Indian Institute of Technology, Delhi
EEL 782: Analog Integrated Circuits
Practice Problem Set 1

1. In Fig. 1, R is 1.3 kΩ, VDD is 2.5 V, I_0 is 10 μA. Both M1 and M2 are of equal size, and in strong inversion and saturation, their characteristics are given by:
$$I_D = K(V_{GS} - V_T)^2$$
where K is 1 mA/V^2 and V_T is 0.5 V.
   (a) Compute all the bias voltages and currents in the circuit.
   (b) Compute the small signal g_m of M1 and M2.
   (c) What is the effective input impedance of this circuit looking in from V_{in}?

2. For the circuit in Fig. 2, calculate the small signal differential gain given by $(v_{o_1} - v_{o_2})/(v_{i_1} - v_{i_2})$, and the small signal common mode gain given by $(v_{o_1} + v_{o_2})/(v_{i_1} + v_{i_2})$. Clearly define any symbols that you use in your computations. Assume Vb1 and Vb2 are DC bias voltages.

3. Assume the device equation and parameters as given in question 1. For the circuit in Fig. 3, sketch I_{out}, V_X, V_A, and V_B, as a function of (a) I_{ref} and (b) V_b. What is the impedance looking into the drain of M3? What is the impedance looking into X?

4. Assuming all MOSFETs are in saturation, calculate the small signal voltage gain of each circuit in Fig. 4. Assume all devices have a g_m of 1 mS, g_{ds} of 50 μS, and g_{mb} of 0 S.

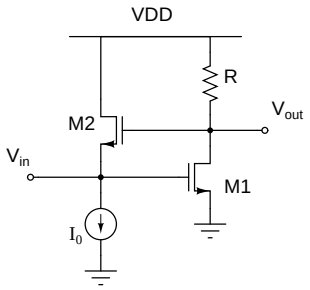

Figure 1: Figure for Question 1

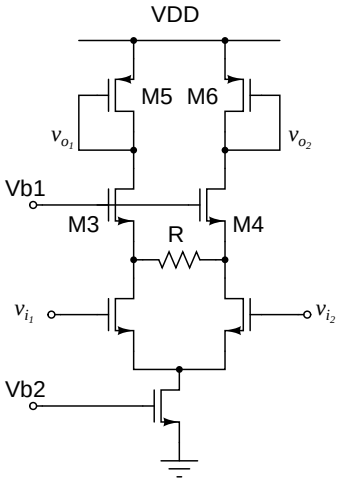

Figure 2: Figure for Question 2

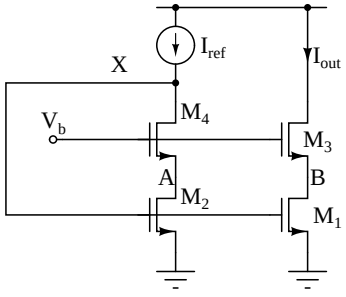

Figure 3: Figure for Question 3

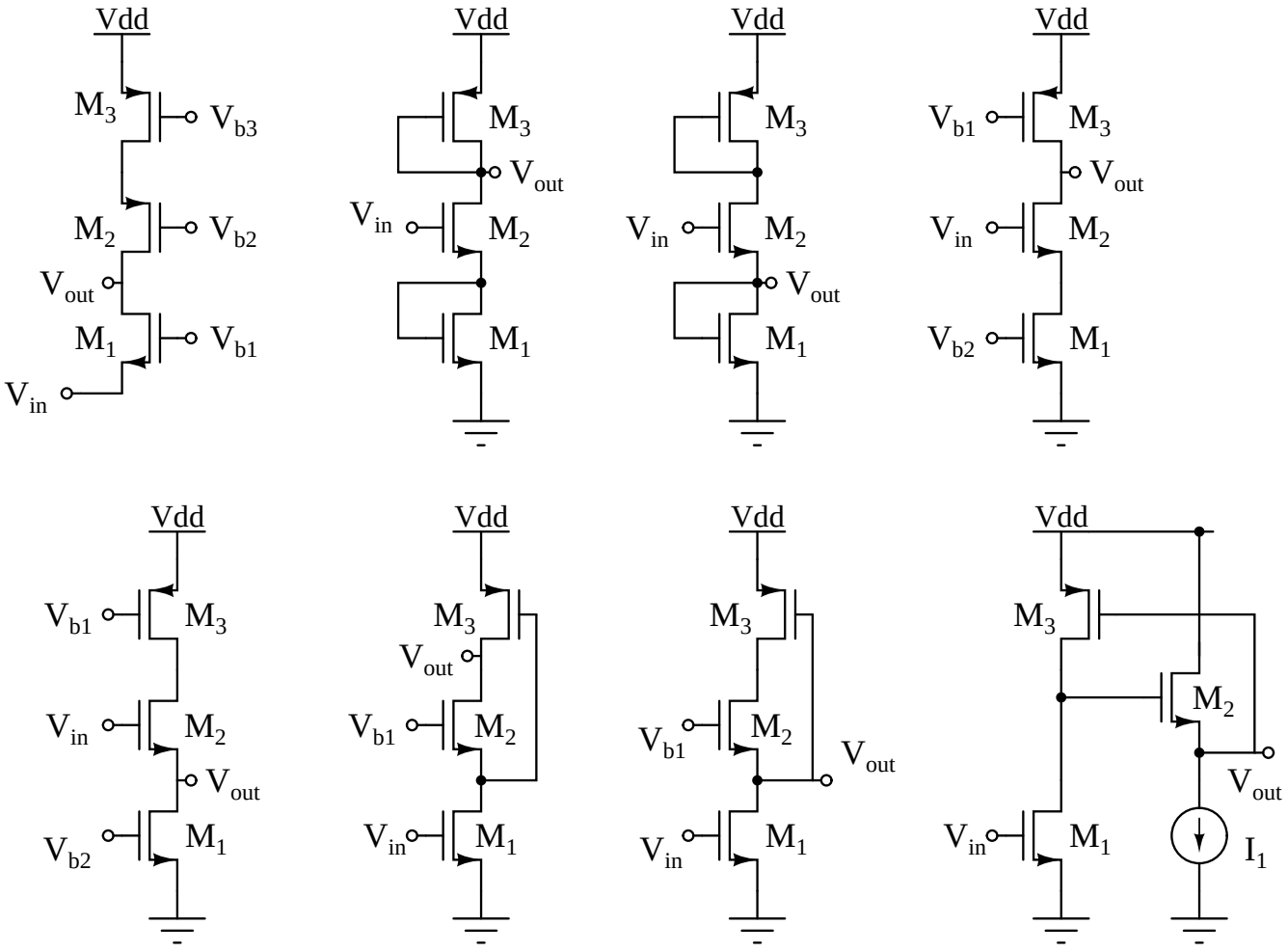

Figure 4: Figure for Question 4