UNIVERSITY OF CALIFORNIA, RIVERSIDE Department of Computer Science and Engineering Department of Electrical Engineering CS/EE120B – Introduction to Embedded Systems Midterm 2 November 15, 2001



Name: Solution Key

Student ID#:_____

Please print legibly

Lab Section: 21 (WF 2-6):____ 22 (MW 6-10):____

(Numbers in parenthesis denote total possible points for question.)

Design a datapath that will implement the following pseudo code using only three functional units (adder, subtractor, and less-than comparator), four single registers and as many muxes as needed. Clearly label the signals to/from the FSM. The constants must be connected as constant values directly to the datapath, i.e. they are not inputs. (6)

```
count=0

sum = 0

input x

input y

while x < y

sum = sum + x

y = y - 1

count = count + 2

output count
```

Answer



Questions 2 to 7 are based on the following next-state / output table. It is possible that a question cannot be answered completely because of insufficient information given. If this is the case, you need to give a reason as to why the question cannot be answered.

		-			
Current State		Next State	Actions		
	$Q_2 Q_1 Q_0$	[Condition, Next-State]	[Condition, Action]		
S_0	110	$(A=0), S_0$	(B>0), <i>Y</i> = <i>X</i> + <i>Z</i>		
		$(A=0)', S_3$			
S_1	011	$(B>0)', S_1$	<i>X</i> = <i>X</i> +1		
		(A=0), <i>S</i> ₂			
		$(B>0), S_0$			
S_2	010	S_3	<i>Y</i> = <i>Y</i> -1		
S_3	101	$(C=D), S_1$	(C=D)', Z=Z>>1		
		$(A=0)', S_2$	(B>0)', Y=Z+X		

2. What type of FSM is the table for?

Answer

Mealy

3. How many input signals are used by this FSM and what are their names? A signal and its inverse are counted as one. (1)

Answer

Three (3). (*A*=0), (*B*>0), and (*C*=*D*)

4. Derive the next-state equations for the FSM in terms of the Q_i 's and/or input signals. Do not simplify the equations. (4)

Answer

 $\begin{aligned} Q_{0next} &= S_0(A=0)' + S_1(B>0)' + S_2 + S_3(C=D) \\ Q_{1next} &= S_0(A=0) + S_1(B>0)' + S_1(A=0) + S_1(B>0) + S_3(C=D) + S_3(A=0)' \\ Q_{2next} &= S_0(A=0) + S_0(A=0)' + S_1(B>0) + S_2 \end{aligned}$

5. Derive the output equations for the FSM in terms of the Q_i 's and/or input signals. Do not simplify the equations. (4)

Answer

Cannot be done. The output equations are dependent on the datapath control signals. Since the datapath is not given, we do not know what the datapath control signals are.

(1)

6. Convert the next-state table to the format where the input values are all enumerated out instead of using the [condition, next-state] pair format, i.e. instead of having the [condition, next-state] entries, all input values are listed out. In your next-state table, use only the symbolic state names and <u>not</u> their encodings. List the input signal names in alphabetical order. (4)

Answer

Some of the entries have two next states and one entry has no next state. These are wrong. All entries must have exactly one next state.

	Next State								
Current State	(A=0), (B>0), (C=D)								
	000	001	010	011	100	101	110	111	
S_0	S_3	S_3	S_3	S_3	S_0	S_0	S_0	S_0	
S_1	S_1	S_1	S_0	S_0	S_1 / S_2	S_1 / S_2	S_0 / S_2	S_0 / S_2	
S_2	S_3	S_3	S_3	S_3	S_3	S_3	S_3	S_3	
S_3	S_2	S_1 / S_2	S_2 / S_2	S_1 / S_2		S_1		S_1	

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7. Draw the ASM chart for the given next-state / output table

Answer

