CSE 599 Winter 2001

Homework Assignment # 2

Due Date: January 25 (at the beginning of class)

1. (a) Consider Boolean functions that take as input a one bit number and produce as output a one bit number. How many such functions exist? Write down the truth table for each of them.
   (b) How many Boolean functions exist which map two bit numbers to a one bit number? Write down the truth tables for four of these functions (other than NAND).
   (c) How many Boolean functions exist which map n bit numbers to a one bit number? How many Boolean functions exist which map n bit numbers to a two bit number?
   (c) The NAND function is known to be a complete operator. Show how the four functions in (b) can be implemented using NAND gates.
2. (a) Draw a 2-to-4 binary decoder using only NAND gates.
   (b) Use the decoder above to construct a 4-to-1 multiplexer that uses only NAND gates.
3. Design a vending machine control circuit that accepts dimes and nickels, and dispenses a piece of gum (by outputting a 1 to the dispenser) when the total equals or exceeds 15 cents. Assume that there is a binary counter that counts the number of dimes and nickels as they are deposited and resets to zero when a gum is dispensed. Your inputs are the two binary numbers representing the number of dimes and nickels deposited so far, and your output is 1 or 0 depending on whether the total equals/exceeds 15 cents or not. (Hint: Write the truth table first and then build the circuit using ANDs, ORs, and NOTs to match the truth table)
4. (a) Design an RS flip-flop similar to the one in Fig. 2.29 of the Feynman textbook by replacing the 2 NOR gates with 2 NAND gates.
   (b) Write down the truth table for this flip-flop.
   (c) What input values for R and S lead to an invalid state?
5. (a) What is Moore's Law?
   (b) Discuss two factors that may limit the validity of Moore's law in the next two decades. You may use data from the handouts or other sources to support your arguments.