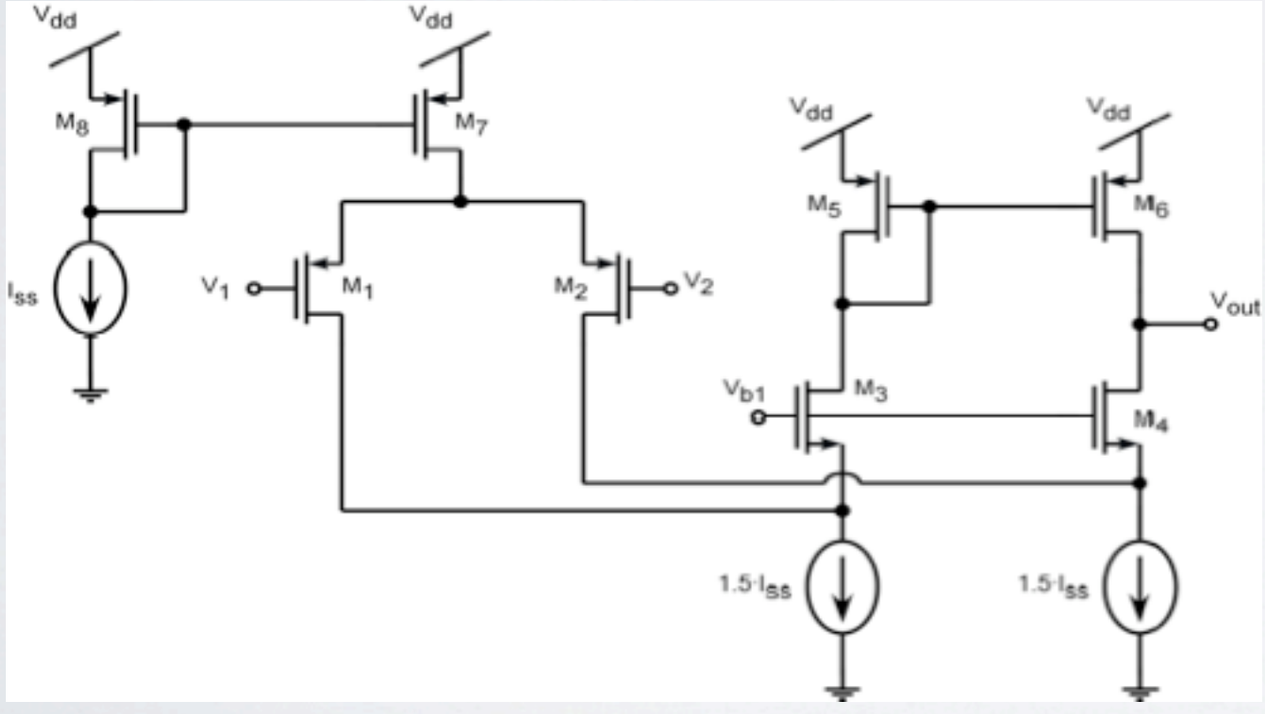
Assume: I_{ss} = ideal current source



III. For the following CMOS amplifier, where V_{b1} and V_{b2} are DC voltages for proper operation of the circuit:

a) identify the negative and the positive terminals
b) find the expression for the differential gain $A_{id}=V_{out}/V_{id}$
c) find the expression for the differential input resistance R_{ind}
d) find the expression for the output resistance R_{out}

Assume: I_{ss} = ideal current source



a)

$v_I \uparrow \Rightarrow i_{dI} \uparrow \Rightarrow i_{d5} \downarrow \Rightarrow i_{d6} \downarrow$

$\therefore v_I$ is + ; v_2 is -

b)

$$
\begin{aligned}
A_{id} &= \frac{v_{OUT}}{v_{id}} = g_{m1} R_O \\
R_O &= r_{O6} \| r_{O4} \left(1 + g_{m4} r_{O2}\right) \\
g_{m1} &= 2\sqrt{K_P I_{SS}/2} \qquad g_{m4} = 2\sqrt{K_N I_{SS}} \\
r_{O6} &= \frac{1}{\lambda_{P6} I_{SS}} \qquad r_{O2} = \frac{2}{\lambda_{P2} I_{SS}} \\
r_{O4} &= \frac{1}{\lambda_{N4} I_{SS}}
\end{aligned}
$$

c) $R_{ind} = \infty$

d)

$$
\begin{aligned}
R_O &= r_{O6} \| r_{O4} \left(1 + g_{m4} r_{O2}\right) \\
g_{m1} &= 2\sqrt{K_P I_{SS}/2} \qquad g_{m4} = 2\sqrt{K_N I_{SS}} \\
r_{O6} &= \frac{1}{\lambda_{P6} I_{SS}} \qquad r_{O2} = \frac{2}{\lambda_{P2} I_{SS}} \\
r_{O4} &= \frac{1}{\lambda_{N4} I_{SS}}
\end{aligned}
$$