Midterm # 2
(November 6th, 2003)

Closed Book, Closed Notes
Device Equations on Device Problem
Write on the Exam paper

Print Your Name:____________________

Sign Your Name:____________________

Show your work so that the method as well as the answer can be graded for correctness and completeness. Correct answers alone are only worth 70% of full credit.

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I (25 Points) Logic and Timing Diagrams

a) (9 points) Using the inputs in the diagram, determine the initial and final values of X, Y, Z.

b) (16 points) For each of the outputs, circle (with an “o”) when new information is received and complete the timing diagram.
II (25 Points) Op Amp

a) (10 points) Find $V_{OUT}$ in terms of $V_1$, $V_2$, and $I$, and the resistors $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$ when the switch is in position 1.

b) (15 points) Assume the switch is now in position 2.
1. Give an equation that could be solved to find the new $V_{OUT}$.
2. Specify those and only those sources and resistances that will appear in the answer.
3. State if the proportionality between $V_{OUT}$ and $V_1$ will change or not. Briefly explain your answer.
III (28 Points) Dependent Source Analysis

a) (10 points) Find one equation between $V_{IN}$ and $V_{OUT}$ with no other voltages.

b) (12 points) Find the equivalent resistance looking to the right of the AA' cut-line.

c) (6 points) If A is large and if $R_1$ and $R_2$ are similar, will the equivalent resistance found in part b) be much larger, the same, or much smaller than $R_1$ and $R_2$ by themselves? Give an intuitive explanation.
IV (22 Points) Logic Circuit with an EE42 Device

Use the I versus V curves shown to the right and assume V_{DD} = 2.5V.

a) (10 points) Choose a pull-up resistance that will make V_{OUT} = V_{IN} = V_{MID} = 1.25V.

b) (12 points) Assuming, (W/L) = 4, find V_{Th}, V_{SAT_{SAT-n}}, and k' for this NMOS device graph?

\[ I_{OUT-SAT-n} = k_n \left( \frac{W}{L} \right) \left( V_{IN} - V_{Th} \right) V_{OUT-SAT-n} \]
\[ I_{OUT-SAT-p} = k_p \left( \frac{W}{L} \right) \left( V_{DD} - V_{IN} - |V_{Tp}| \right) V_{OUT-SAT-p} \]