CS/COE 0447 Fall 2009
Homework 3
Due Date: November 16, 2009

You should turn in a hard copy of this assignment at the beginning of class on Monday, November 16, 2009.

Show all your work. Answers with only numbers will not get full credit.

1. Convert the following decimal numbers into 8-bit binary numbers in biased notation with a bias of 127:

121, -25, -71

2. Convert the following decimal numbers to binary numbers:

5.75
45.375
13.40625

3. Convert the following binary numbers to decimal numbers:

110010110.11001
1001110.0000101
100111011.11001101

4. Write down the binary representation of the following decimal numbers, assuming the IEEE 754 single precision format:

-1609.5
-938.8125
130.59375

5. Show the steps for the division of 1101b and 0011b (unsigned) using Hardware Design 3 (available here: http://www.cs.pitt.edu/~childers/CS0447/lectures/division-floats.pdf). Draw a table similar to the following one and fill up the columns:

Iteration	Divisor	Step	Remainder (8 bits)
...	...	...	...

6. Show the steps for the division of 1101b and 0011b (unsigned) using Hardware Design 3 and non-restoring division (available here: http://www.cs.pitt.edu/~childers/CS0447/lectures/division-floats.pdf). Draw a table similar to the following one and fill up the columns:

Iteration	Divisor	Step	Remainder (8 bits)
...	...	...	...

7. Write down the function represented by the following Karnaugh map as a sum of products. Make sure you minimize the number of products.

	AB = 00	**AB = 01**	**AB = 11**	**AB = 10**
CD = 00	1	0	0	1
CD = 01	0	0	1	1
CD = 11	1	1	1	1
CD = 10	1	0	0	1

8. Write down the function represented by the following Karnaugh map as a sum of products. Make sure you minimize the number of products.

	AB = 00	**AB = 01**	**AB = 11**	**AB = 10**
CD = 00	0	1	1	0
CD = 01	1	1	0	1
CD = 11	0	0	0	0
CD = 10	0	1	1	0

9. Consider two 2-bit inputs X and Y, each consisting of individual bits x1 and x0, and y1 and y0, respectively. Write down the truth table for each of the following relations:

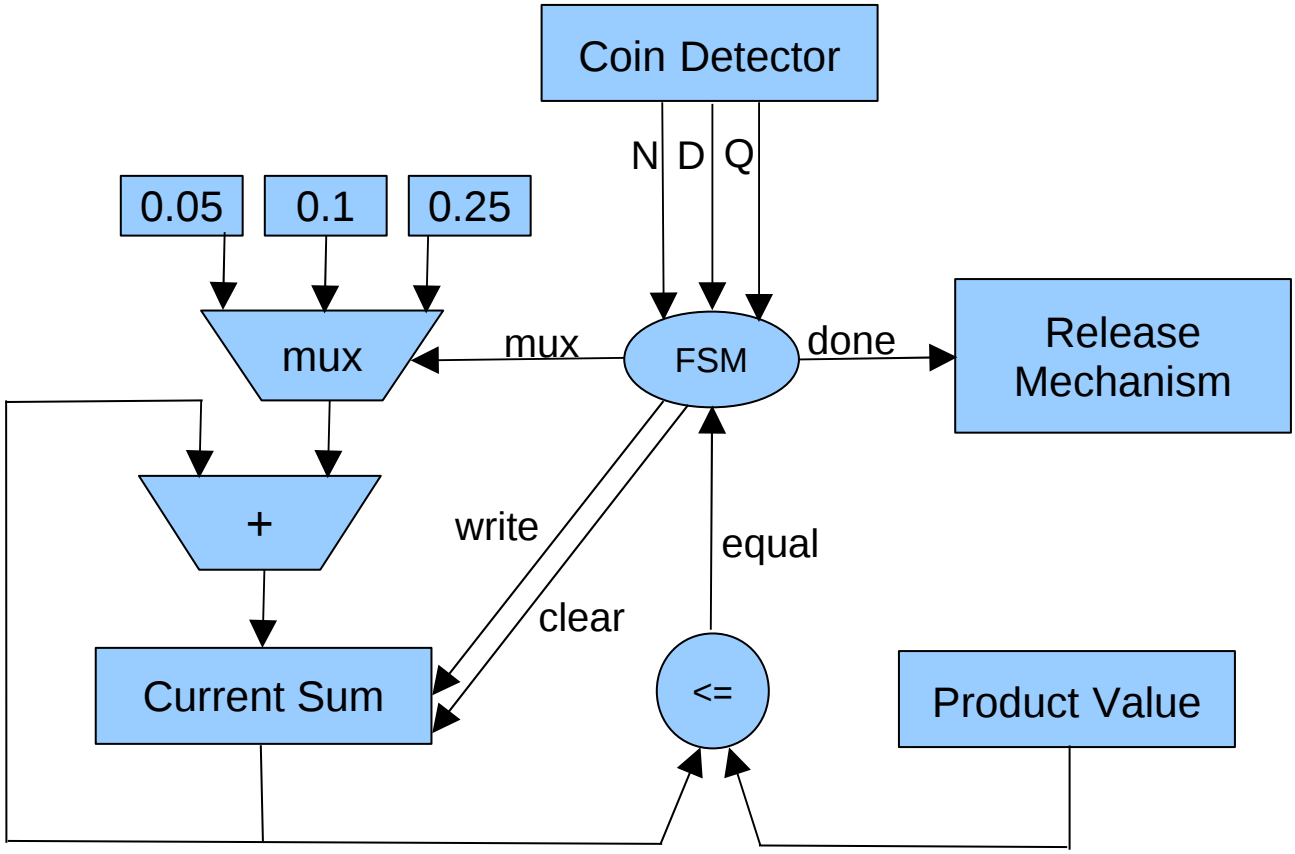
X < Y, where X and Y are unsigned binary numbers
X = Y

Write down each function as a sum of products and draw the circuit using AND/OR/NOT gates. Use Karnaugh maps to minimize the number of products.

10. In this problem, we'll construct a finite state machine (FSM) that controls a simple vending machine. The vending machine accepts three types of coins: nickels, dimes and quarters. When a coin is deposited, the vending machine updates the current sum depending on the value of the new coin. When the value of the

current sum is greater than or equal to the cost of the product, the machine releases product to the customer. The machine does not give any change back to the customer.

The following figure shows a high level description of the vending machine:



When a coin is deposited, the coin detector signals the type of coin to the FSM, using the N (nickel), D (dime) and Q (quarter) signals. The FSM should select the corresponding value using the mux signal and then set the write signal of the register to update the current sum. The value of the current sum is continuosly being compared to the value of the product value and the equals signal is set whenever the former is less than or equal to the latter. When the equals signal is set, the FSM should release the product using the done signal and clear the current sum so that the vending machine is ready to service the next customer.

Give a description of the FSM for the vending machine using a state diagram. Make sure to include the values of the inputs for each transition and the values of the outputs for each state.