University of California
College of Engineering
Department of Electrical Engineering
and Computer sciences

EE140 **Midterm Exam** **Mar. 13, 2003**

Name: _____ SID#: _____

grad ☐ undergrad ☐

- Closed book except for 1 - 8.5" x 11" sheet of your notes.
- There are two problems. Be sure to show all your work to receive full or partial credit.

1	
2	
Total	

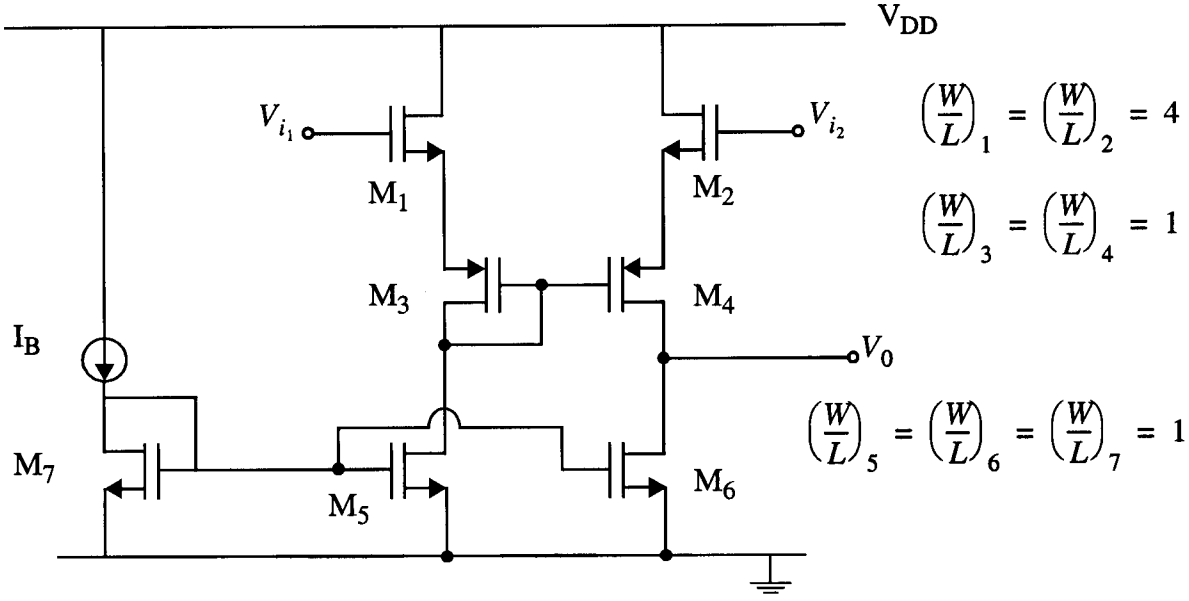

Fig. 1.

1) In the amplifier of Fig. 1, assume all NMOS devices have $V_T = V_{T_n}$, and all PMOS devices have $V_T = V_{T_p}$. You may neglect body effect. Further, assume all devices are minimum length, and are characterized by k'_n, λ_n and k'_p, λ_p for NMOS and PMOS devices respectively.

a) (10 pts.)
For the nominal input $V_{i_1} = V_{i_2} = V_{DD}$, determine the circuit operating point. Fill in the data below in terms of symbolic parameters. $V_{T_n}, V_{T_p}, k'_n, k'_p, \lambda_n, \lambda_p, I_B, \left(\frac{W}{L}\right)$'s, etc.

I_{D_1}	
I_{D_2}	
V_{S_1}	
V_{S_2}	
V_{D_3}	
V_0	

b) (10 pts.)
Determine the common mode input range, consistent with keeping all devices active.

c) (10 pts.)
If $V_{i_2} = V_{DD}$, determine the output range, consistent with keeping all devices active.

d) (10 pts.)
For the operating point with $V_{I_1} = V_{I_2} = V_{DD}$, determine the differential mode circuit G_m, i.e. $G_{m_{diff}} = \frac{i_{out}}{(v_{i_1} - v_{i_2})}$.

e) (10 pts.)

For the operating point with $V_{i_1} = V_{i_2} = V_{DD}$, determine R_{out}.

f) (10 pts.)

Determine the common mode gain, i.e. $A_{v-cm} = \left.\frac{v_0}{v_{in}}\right|_{v_{i_1} = v_{i_2} = v_{in}}$.

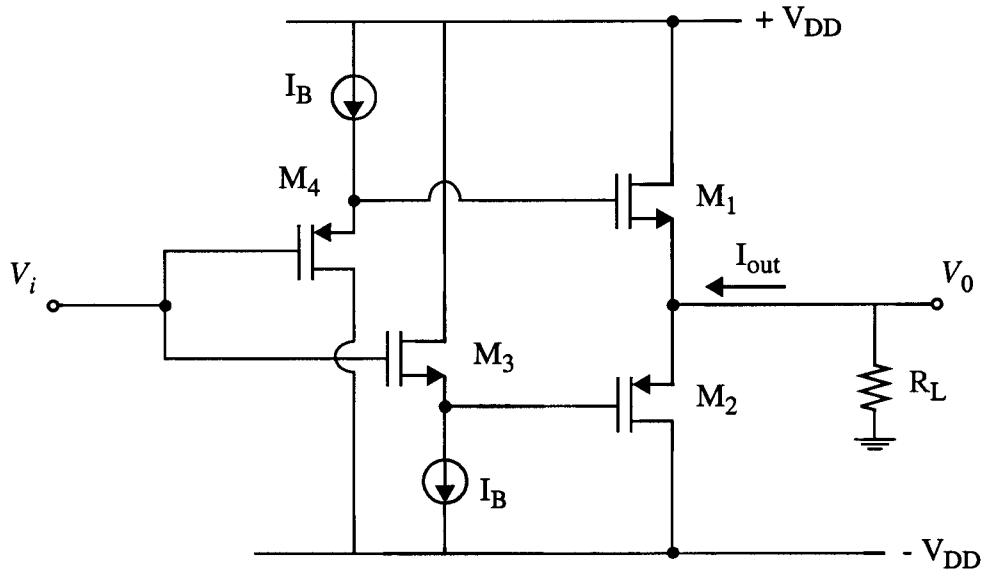

Fig. 2

2) For the circuit of Fig. 2, take the following: $\left(\frac{W}{L}\right)_1 = N\left(\frac{W}{L}\right)_3$; $\left(\frac{W}{L}\right)_2 = N\left(\frac{W}{L}\right)_4$;

$k'_n\left(\frac{W}{L}\right)_3 = k'_p\left(\frac{W}{L}\right)_4$. Neglect body effect and channel length modulation.

Assume $V_{T_n} = V_{T_p}$.

a) (10 pts.)

For $V_i = 0$ and $R_L = \infty$, determine V_0, I_{D_1} and I_{D_2}.

V_0	
I_{D_1}	
I_{D_2}	

b) (10 pts.)
For the bias condition determined in part (a), determine the circuit G_m.

c) (10 pts.)
For the bias condition determined in part (a), determine R_{out}.

d) (10 pts.)

Take $V_i = 0$ and $R_L = \infty$. Determine the large signal I_{out} - V_0 curve obtained by applying an appropriate test source at the circuit output.