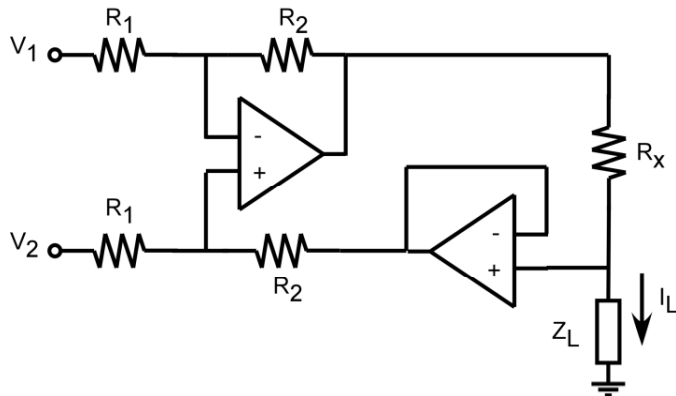


NAME \_\_\_\_\_

Solve the following problems. Please show all your work leading to your solution.

I. (33 pts.) Assuming ideal operation of the amplifiers ( $A_v = \infty$ ), find the expression for  $I_L$  in terms of the differential voltage  $v_2 - v_1$  and the resistors  $R_x$ ,  $R_1$ , and  $R_2$ .

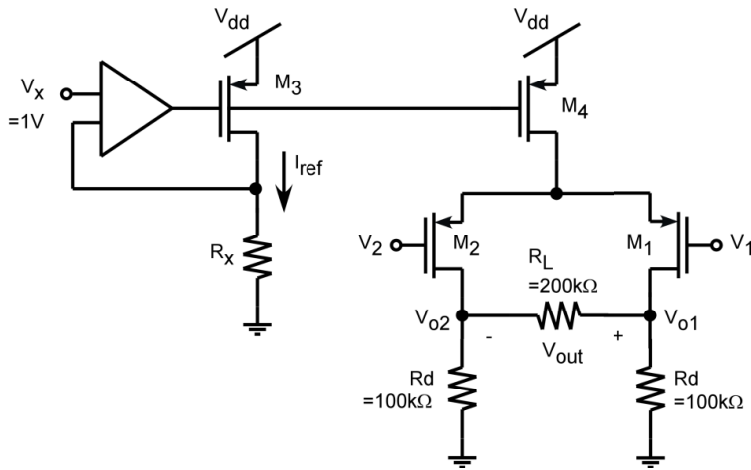


NAME \_\_\_\_\_

II(33 pts.) For the following circuit, where  $V_x$  is DC bias voltage:

- determine the correct polarity of the amplifier terminals so that it works properly with negative feedback
- determine the value of the resistor  $R_x$  for a reference current of  $10\mu\text{A}$
- find the differential mode gain  $A_d = V_{out}/V_{id}$  (use  $I_{ref} = 10\mu\text{A}$ )
- determine the common mode gain  $A_{cm} = V_{o1}/V_{cm}$  (use  $I_{ss} = 10\mu\text{A}$ )

Assume: Ideal Amplifier ( $A_v = \infty$ ),  $K_p = 500\mu\text{A}/\text{V}^2$ ,  $K_{p4}/K_{p3} = 2$ ,  $\lambda_{p1} = \lambda_{p2} = 0$ ,  $\lambda_{p4} = 0.01\text{V}^{-1}$



NAME \_\_\_\_\_

III. (34 pts.) For the following CMOS amplifier, where  $V_{b1}$  and  $V_{b2}$  are DC voltages for proper operation of the circuit:

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

Assume:  $I_{ss}$  = ideal current source

