

Introduction to Computer Engineering (E85)

Harris

Spring 2001

Problem Set 2

Due: Friday, February 2

PEANUTS Classics By Charles M. Schulz



1) Karnaugh Maps

a) Draw a Karnaugh map for the following function f :

a	b	c	d	f
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	x
1	1	1	1	x

b) Write a Boolean expression for f using your K-map. Use the fewest prime implicants necessary.

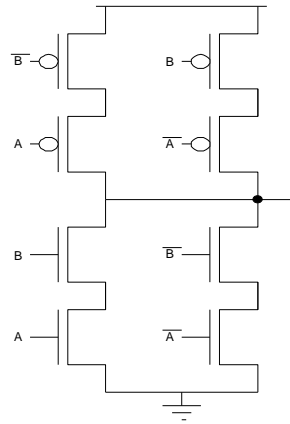
c) Sketch logic gates to implement your expression.

d) Does your circuit have any potential hazards? If not, explain why not. If so, show how to modify the circuit to eliminate the hazards.

2) Transistor-Level Circuits

a) Sketch a transistor-level design of a 4-input NAND gate.

b) Write a truth table for the following gate. What kind of gate is it?



c) Sketch a transistor-level design for the 3-input XOR function as a single complex logic gate. Recall that this XOR is the logic necessary to compute Sum in a full adder. You may assume you receive both true and complementary forms of each input A, B, and C.

3) Interpreting Data Sheets

Look up the datasheet for the 74HC00A NAND chip made by ON Semiconductor (formerly Motorola) at www.onsemi.com. Suppose we operate the chip with a power supply of nominally 5v +/- 10%, so answer the questions assuming worst-case V_{CC} of 4.5 volts or 5.5 volts, depending on what will make the answer less desirable. Further assume the operating temperature is 85 degrees C?

- How many two-input NAND gates are on the chip?
- If the outputs supply no more than 10 μ A, what are the input and output high and low logic levels? What are the high and low noise margins?
- How much power does the chip consume when none of the inputs are switching (i.e. the chip is quiescent)?
- What is the propagation delay through a NAND gate?
- Suppose you wanted to build a computer out of 74HC00 NAND gates. If every gate switched at 20 MHz and you could cool at most 50 watts from your chassis, how many 74HC00 chips could you use? Optimistically assume you can neglect the power consumed by the loads being driven.
- Why aren't computers built with HC-series logic chips anymore?

4) Time

Please indicate how many hours you spent on this problem set. This will not affect your grade, but will be helpful for calibrating the workload for next semester's class.