

## Sheet 7

- 1) Analyze the clocked synchronous state machine in Figure 7.1. Write excitation equations, excitation/transition table, and state/output table (use state names A-H for Q1 Q2 Q3 = 000-111).

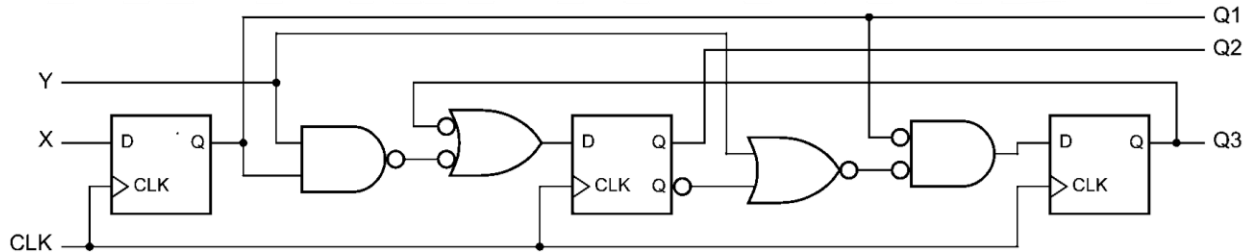


Figure 7.1

- 2) Design a clocked synchronous state machine with the state/output table shown in Table 7.2, using D-flip-flops. Use two state variables Q1 Q2, with the state assignment A = 00, B = 01, C = 11, D = 10

		X		
S		0	1	Z
A	B	D	0	
B	C	B	0	
C	B	A	1	
D	B	C	0	
		S*		

Table 7.2

- 3) Repeat Exercise 2 using J-K flip-flops.
- 4) Write a transition table for the nonminimal state table in Figure 7.4 that results from assigning the states in binary counting order INIT-OKA1 = 000-110. Write corresponding excitation equations for D flip-flops, assuming a minimal-cost disposition of the unused state 111.

		A B				
Meaning	S	00	01	11	10	Z
Initial state	INIT	A0	A0	A1	A1	0
Got a 0 on A	A0	OK00	OK00	A1	A1	0
Got a 1 on A	A1	A0	A0	OK11	OK11	0
Got 00 on A	OK00	OK00	OK00	OKA1	A1	1
Got 11 on A	OK11	A0	OKA0	OK11	OK11	1
OK, got a 0 on A	OKA0	OK00	OK00	OKA1	A1	1
OK, got a 1 on A	OKA1	A0	OKA0	OK11	OK11	1
		S*				

Figure 7.4

- 5) Redesign the 1s-counting machine of Table 7.5, assigning the states in binary counting order (S0-S3 = 00,01,10,11).

<i>Meaning</i>	<i>S</i>	<i>XY</i>				<i>Z</i>
		<i>00</i>	<i>01</i>	<i>11</i>	<i>10</i>	
Got zero 1s (modulo 4)	S0	S0	S1	S2	S1	1
Got one 1 (modulo 4)	S1	S1	S2	S3	S2	0
Got two 1s (modulo 4)	S2	S2	S3	S0	S3	0
Got three 1s (modulo 4)	S3	S3	S0	S1	S0	0

S\*

Table 7.5

- 6) Redesign the combination-lock machine of Table 7.6, assigning coded states in Gray-code order (A-H = 000, 001, 011, 010, 110, 111, 101, 100).

<i>Meaning</i>	<i>S</i>	<i>X</i>	
		<i>0</i>	<i>1</i>
Got zip	A	B, 01	A, 00
Got 0	B	B, 00	C, 01
Got 01	C	B, 00	D, 01
Got 011	D	E, 01	A, 00
Got 0110	E	B, 00	F, 01
Got 01101	F	B, 00	G, 01
Got 011011	G	E, 00	H, 01
Got 0110111	H	B, 11	A, 00

S\*, UNLK HINT

Table 7.6

- 7) Design a clocked synchronous state machine with four inputs, G1-G4, that are connected to push buttons. The machine has four outputs, L1-L4, connected to lamps or LEDs located near the like-numbered push buttons. There is also an ERR output connected to a red lamp. In normal operation, the L1-L4 outputs display a 1-out-of-4 pattern. At each clock tick, the pattern is rotated by one position; the clock frequency is about 4 Hz.

Guesses are made by pressing a push button, which asserts an input Gi. When any Gi input is asserted, the ERR output is asserted if the "wrong" push button was pressed, that is, if the Gi input detected at the clock tick does not have the same number as the lamp output that was asserted before the clock tick. Once a guess has been made, play stops and the ERR output maintains the same value for one or more clock ticks until the Gi input is negated, then play resumes.