

Electrical and Computer Engineering Department  
Rutgers University  
14:332:437 Digital Systems Design  
Fall 2007  
Examination 2 – Closed Book

Prof. Michael L. Bushnell

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Name: \_\_\_\_\_

Last 4 Digits Student Number: \_\_\_\_\_

Write all of your work for this examination in your blue book.

Problem 1	14	
Problem 2	34	
Problem 3	41	
Problem 4	11	
Total	100	

**Problem 1 (14 Points, 11 Minutes) STATE MINIMIZATION.**

Please use the *method of partitions* to minimize the number of states in the following state transition table in Table 1. Please write the minimized state transition table for this machine, naming each state after the first state in the state equivalence class.

Table 1: State Transition Table for Problem 1.

Present State	Next State / Output			
	00	01	10	11
A	I/0	B/1	C/0	E/0
B	G/0	C/0	H/0	D/0
C	A/0	D/0	F/0	H/0
D	I/0	F/0	E/0	B/0
E	C/0	D/0	I/0	G/0
F	G/0	B/0	C/0	E/0
G	G/0	D/1	F/0	H/0
H	F/0	B/0	G/0	A/0
I	A/0	B/1	C/0	E/0

**Problem 2 (34 Points, 28 Minutes)** VERILOG STATE MACHINE DESIGN.

Figure 1 shows the state transition diagram for a state machine. Please code this machine in VERILOG, and give it an asynchronous active-low */INIT* signal that puts the machine in state *A*, and an asynchronous active-high *SET* signal that puts it in state *C*. The machine should change states on the falling edge of the clock signal *CLK*.

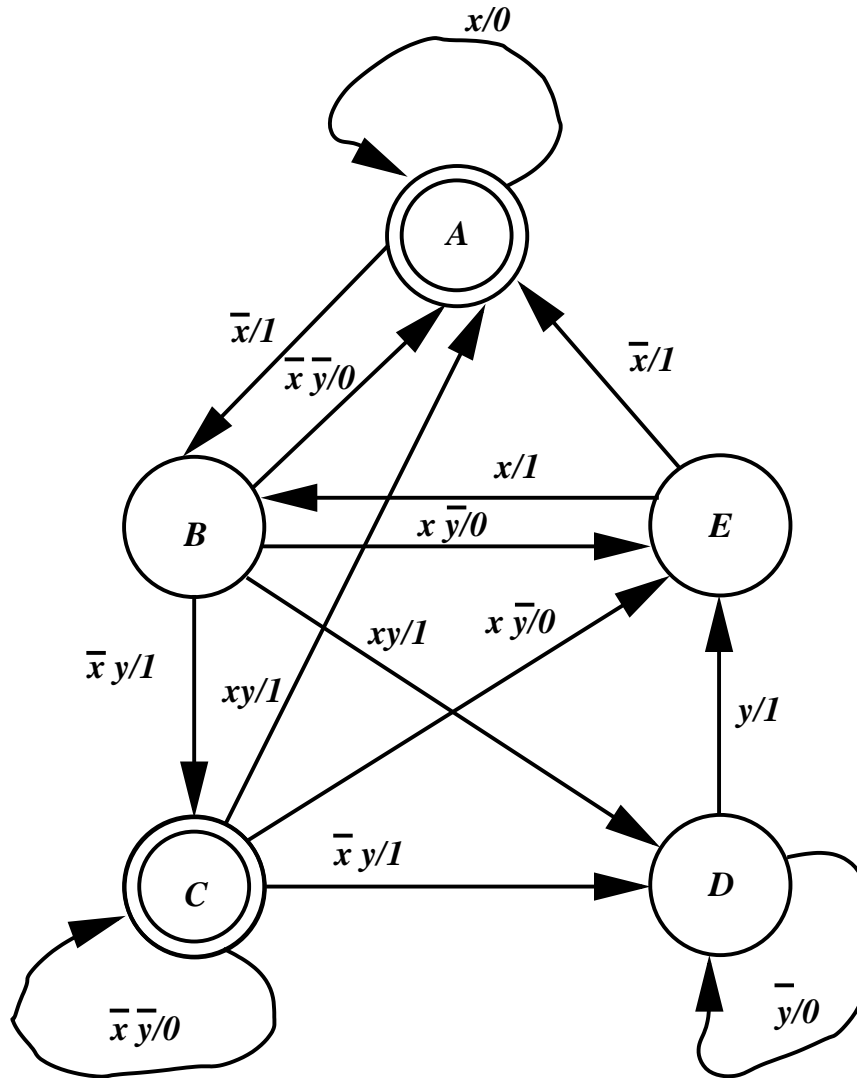


Figure 1: State Transition Diagram for Problem 2.

**Problem 3 (41 Points, 28 Minutes) STATE MACHINE DESIGN.**

You are to design a building control system for the Social Security Administration's new office building in Cincinnati, Ohio. Each floor of the building has an independent security system (a copy of the system that you will design). On each floor, there are 10 IBM file servers, each with 20,000 microprocessors, and a central on-line disk drive vault that serves all 10 machines. The disk drive vault is fireproof, waterproof, and hermetically sealed when it is locked.

Table 2 shows the signals for the machine. Your controller must be able to handle multiple input

Table 2: State Machine Signals for Problem 3.

SIGNAL	TYPE	MEANING
<i>/INIT</i>	input	Asynchronous reset (active low) for your controller.
<i>CLK</i>	input	Clocks your controller on the rising edge.
<i>CHECKOUT</i>	input	When set to 1, the system displays lights indicating its states and outputs, but has no effect on the building. When 0, the signals set by your system actually affect the building.
<i>SMOKE</i>	input	When 1, a smoke detector has detected a fire. Call the Fire Department, the Police Department, send all elevators to floor 1, Turn off the Power, call in Maintenance, and Lock the Vault.
<i>BURGLAR</i>	input	When 1, a burglar tripped a burglar alarm. Call the Police and Lock the Vault.
<i>WATER</i>	input	A water detector found water on the floor. Call maintenance and Lock the Vault.
<i>CO</i>	input	A detector found Carbon Monoxide on this floor. Call the Fire Department, Maintenance, Turn off the Power, Lock the Vault, and send all elevators to floor 1.
<i>POWEREM</i>	input	Someone pressed an emergency power off switch for this computer room. Shut down the power, call Maintenance, and Lock the Vault.
<i>SPRINKLER</i>	input	A fire has tripped the water sprinklers in the computer room. Call the Fire Department, Maintenance, turn off power, Lock the Vault, Call the Police, and send all elevators to floor 1.
<i>POLICE</i>	output	When 1, call in the Police.
<i>FIREDP</i>	output	When 1, call in the Fire Department.
<i>MAINT</i>	output	When 1, call in Maintenance.
<i>ELEV</i>	output	When 1, force all elevators in the building to go to floor 1 and open their doors.
<i>POWEROFF</i>	output	When 1, shut off power to all equipment on this floor.
<i>LOCKVAULT</i>	output	When 1, hermetically seal the disk drive vault so that no one can get in or out.

building conditions correctly. It should stay in the appropriate tripped state until problems in the building have been corrected, and sensors have turned off. PLEASE CREATE **ONLY** A STATE TRANSITION DIAGRAM FOR THIS MACHINE. **DO NOT CREATE ANY STATE TRANSITION TABLES OR VERILOG CODE.** Show detailed hardware only for the *CHECKOUT* gating logic. All output signals automatically set a set of the same signal names with *LIGHT* appended to turn on status lights. When *CHECKOUT* == 0, all output signals set a set of the same signal names with prefixes of *REAL* to affect the building.

**Problem 4 (11 Points, 8 Minutes)** ASYNCHRONOUS INPUTS AND STATE ASSIGNMENTS.

The following machine has asynchronous inputs  $IN1$  and  $IN2$  and synchronous inputs  $S1$  and  $S2$ . Figure 2 shows the state transition diagram for this machine. Please redesign the diagram so that the machine ultimately exhibits the same behavior, but possibly using more state transitions and states. You can take additional clocks for the decisions on inputs  $IN1$ ,  $IN2$ ,  $S1$ , and  $S2$ . Your redesigned diagram should observe the rules of *reduced input dependency* and should have state transitions redesigned to avoid problems with flakey transitions caused by asynchronous inputs. Propose a state assignment for this machine and write VERILOG code to create **ONLY THE STATE ASSIGNMENT**.

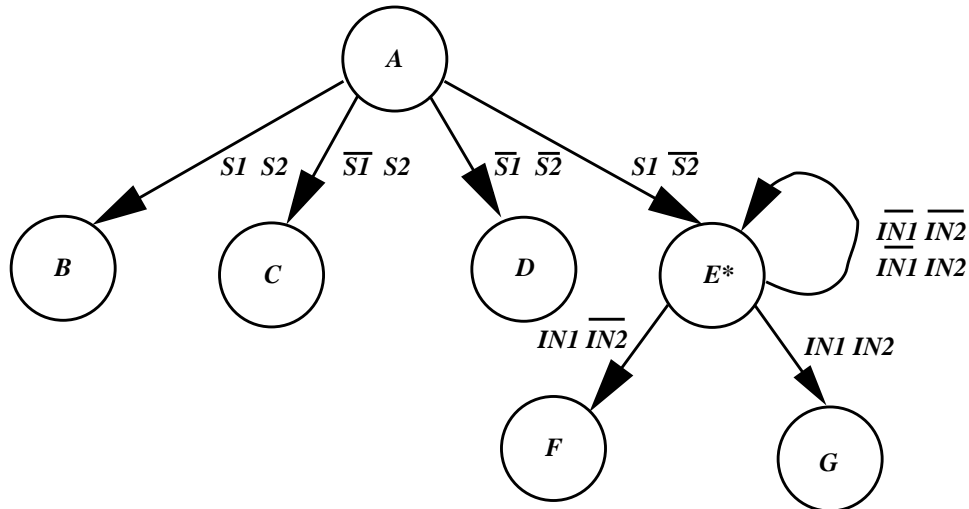


Figure 2: Preliminary State Transition Diagram for Problem 4.