Homework Assignment No. 5

Due on Wednesday, February 16, 2005

1.) Problem P4.3 of the text. Use SPICE to confirm the results.

[Partial Answers: $V_{IH} = 0.65\text{V}$ and $V_{IL} = 0.55\text{V}$]

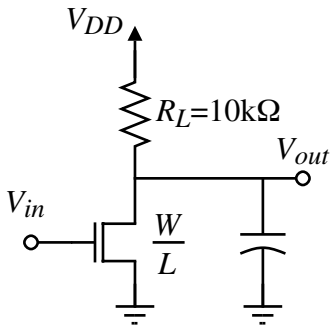
2.) Problem P4.9 of the text.

[Answers: $W_n = 0.2\mu\text{m}$, $0.1\mu\text{m}$ and $0.6\mu\text{m}$]

3.) Problem P4.10 of the text.

[Partial Answers: $V_S = 0.566\text{V}$, $V_{IL} \approx 0.533\text{V}$, $V_{IH} \approx 0.667\text{V}$]

4.) An NMOS transistor with a 10kΩ resistor as a load is used to implement a simple inverter as shown. The alpha-power model of Section 2.6 is used to fit the measured data for the NMOS transistor to produce the following two equations:



$$i_{DS} = (W/L)K_L(v_{GS} - V_{TN})v_{DS} \qquad v_{DS} \le V_{DS(\text{sat})}$$

$$i_{DS} = (W/L)K_S(v_{GS} - V_{TN})^{1.5} \qquad v_{DS} \ge V_{DS(\text{sat})}$$

where $K_L = 100\mu\text{A/V}^2$ and $K_S = 100\mu\text{A/V}^{1.5}$ and $V_{TN} = 0.6\text{V}$.

a.) Derive the expression for $V_{DS(\text{sat})}$ assuming the model above.

b.) Design V_{DD} and W/L of the resistively loaded inverter above to achieve $V_{OH} = 3.3\text{V}$ and $V_{OL} = 0.3\text{V}$.

c.) For the inverter of part b.) derive an expression for V_{IL} using the given alpha-power model. Using the previous values, evaluate V_{IL}.

5.) For the pseudo-NMOS load inverter shown using 0.18μm CMOS technology, determine V_{OH} and estimate V_{OL} using the velocity saturated model with effective mobility (high vertical field). Be sure to clearly state any assumptions used in estimating V_{OL}.