1. (30 points) For the current source shown below, find the minimum voltage needed at the output to
to keep all devices in saturation. Use: \( I_{ref1} = I_{ref2} = 40\mu A, \frac{W}{L_1} = \frac{W}{L_2} = \frac{W}{L_3} = \frac{W}{L_4} = 8/0.4, \frac{W}{L_5} = 1/0.4, k'_N = 100\mu A/V^2, \gamma = 0 \) (neglect body effect).
2. (30 points) Find the DC voltage gain for the circuit shown below. Use: \( V_{DD} = 3.3 \text{V} \), \( I_{bias} = 200\mu\text{A} \), \( W/L_1 = W/L_2 = W/L_3 = W/L_4 = W/L_9 = W/L_{10} = 10/0.4 \), \( W/L_5 = W/L_6 = W/L_7 = W/L_8 = 4/0.4 \), \( k'_N = 100\mu\text{A/V}^2 \), \( k'_P = 40\mu\text{A/V}^2 \), \( \lambda_N = 0.1 \), \( \lambda_P = 0.2 \), \( \gamma = 0 \) (neglect body effect).
3. (40 points) Find all pole frequencies for the circuit shown below. Use: $I_{bias} = 100\mu A$, $R_s = 1e6 \ \Omega$, $W/L_1 = W/L_2 = 4/0.4$, $k_N = 100\mu A/V^2$, $\lambda_N = 0.1$, $\gamma = 0$ (neglect body effect), $C_{load} = 2pF$ (not shown), $C_{ox} = 5fF/\mu m^2$, $C_{overlap} = 0.2 fF/\mu m$ of $W$, $C_{db} = C_{ab} = 0.8 fF/\mu m$ of $W$. Assume the $I_{bias}$ current source shown is ideal.
extra work space for problem 3
BONUS (5 points) Explain qualitatively (in words only, no numbers) which device in problem 1 would triode first if $W/L_5$ was decreased. Why?