Fundamentals of Digital System Design
ECE/CS 3700
Practice Exam for the final
Spring 2009

Note: Time yourself for 2 hours. 30 total points. Closed book, closed notes, open minds. Do not panic. Good luck.

1. Study Section 7.15, pp. 470, and study (solved) example 7.22 pp. 476, so you understand setup, hold times and propagation delays well.

2. (5 points) You are asked to design a vending machine controller that dispenses *gum (G)* or coke (C). Both items cost 15 cents. The machine takes only nickles (N) or dimes (D), one at a time. The machine operates as follows:

- First, 15 cents have to be deposited. Then, select input G or C. If G or C is asserted before 15 cents have been deposited, nothing happens.
- When input G is selected, G = 1 AND C = 0. When C is selected, G = 0 and C = 1. Assume that the sensors are designed in such a way that condition G = C = 1 will never occur.
- The machine doesn't dispense any change. If you deposit 20 cents and select an item, you're out of 5 cents.

Design the above machine in Mealy or Moore style. But first, draw a block diagram and list (or label) the inputs and outputs of the system. Then decide whether you wish to design a Mealy or Moore machine. Draw the state transition graph (STG) of the machine. Just design the machine, no need to minimize/synthesize it.

3. (5 points) Given the finite state machine in Table I, answer the following.

(a) Identify all the equivalent states of the machine and derive its reduced, minimized form.

(b) Can states B and C be distinguished from each other? If yes, then derive an input sequence that distinguishes between these states.

(c) Synthesize the minimized machine: i.e. state assign the minimized machine and derive next-state and output logic equations and draw the circuit schematic.

4. (5 points) Given in Table II is another machine to try the same question above:

5. (5 points) Draw the circuit schematic for a NOR-gate based Set-Reset latch. Label the circuit/signals properly, and demonstrate the functioning (memory operation) of the circuit. Under what conditions does the circuit become unstable? Repeat the above for a NAND-gate based design.

6. (5 points) State whether the following are true or false. Explain your answer - no points for bluffing! If false,

TABLE I

STATE TRANSITION TABLE OF THE MACHINE

Present State	Next State, Output	
	$x = 0$	$x = 1$
A	F, 0	B, 1
B	G, 0	A, 1
C	B, 0	C, 1
D	C, 0	B, 1
E	D, 0	A, 1
F	E, 1	F, 1
G	E, 1	G, 1

TABLE II

STATE TRANSITION TABLE OF THE MACHINE

Present State	Next State, Output	
	$x = 0$	$x = 1$
A	B, 0	E, 0
B	E, 0	D, 0
C	D, 1	A, 0
D	C, 1	E, 0
E	B, 0	D, 0

re-phrase the statement.

(a) A minterm is a sum of literals that denotes a point, or a set of points, in the Boolean space.

(b) There exists a minimum cover of a Boolean function consisting solely of prime implicants.

(c) A prime implicant can be contained in the union of two other prime implicants.

(d) Any Boolean function can be implemented using only XNOR gates. (XNOR is universal logic?)

7. Also, take a look at the solved problems at the end of Chs 4, 5, 6, 7, 8.