

UNIVERSITY OF CALIFORNIA, RIVERSIDE
Department of Computer Science and Engineering
Department of Electrical Engineering
CS/EE120B – Introduction to Embedded Systems
Midterm 1
October 23, 2001

20

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.)

1. Synthesize the sequential circuit for the following next-state/output table using a *SR* flip-flop for Q_0 and a *JK* flip-flop for Q_1 . (10)

Current State $Q_1 Q_0$	Next State / Output $Q_{1next} Q_{0next}$			
	AB			
	00	01	10	11
0 0	11/1	01/1	11/1	10/1
0 1	10/0	00/0	11/0	01/0
1 0	00/0	00/0	10/0	11/0
1 1	01/0	11/0	01/0	11/1

Answer

Implementation table

Current State $Q_1 Q_0$	Implementation $J_1 K_1 S_0 R_0$			
	AB			
	00	01	10	11
0 0	1×10	0×10	1×10	1×0×
0 1	1×01	0×01	1××0	0××0
1 0	×10×	×10×	×00×	×010
1 1	×1×0	×0×0	×1×0	×0×0

3 points

K-Map

	K-Map $J_1 K_1 S_0 R_0$			
Current State $Q_1 Q_0$	AB			
	00	01	11	10
0 0	1×10	0×10	1×0×	1×10
0 1	1×01	0×01	0××0	1××0
1 1	×1×0	×0×0	×0×0	×1×0
1 0	×10×	×10×	×010	×00×

Excitation equations:

$$J_1 = B' + AQ_0'$$

$$K_1 = A'B' + B'Q_0 + A'Q_0'$$

$$S_0 = A'Q_1'Q_0' + ABQ_1 + AB'Q_1'$$

$$R_0 = A'Q_1'Q_0$$

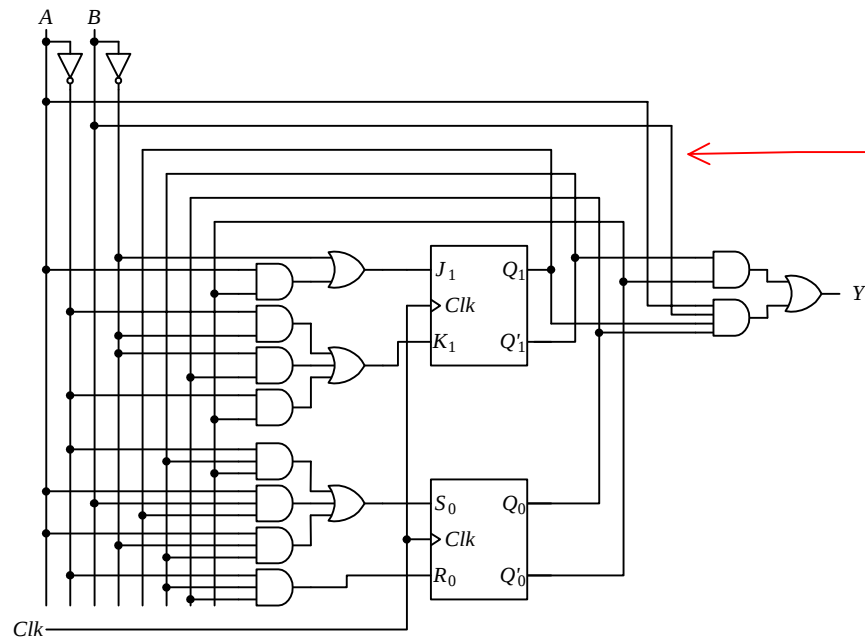
2 points

Output equation:

$$Y = Q_1'Q_0' + ABQ_1Q_0$$

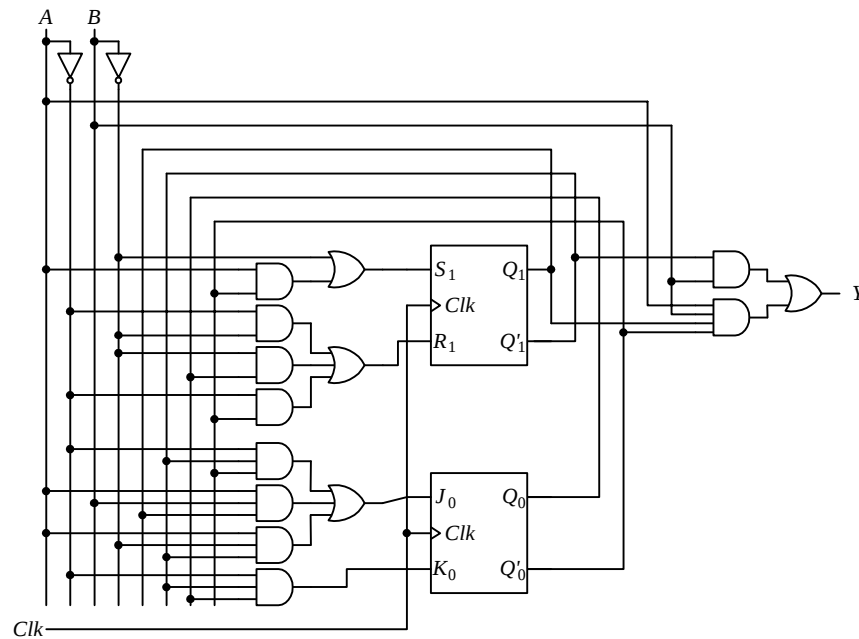
2 points

Circuit:



3 points

2. Derive the next-state/output table and state diagram for the following sequential circuit. (10)



Answer

Excitation equations:

$$\begin{aligned} S_1 &= B' + AQ_0' \\ R_1 &= A'B' + B'Q_0 + A'Q_0' \\ J_0 &= A'Q_1'Q_0' + ABQ_1 + AB'Q_1' \\ K_0 &= A'Q_1'Q_0 \end{aligned}$$

2 points

Output equation:

$$Y = Q_1'B + ABQ_1Q_0'$$

2 points

Characteristic and next-state equations:

$$\begin{aligned} Q_{1next} &= S + R'Q \\ &= S_1 + R_1'Q_1 \\ &= B' + AQ_0' + (A'B' + B'Q_0 + A'Q_0')'Q_1 \\ &= B' + AQ_0' + (A'B')' (B'Q_0)' (A'Q_0')' Q_1 \\ &= B' + AQ_0' + (A+B) (B+Q_0)' (A+Q_0) Q_1 \\ &= B' + AQ_0' + (ABQ_1) + (ABQ_1Q_0) + (AQ_1Q_0') + \\ &\quad (\cancel{ABQ_1}) + (BQ_1Q_0) + (ABQ_1Q_0') \end{aligned}$$

2 points

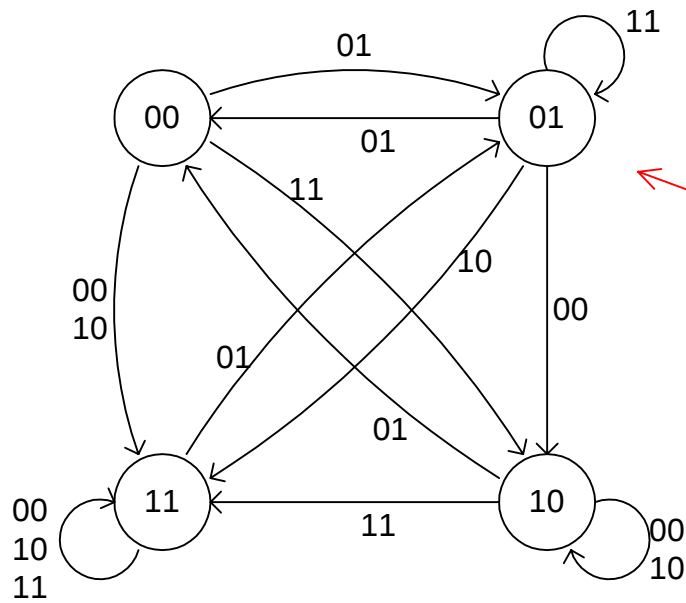
$$\begin{aligned} Q_{0next} &= K'Q + JQ' \\ &= K_0'Q_0 + J_0Q_0' \\ &= (A'Q_1'Q_0)'Q_0 + (A'Q_1'Q_0' + ABQ_1 + AB'Q_1')Q_0' \\ &= (A + Q_1 + Q_0')Q_0 + A'Q_1'Q_0' + ABQ_1Q_0' + AB'Q_1'Q_0' \\ &= AQ_0 + Q_1Q_0 + A'Q_1'Q_0' + ABQ_1Q_0' + AB'Q_1'Q_0' \end{aligned}$$

Next-state table:

Current State $Q_1 Q_0$	Next State / Output $Q_{1next} Q_{0next}$			
	AB			
	00	01	10	11
0 0	11/0	01/1	11/0	10/1
0 1	10/0	00/1	11/0	01/1
1 0	10/0	00/0	10/0	11/1
1 1	11/0	01/0	11/0	11/0

2 points

State diagram:



2 points