UNIVERSITY OF CALIFORNIA
Department of Electrical Engineering and Computer Sciences
CS150 Fall 2001

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Homework #1

Due: Friday, September 14, 2001

1. Which of the following contain circuits that are likely to be combinational and which contain sequential circuits? Explain the rationale behind your answer!
   a. A circuit that takes as an input a number between 0_{10} and 15_{10} and outputs the square of the input.
   b. A circuit that takes two numbers, one at a time, for input and outputs the sum of the two numbers.
   c. A circuit that takes a year (ex. 2001), in decimal form, and outputs a 1 if it is a leap year, 0 if it is not.
   d. A circuit that takes as an input an alternating stream of 1's and 0's and inverts its one output bit after receiving 2 alternations on the input.
   e. A circuit which has eight binary inputs, numbered 0-7, and three binary outputs and works as follows. The output is the binary representation for the lowest numbered input which is a 1. If no inputs are a 1 the output is all zeros. (For example, if the input is 00100111 on inputs 0-7 respectively, the output will be 010_2 or 2_{10}. If the input were 00000011, the output would be 110_2 or 6_{10})
2. Consider all possible functions of two Boolean input variables.
   a. Write down a truth table that enumerates all of these possible functions.
   b. Write down the Boolean equations for each of these functions.
   c. Which function(s) is/are the most complex, i.e. would take the most gates to realize?
   d. How many possible functions are there of three Boolean variables? Four variables? Twenty?
3. Given the following Boolean equation:

   $$f(X,Y,Z) = \big((X+X') \bullet Y + (X \bullet Y \bullet Z') + Z \bullet (X+Y') \bullet (X'+Y) \big) \bullet (X + Y + Z')$$

   a. Write out the truth table.
   b. Can you see a way that this equation could be simplified? If so, what is it?
4. A vending machine sells 12 oz cans of Slurm for 50¢. The machine only takes quarters. A digital circuit inside the machine determines how much money has been inserted and when to dispense its product.
   a. Define the system's inputs and outputs
   b. Draw a finite state diagram for this subsystem, showing states, transition arcs, and logical conditions under which the machine moves from one state to the next.
5. Consider if the beverage machine in problem 4 could accept other forms of coinage.
   a. What other inputs and outputs would you need?
   b. What other states would you need?
   c. What if the machine contained products of varying cost? How could the machine make change? What about a coin release button?