

14:332:437 Concepts in Digital Systems Design
Fall 2007
Problem Set 3
Electrical and Computer Engineering Department
College of Engineering
Rutgers University

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Assigned: October 8, 2007

Due: October 17, 2007

STUDENTS ARE EXPECTED TO WORK INDEPENDENTLY ON BOTH HOMEWORK AND EXAMINATIONS. NO COLLABORATION IS PERMITTED. YOUR WORK MUST BE YOUR OWN.

1. *State Machine Design.* Given the state machine transition graph in Figure 1, please write a Verilog description for the state transitions of this diagram. You need to provide signals for the *present* and *next* states of the machine, an module declaration for the entire machine (*clk*, input *g*, input *h*, output *Z1*, output *Z2*, and *reset*), an always block for the state transition behavior (expressed as if-then-else or case statements), and an always block for clocking and resetting the machine. Note that in the state transition graph, we show the transition behavior as $g h = 00 / 1 0$ to indicate that the transition occurs when $g = 0$ and $h = 0$, and causes *Z1* to be 1 and *Z2* to be 0. Assume that state *A* is the reset state for this machine. This machine uses positive edge-triggered flip-flops, and the *reset* signal is active low (negative logic). Turn in your Verilog behavioral description, timing waveforms for the behavioral description simulation, the Verilog synthesized logic description, and a plot of the logic schematic.
2. *State Machine Design.* Please design a Finite State Machine in Verilog to implement the ECE graduate student salary and job selector according to the following rules:
 - (a) The student gets a base salary of \$ 35 K and works 40 hours/week.
 - (b) If the student has top grades, he gets a \$ 8 K bonus.
 - (c) If the student has recommendations from industrial experience, he gets a \$ 10 K bonus.
 - (d) If the student is a pain in the %**\$—\$, deduct \$ 15 K from his salary.
 - (e) If the student must be micromanaged to get him to do anything, deduct \$ 15 K from his salary.
 - (f) If the student knows VLSI, add a chip design company to his job prospects and raise the salary by \$ 20 K and increase his working hours by 20 hours/week.

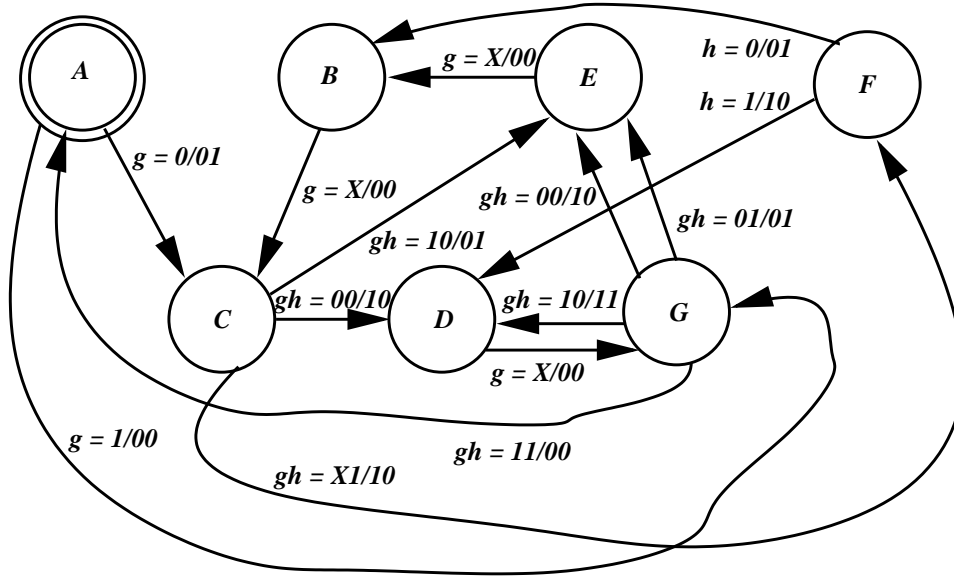


Figure 1: State Transition Diagram for Problem 1.

- (g) If the student knows FPGAs, add instrument companies, pharmaceuticals (salary goes up by \$ 10 K only for pharmaceuticals), and defense contractors to his job prospects.
- (h) If the student knows software, add software, pharmaceutical, and finance companies to his prospects.
- (i) If the student knows medical technology, add all medical instrument companies to his prospects (salary goes up by \$ 20 K and his work week increases by 10 hours/week).
- (j) If the student gets 4 or more offers, add \$ 20 K to his salary.
- (k) If the student knows DSP/Communications and VLSI, increase the salary by \$ 20 K and add Communications companies to his prospects. His work week increases by 20 hours/week.
- (l) If the student knows medical technology and VLSI, increase the salary by \$ 25 K and add Medical Instrument companies to his prospects. His work week increases by 10 hours/week.
- (m) If the student knows DSP/Communications, medical technology, and VLSI, increase the salary by \$ 10 K and add Medical Instrument companies to his prospects. His work week increases by 10 hours/week.
- (n) If the student is a great talker, increase the salary by \$ 10 K. His work week decreases by 10 hours/week.

Turn in the state transition diagram for this finite state machine, the Verilog code, and the behavioral simulation using the test bench. Table 1 lists all of the input and output hardware variables for the machine. For your information, Table 2 lists some of the relevant companies.

Table 1: Hardware Variables for this Problem

Input Variable	Meaning
SOFTWARE	Set to 1 if student knows software
TOP_GRADES	Set to 1 if student has top grades
INDUSTRIAL_EXP	Set to 1 if student has good industrial experience
DIFFICULT_PERSON	Set to 1 if student is a difficult person
MICRO_MANAGE	Set to 1 if student must be micromanaged to make him productive
GREAT_TALKER	Set to 1 if the student is a great presenter
FOUR_OFFERS	Set to 1 if student has 4 or more job offers
FPGA	Set to 1 if student knows FPGAs
DSPCOM	Set to 1 if student knows DSP and Communications
VLSI	Set to 1 if student knows VLSI
MEDICAL	Set to 1 if student knows medical technology
Output Variable	Meaning
HOURS	Counter giving the likely work hours per week of the job
SALARY	Counter giving the maximum salary the student could get in thousands of dollars
DEFENSE_CO	Set to 1 if student can get a job at a defense contractor
INSTRUMENT_CO	Set to 1 if student can get a job at an instrument company
DRUG_CO	Set to 1 if student can get a job at a drug company
MEDICAL_INSTR_CO	Set to 1 if student can get a job at a medical instrument company
FINANCIAL_CO	Set to 1 if student can get a job at a Wall Street financial company
CHIP_CO	Set to 1 if student can get a job at a chip company
SOFT_CO	Set to 1 if student can get a job at a software company
COMMUNICATIONS_CO	Set to 1 if student can get a job at a communications company

Table 2: Employers

Software	Computer Science Associates, IBM, Accenture, EDS
Chips	Intel, AMD, IBM, Texas Instruments, Micron Technologies, Agilent, Synopsys, Cadence, Mentor Graphics
Financial	Merrill Lynch, Goldman Sachs, Citibank, Fidelity Magellan
Drug	Johnson & Johnson, Merck, Eli Lilly, Schering-Plough
Instrument	MTS, Keithly, Instron, Foxboro, Teradyne, LTX
Medical Instrument	Medtronic, Boston Scientific, MedRad, GE Medical, Philips
Defense	Lockheed-Martin, Boeing, General Dynamics, BAE Systems
Communications	Motorola, Qualcomm, Broadcomm, Texas Instruments