Solution

CSU0007 Basic Electronics, Homework 4

- Three questions in total. Submit your work via Moodle before 9PM, Dec 4th, 2020.
- Clearly state your reasoning to earn full score.
- Textbook coverage: Section 6.1 to Section 6.8 (before Section 6.8.1).
- The assignment for self-study: Section 6.8.1 in the textbook (no need to submit this assignment).

1. (30 points) Consider the S model. In the following circuit, suppose the input {A, B, C} corresponds to logical {0, 1, 0}. What would be the logical value output at D?

$D \equiv \overline{\overline{AB+C}} = AB+C$

$\{A,B,C\} = \{0,1,0\}$

$\Rightarrow D \equiv 0$

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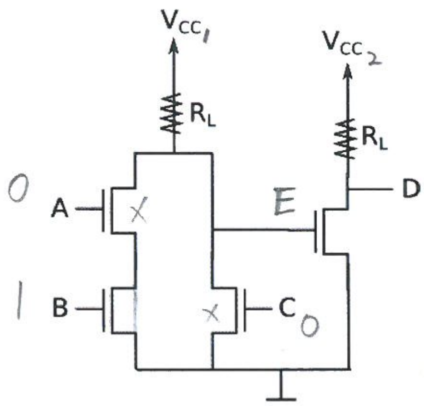

Typically, in this configuration we'll get E as logical 1, and therefore D is logical 0.
In an unusual case where $V_{CC_1} < V_{IL}$, then E will be always logical 0; similarly, if $V_{CC_2} < V_{OH}$, then there's no way to make D equal to logical 1.

2. (40 points) Now, consider the SR model. Explain in your own words that under the static discipline,

   1. (20 points) why we must have $V_{IL} < V_T$?
   2. (20 points) why we must have $V_{OL} > V_{CC}\frac{R_{ON}}{R_{ON}+R_L}$?

3. (30 points) Consider the SR model and the following specification: The noise margin is 0.5V for logical 0 and 1V for logical 1. The forbidden region is from 1V to 1.5V. V_T=1.2V, V_{cc}=3.3V, and R_N=5kΩ. Now, to build a MOSFET to meet this specification, what would be the maximum feasible value of ratio $\frac{L}{W}$? Assuming that R_L=8kΩ.

2.1 Otherwise, we might have two outcomes for logical 0 input $\begin{cases} \text{outcome A for } V_T < V_{in} < V_{IL} \\ \text{outcome B for } V_{in} < V_T \end{cases}$ #

2.2 otherwise, we may never be able to output logical 0, since $V_{cc} \times \frac{R_{ON}}{R_{ON}+R_L}$ is the minimum value of the output voltage. #

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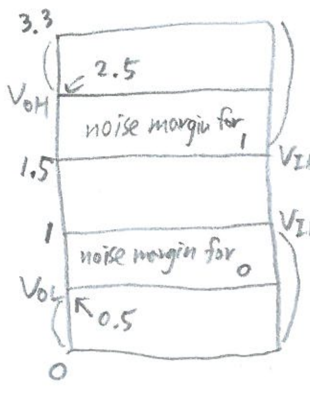

To meet the static discipline, we must have $V_{IL} < V_T$ and $V_{OL} > V_{cc} \times \frac{R_{ON}}{R_{ON}+R_L}$

$\Rightarrow 0.5 > 3.3 \times \frac{R_{ON}}{R_{ON}+8}$

$\Rightarrow R_{ON} < \frac{4}{2.8}$

$\Rightarrow 5 \times \frac{L}{W} < \frac{4}{2.8} \Rightarrow \frac{L}{W} < \frac{2}{7}$

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