Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Circuits & Electronics
Spring 2007
Homework #3
Handout S07-019

Issued 2/22/07 – Due 3/2/07

Reading: Chapter 5, Chapter 6.1-6.10.

Exercise 3.1. The number of Boolean functions of one variable (A) is four (F_1, F_2, F_3, and F_4), as it can be learned from the truth table given in Table 1. Then:

a. How many different Boolean functions are there of 2 variables, and of 3 variables?

b. How many different Boolean functions are there of n variables?

A	F_1	F_2	F_3	F_4
0	0	0	1	1
1	0	1	0	1

Table 1: Truth table for the different Boolean Functions of one variable.

Exercise 3.2. Do Exercise 5.6, page 275 of the textbook, parts a, b, and d.

Exercise 3.3. Do Exercise 6.2, page 322 of the textbook.

Problem 3.1. Do Problem 5.2, page 278 of the textbook.

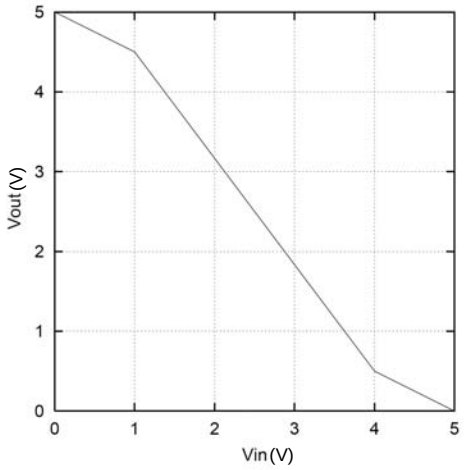

Figure 1: Input/Output transfer characteristic for inverter of Problem 3.2.

Problem 3.2. An inverter has the input/output transfer characteristic shown in Fig. 1. This inverter obeys the static discipline for suitable choices of the voltages V_{OL}, V_{IL}, V_{IH}, and V_{OH}, (see Fig. 5.8 on page 250 of the textbook), and those are such that $NM_H = NM_L$. Then:

a. Give values of V_{OL}, V_{IL}, V_{IH}, and V_{OH} that actually achieve the static discipline with the maximum positive noise margin.

b. What is the noise margin you obtained?

Problem 3.3 For this problem, consider the convention that a logical one corresponds to a high voltage level and a logical zero corresponds to a low voltage level. Thus, when the voltage v_A associated with the Boolean variable A is high (3V), $A = 1$. When v_A is low ($\approx 0V$), $A = 0$. The same relation holds with v_B and B, v_C and C. Assume also the following:

- The high voltage level is much greater than the threshold voltage.
- The "on" resistance of the MOSFET is 100Ω.
- The "off" resistance of the MOSFET is $100M\Omega$.

Then, for ***each*** circuit in Fig. 2:

a. Generate a truth table which shows how the variable C (associated with v_C) depends on the inputs A (associated with v_A) and B (associated with v_B).

b. For each particular entry of C in the corresponding truth table of part **a.**, find the value of the output voltage v_c .

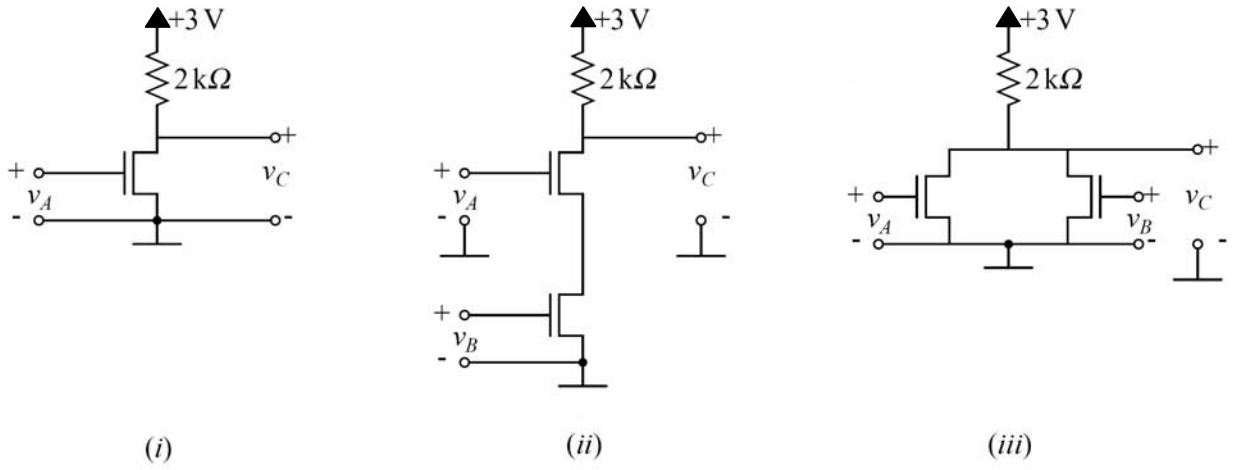

Figure 2: Circuits for Problem 3.3.