UNIVERSITY OF CALIFORNIA, RIVERSIDE

Department of Computer Science and Engineering
Department of Electrical Engineering
CS/EE120B – Introduction to Embedded Systems
Midterm 2
May 21, 2001

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Name: Solution Key **Student ID#:**
Please print legibly

Lab Section: 21 (TR 6-10):_____ **22** (WF 6-10):_____ **23** (WF 2-6):_____

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

1. Given the following state-action table, determine the values of *i* that are outputted. (2)

Current State name, $Q_2Q_1Q_0$	Next State Condition, State	Control and Datapath Actions Condition, Actions
s_0 000	$\begin{bmatrix} Start = 0, s_0 \\ Start = 1, s_1 \end{bmatrix}$	$\begin{bmatrix} Done = 0 \\ Output = Z \end{bmatrix}$
s_1 001	s_2	$i = 3$
s_2 010	$\begin{bmatrix} i \neq 7, s_2 \\ i = 7, s_3 \end{bmatrix}$	$\begin{bmatrix} i{+}{+} \\ i \neq 5, \text{Output } i \end{bmatrix}$
s_3 011	s_0	

Answer

3, 4, 6, 7.

2. Derive the next-state equations for the following state-action table. Do not simplify the equations. (6)

Current State name, $Q_2Q_1Q_0$		Next State Condition, State	Control and Datapath Actions Condition, Actions
s_0	000	$\begin{bmatrix} Start = 0, s_0 \\ Start = 1, s_1 \end{bmatrix}$	$\begin{bmatrix} Done = 0 \\ Output = Z \end{bmatrix}$
s_1	001	s_2	Input n
s_2	010	s_3	$Prime = 1$
s_3	011	s_4	$i = 2$
s_4	100	$\begin{bmatrix} n \bmod i \neq 0, s_6 \\ n \bmod i = 0, s_5 \end{bmatrix}$	$n \bmod i$
s_5	101	s_6	$Prime = 0$
s_6	110	$\begin{bmatrix} i \neq 15, s_4 \\ i = 15, s_7 \end{bmatrix}$	i ++
s_7	111	s_0	Output *Prime*

Answer

$Q_{0next} = s_0 Start + s_2 + s_4(n \bmod i = 0) + s_6(i = 15)$
$= Q_2'Q_1'Q_0'\, Start + Q_2'Q_1Q_0' + Q_2Q_1'Q_0'(n \bmod i = 0) + Q_2Q_1Q_0'\,(i = 15)$

$Q_{1next} = s_1 + s_2 + s_4(n \bmod i = 0)' + s_5 + s_6(i = 15)$
$= Q_2'Q_1'Q_0 + Q_2'Q_1Q_0' + Q_2Q_1'Q_0'(n \bmod i = 0)' + Q_2Q_1'Q_0 + Q_2Q_1Q_0'\,(i = 15)$

$Q_{2next} = s_3 + s_4(n \bmod i = 0) + s_4(n \bmod i = 0)' + s_5 + s_6(i = 15) + s_6(i = 15)'$
$= s_3 + s_4 + s_5 + s_6$
$= Q_2'Q_1Q_0 + Q_2Q_1'Q_0'(n \bmod i = 0) + Q_2Q_1'Q_0'(n \bmod i = 0)' + Q_2Q_1'Q_0$
$\quad + Q_2Q_1Q_0'\,(i = 15) + Q_2Q_1Q_0'\,(i = 15)'$
$= Q_2'Q_1Q_0 + Q_2Q_1'Q_0' + Q_2Q_1'Q_0 + Q_2Q_1Q_0'$

3. The state-action table in question 2 is for a Moore machine. Derive the corresponding state-action table for a Mealy machine. Use as few states as possible. Combine actions in multiple states into a single state as much as possible. The functionality of your Mealy machine should be the same as the original Moore machine. The only difference is in the number of states. (6)

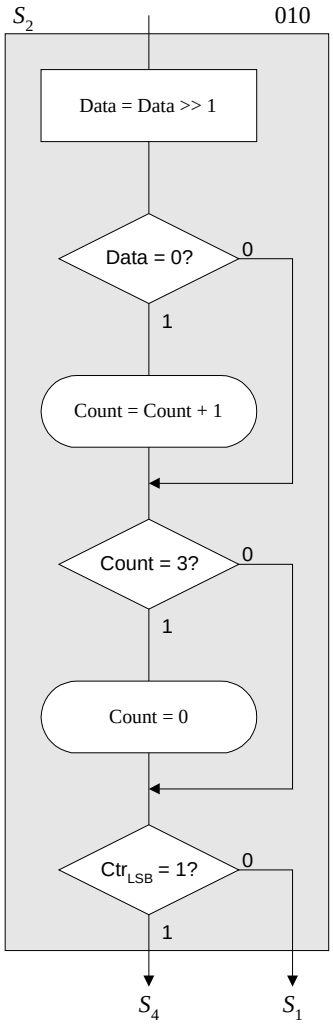
Answer

Current State name, $Q_2Q_1Q_0$	Next State Condition, State	Control and Datapath Actions Condition, Actions
s_0 000	$\begin{bmatrix} Start = 0, s_0 \\ Start = 1, s_1 \end{bmatrix}$	$\begin{bmatrix} Done = 0 \\ Output = Z \end{bmatrix}$
s_1 001	s_2	$\begin{bmatrix} \text{Input } n \\ Prime = 1 \\ i = 2 \end{bmatrix}$
s_2 010	$\begin{bmatrix} i \neq 15, s_2 \\ i = 15, s_3 \end{bmatrix}$	$\begin{bmatrix} n \bmod i = 0, Prime = 0 \\ i{+}{+} \end{bmatrix}$
s_3 011	s_0	Output *Prime*

4. Draw the ASM block for state s_2 in the following state-action table. (6)

Current State $Q_2Q_1Q_0$	Next State Condition, State	Control and Datapath Actions Condition, Actions
0 0 0 s_0	$\begin{bmatrix} Start = 1, s_0 \\ Start = 0, s_3 \end{bmatrix}$	$Done = 0$
0 0 1 s_1	$\begin{bmatrix} Data \neq 0, s_3 \\ Data = 0, s_2 \end{bmatrix}$	$Data \neq 0, Count = Count - 1$
0 1 0 s_2	$\begin{bmatrix} Ctr_{LSB} \neq 1, s_1 \\ Ctr_{LSB} = 1, s_4 \end{bmatrix}$	$\begin{bmatrix} Data = Data >> 1 \\ Data = 0, Count = Count + 1 \\ Count = 3, Count = 0 \end{bmatrix}$
0 1 1 s_3	s_1	$\begin{bmatrix} Data = Input \\ Count = 4 \end{bmatrix}$
1 0 0 s_4	s_0	$\begin{bmatrix} Done = 1 \\ Output = Count \end{bmatrix}$

Answer:


S_2
010
Data = Data >> 1
Data = 0?
0
1
Count = Count + 1
Count = 3?
0
1
Count = 0
Ctr_{LSB} = 1?
0
1
S_4
S_1