Analog Circuits (EE3002/EE5310) : Problem Set 4

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For all the problems, use $\mu_n C_{ox}(W/L)$ =1 mA/V^2 and $V_T = 0.7$ V. Assume that $\lambda = 0$ unless otherwise mentioned. All capacitors are infinite.

Problem 1

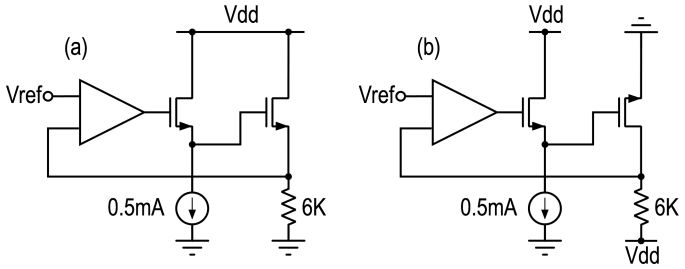

Figure 1: Circuit for problem 1.

In Fig. 1(a), determine the signs on the opamp for negative feedback operation. Determine the gate potentials of the transistors for Vref=3 V and Vdd=7 V. Repeat for Vref=3 V and Vdd=5 V.

In Fig. 1(b), determine the signs on the opamp for negative feedback operation. Determine the gate potentials of the transistors for Vref=3 V and Vdd=6 V. Repeat for Vref=3 V and Vdd=2.2 V.

Problem 2

Fig. 2 shows a progression of current mirrors. For this problem, assume that all transistors have $\lambda = 1/50$ V. Further, use Vdd = 10 V. To find the potentials at various nodes of the mirrors, assume that $\lambda = 0$. Use this information to determine the gm's and ro's of the transistors. The opamps in parts (f) and (h) are ideal. Determine the signs on these opamps for negative feedback operation.

For each of the current mirrors, determine

- The minimum voltage Vo needed to ensure that the output behaves like a current source.
- The incremental output resistance, assuming all devices are in saturation.

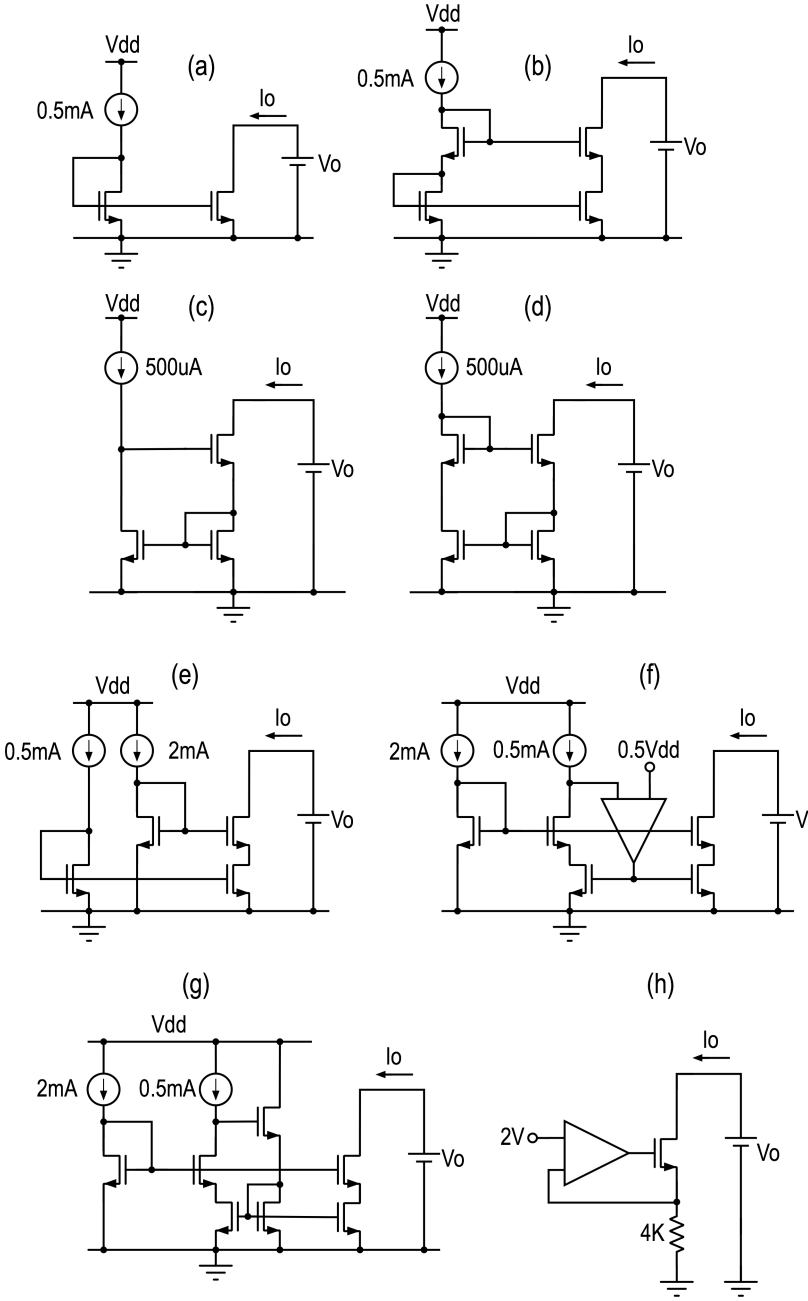

Figure 2: Circuit for problem 2.

- Current error, which we will define as (Io-0.5 mA)/Io when Vo = 0.5 Vdd.

Problem 3

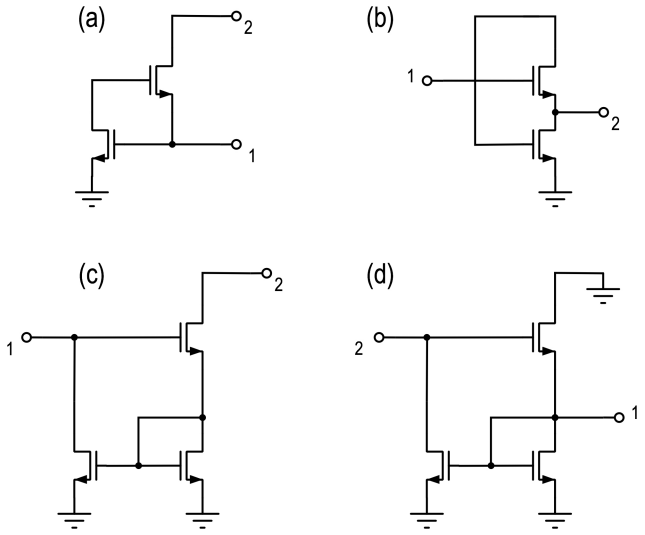

Figure 3: Circuit for problem 3.

Fig. 3 shows four incremental controlled sources, where all transistors are in saturation, and have transconductances given by g_m, and output resistances r_o. 1 denotes the input port, and 2 is the output port. Determine the incremental input and output resistances, where you can use $g_m r_o \approx g_m r_o + 1$ to simplify your analysis. What kind of controlled source does each circuit represent?