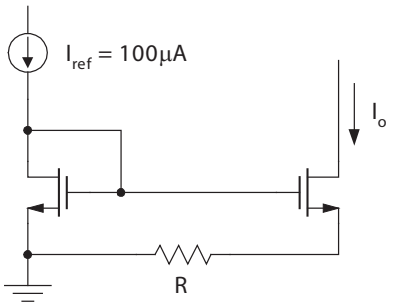
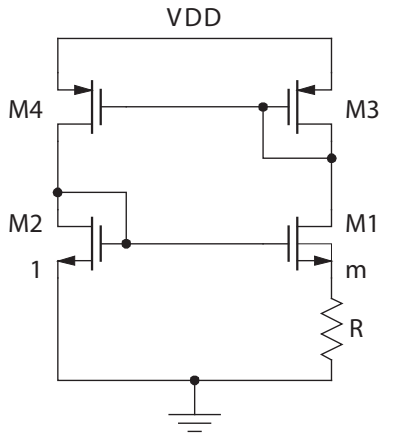
Problem Set 4
Due Thursday February 23, 2006

1. For the current mirror below, calculate the maximum value of R that results in less than one percent mismatch, i.e. $I/I_{ref} < 0.01$. Ignore all other sources of current mismatch. Both transistors are the same size. (a) Bias both transistors at $V^* = 500\text{mV}$. (b) Same, but bias the transistors in weak inversion ($n = 1.5$). (c) Calculate the total output noise of the current source. Draw up instructions for the layout draftsman to meet the resistance constraints.



2. Find the minimum width and length for two 1k poly resistors with 0.2% matching with a yield of 89%. Poly sheet resistance: 100Ω/square, standard deviation of the width: $W = 20\text{nm}$.

3. Find an expression for the transconductance of M1 as a function of R and m. Assume that the mirror has an exact 1:1 ratio, and neglect the body effect. Add a startup circuit.



4. Calculate the minimum value of ISS to meet specifications for $f_{-3\,\text{dB}}$, $\overline{v_{oT}^2}$, V_1^* and V_2^*. Definitions: $f_{-3\,\text{dB}}$ is the frequency at which the gain drops by 3dB from it's

value at DC; $\overline{v_{oT}^2}$ is the total noise integrated over all frequencies at the output of the amplifier; V_1^* and V_2^* are the bias points of M1, M1' and M2, M2', respectively. Assume all devices operate in saturation and ignore finite output resistance.