

Assignment 3

Problem 1:

a) $K' = N$

J	K	N	$Q(t+1)$
0	0	1	$Q(t)$
0	1	0	0
1	0	1	1
1	1	0	$Q'(t)$

Characteristic Table:

J	N	$Q(t)$	$Q(t+1)$
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Excitation Table:

$Q(t)$	$Q(t+1)$	J	N
0	0	0	X
0	1	1	X
1	0	X	0
1	1	X	1

b.)

J \ NQ	00	01	11	10
0	0	0	1	0
1	1	0	1	1

$$Q(t+1) = JQ' + NQ$$

So, if we connect J and N together, we get:

$$Q(t+1) = JQ' + JQ = J = D$$

QED

Question 2:

Design a sequential circuit with two JK flip flops and two inputs E and x. when E=0, the circuit holds its state. when E=1 and x=1 the circuit repeatedly counts through 0,2,3,1. when E=1 and x=0, the circuit repeatedly counts through 0,1,3, 2. Implement and test this circuit using LogicWorks.

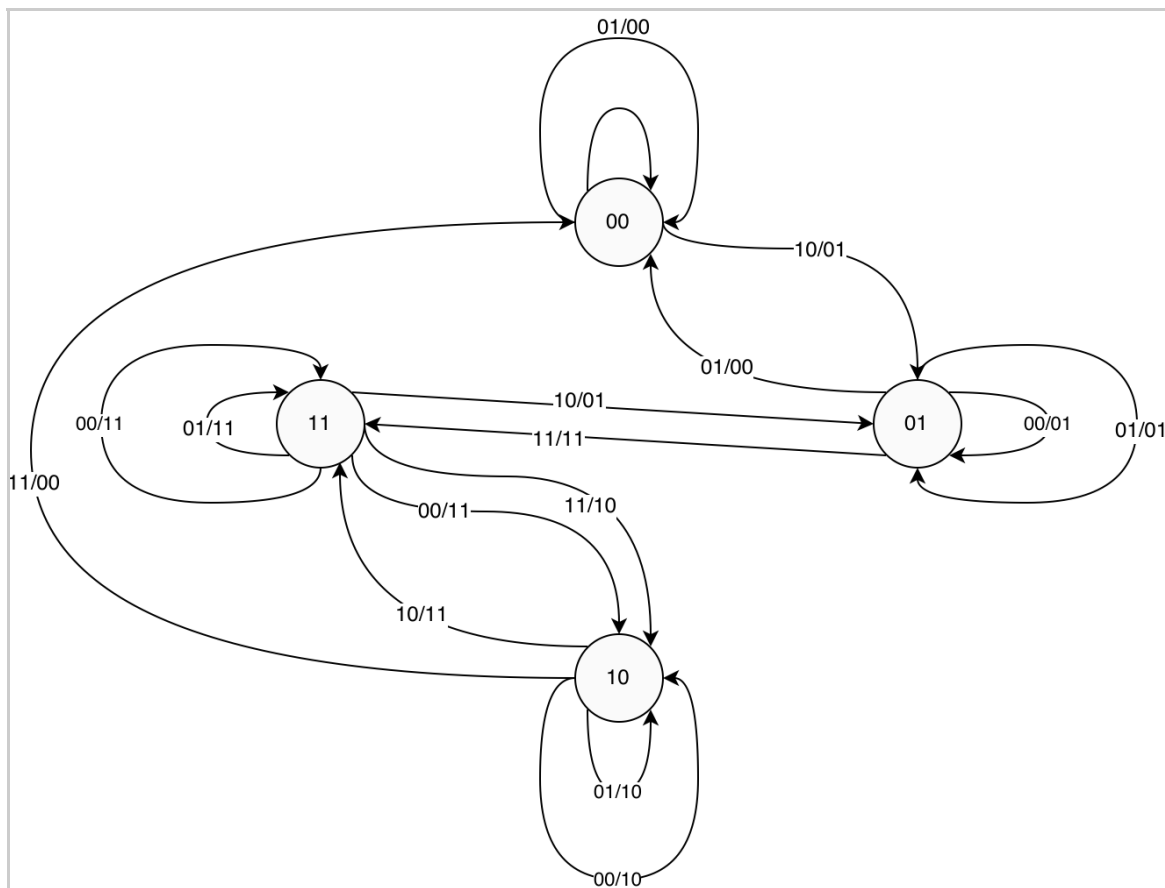
Solutions:

Two inputs: E, x

Two outputs: A, B

We only need two bits to represent the numbers so only two JK Flip-Flops will be used.

The following is a state diagram:



From this, We get our State Iable:

Initial State		Input		Next State/Outputs		JK Flip Flops			
A	B	E	X	A+	B+	JA	KA	JB	KB
0	0	0	0	0	0	0	x	0	x
0	0	0	1	0	0	0	x	0	x
0	0	1	0	0	1	0	x	1	x
0	0	1	1	1	0	1	x	0	x
0	1	0	0	0	1	0	x	x	0
0	1	0	1	0	1	0	x	x	0
0	1	1	1	1	1	1	x	x	0
0	1	1	0	0	0	0	x	x	1
1	0	0	1	1	0	x	0	0	x
1	0	0	0	1	0	x	0	0	x
1	0	1	1	0	0	x	1	0	x
1	0	1	0	1	1	x	0	1	x
1	1	0	1	1	1	x	0	x	0
1	1	0	0	1	1	x	0	x	0
1	1	1	1	1	0	x	0	x	1
1	1	1	0	0	1	x	1	x	0

Obtain the expressions:

J_A:

AB \ EX				
	00	01	11	10
00	0	0	1	0
01	0	0	0	1
11	X	X	X	X
10	X	X	X	X

$$J_A = \bar{B}EX + B\bar{E}\bar{X}$$

K_A:

AB \ EX				
	00	01	11	10
00	X	X	X	X
01	X	X	X	X
11	0	0	1	0
10	0	0	0	1

$$K_A = BEX + \bar{B}\bar{E}\bar{X}$$

J_B:

AB \ EX				
	00	01	11	10
00	0	0	0	1
01	X	X	X	X
11	X	X	X	X
10	0	0	1	0

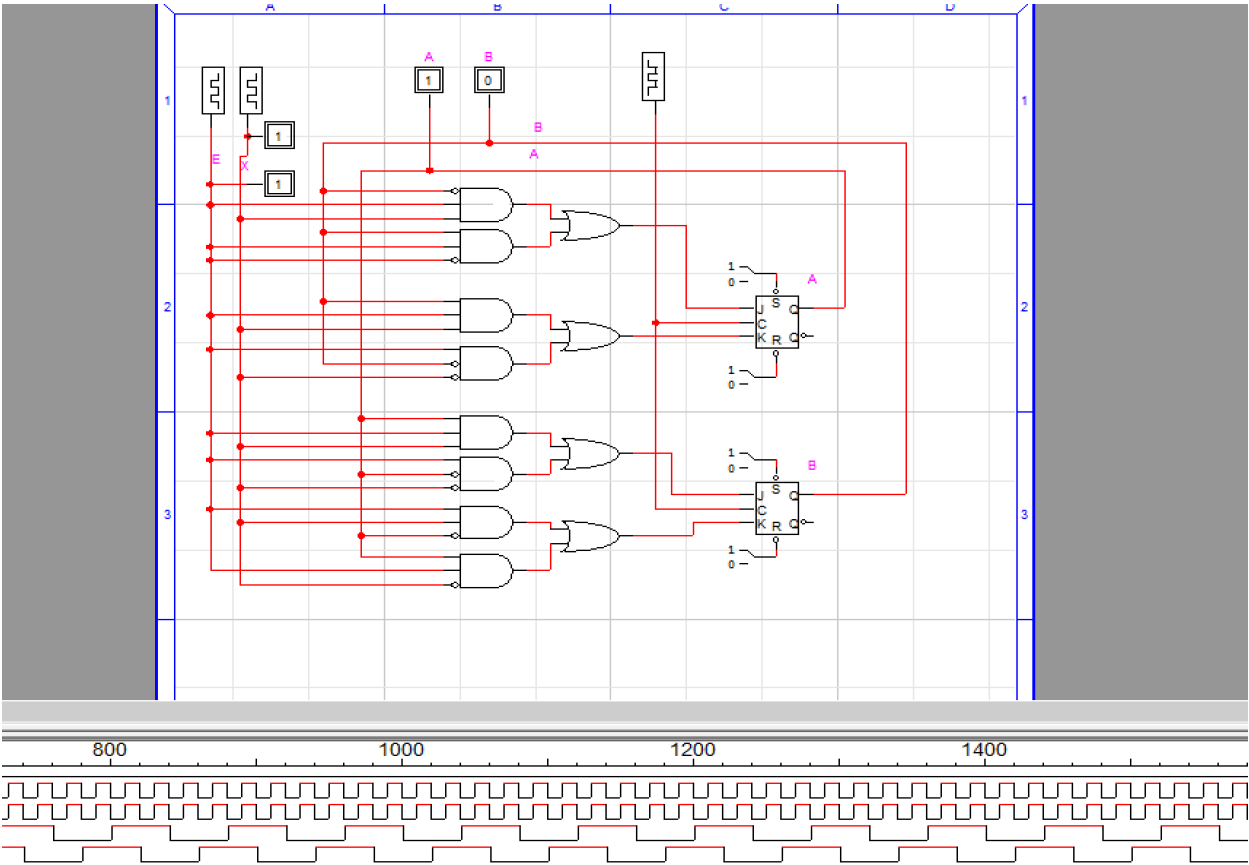
$$J_B = AEX + \bar{A}\bar{E}\bar{X}$$

K_B:

AB \ EX				
	00	01	11	10
00	X	X	X	X
01	0	0	1	0
11	0	0	0	1
10	X	X	X	X

$$K_B = \bar{A}\bar{E}X + A\bar{E}\bar{X}$$

And finally, the circuit:



Question 3: Design a sequential circuit to control a gumball machine. Gumballs are 15 cents each. The machine accepts nickels (N) or dimes (D). The machine should be able to indicate when a gumball should be dispensed (G) and whether or not change is given at that time (C). Follow the sequential design procedures set out in the course. Implement and test this circuit using LogicWorks. Specifically, show what happens when a user inserts 2 dimes, and what happens when a user inserts 3 nickels.

Solution:

One Input I.

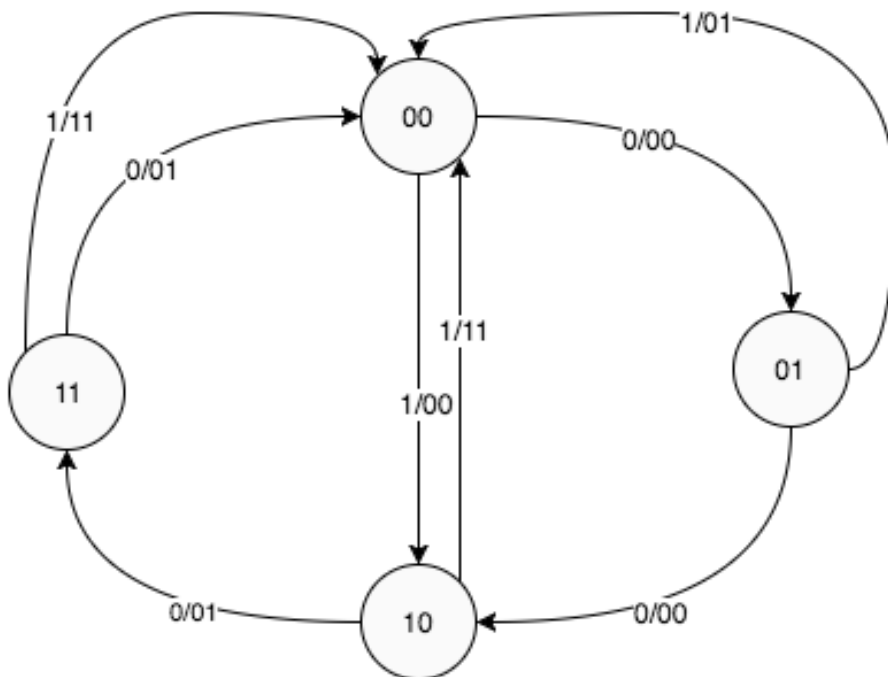
I is 0 if nickel is inserted and 1 if dime is inserted.

D = dime

N = nickel

Two Outputs Gumball(G) and Change (C).

The following is the state diagram:



The following is the state table:

Input		Current State		NextState		Outputs		JK Flip-Flops			
I		D	N	D'	N'	C	G	J _D	K _D	J _N	K _N
0	0	0	0	0	1	0	0	0	x	1	x
0	0	1	1	1	0	0	0	1	x	x	1
0	1	0	1	1	1	0	1	x	0	1	x
0	1	1	1	0	0	0	1	x	1	x	1
1	0	0	1	1	0	0	0	1	x	0	x
1	0	1	1	0	0	0	1	0	x	x	1
1	1	0	0	0	0	1	1	x	1	0	x
1	1	1	1	0	0	1	1	x	1	x	1

J_D:

I \ DN

	00	01	11	10
0	0	1	x	x
1	1	0	x	x

$$J_D = I\bar{N} + \bar{I}N$$

$$J_D = I \oplus N$$

K_D:

I \ DN

	00	01	11	10
0	x	x	1	0
1	x	x	1	1

$$K_D = I + N$$

J_N:

I \ DN

	00	01	11	10
0	1	x	x	1
1	0	x	x	0

$$J_N = \bar{I}$$

K_N:

I \ DN

	00	01	11	10
0	x	1	1	x
1	x	1	1	x

$$K_N = N$$

And finally, the circuit design:

