Homework 3

CSE 232

May 2021

Draw a state diagram for an FSM with an input a and three outputs, x, y and z. The xyz outputs generate a sequence in order 000, 011, 111, 010,001,101, 100, repeat. The output should change only on a rising clock edge when the input a = 1. Make the initial state 000.
Design your solution in five steps

Step 1: Create FSM
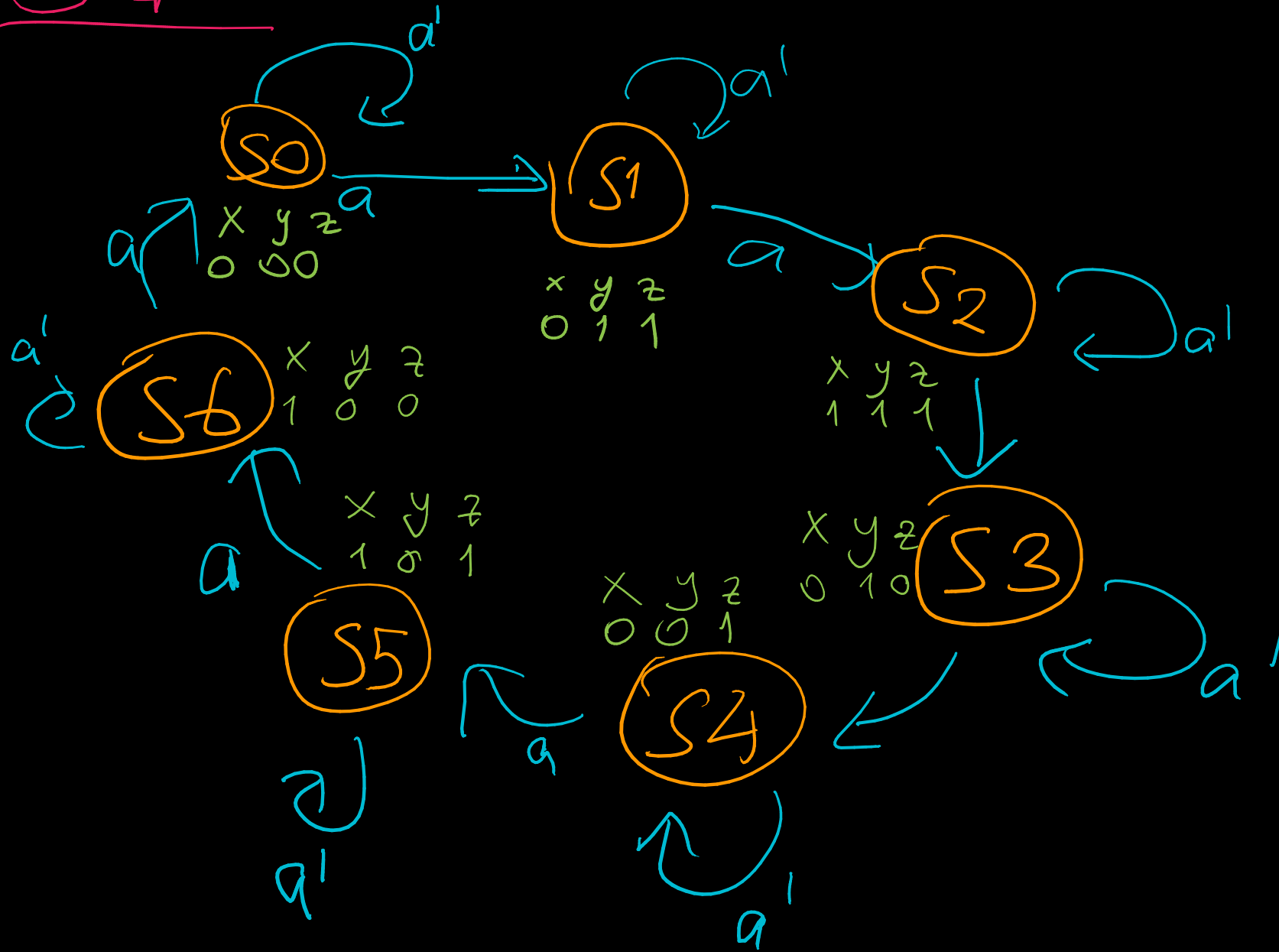Step 2: Obtain architecture
Step 3: Encode states
Step 4: Generate state table
Step 5: Obtain Boolean expressions and draw controller

(Hint, at Step 5, you may use K-maps for simplifications)

Step 1

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S0 —a'→ (self loop)
S0 —a→ S1
x y z
0 0 0

S1 —a'→ (self loop)
x y z
0 1 1

S1 —a→ S2
S2 —a'→ (self loop)
x y z
1 1 1

S2 —a→ S3
S3 —a'→ (self loop)
x y z
0 1 0

S6 —a'→ (self loop)
x y z
1 0 0

S5 —a→ S6
x y z
1 0 1

S4 —a'→ (self loop)
x y z
0 0 1

S5 —a'→ (self loop)

S4 —a→ S5

S0 = 0 0 0
S1 = 0 0 1
S2 = 0 1 0
S3 = 0 1 1
S4 = 1 0 0
S5 = 1 0 1
S6 = 1 1 0

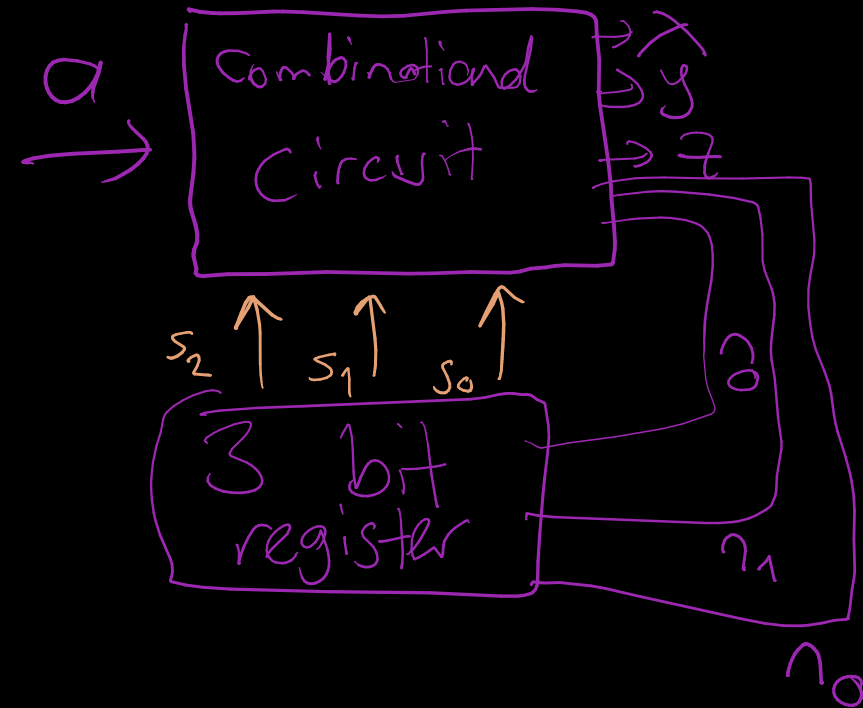Total 7 states $(7 < 2^3)$

So 3 bits
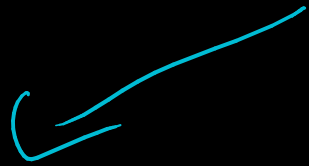
for next state

(n_2, n_1, n_0)

for output

(x, y, z)

a is input

Step 3

Encode States

	S_2	S_1	S_0
Wait:	0	0	0
S_1:	0	0	1
S_2:	0	1	0
S_3:	0	1	1
S_4:	1	0	0
S_5:	1	0	1
S_6:	1	1	0

Create State table

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		INPUT					OUTPUT					
3		INDEX	S2	S1	S0	a	X	Y	Z	N2	N1	N0
4		Index 0	0	0	0	0	0	0	0	0	0	0
5	.000	Index 1	0	0	0	1	0	0	0	0	0	1
6		Index 2	0	0	1	0	0	1	1	0	0	1
7	.011	Index 3	0	0	1	1	0	1	1	0	1	0
8		Index 4	0	1	0	0	1	1	1	0	1	0
9	111	Index 5	0	1	0	1	1	1	1	0	1	1
10		Index 6	0	1	1	0	0	1	0	0	1	1
11	.010	Index 7	0	1	1	1	0	1	0	1	0	0
12		Index 8	1	0	0	0	0	0	1	1	0	0
13	.001	Index 9	1	0	0	1	0	0	1	1	0	0
14		Index 10	1	0	1	0	1	0	1	1	0	1
15	101	Index 11	1	0	1	1	1	0	1	1	1	0
16		Index 12	1	1	0	0	1	0	0	1	0	0
17	100	Index 13	1	1	0	1	1	0	0	0	0	0
18		Index 14	1	1	1	0	O	O	O	O	O	O
19	X	Index 15	1	1	1	1	O	O	O	O	O	O
20		For x,y,z just look itself										
21		Not input										

Obtain Boolean Expression

N2

S2,S1 \ S0,A	.00	10	11	10
0 0	0	0	0	0
0 1	0	0	1	0
1 1	1	0	0	0
1 0	1	1	1	1

$$n_2 = S_2 S_1' + S_2 S_0' a' + S_2' S_1 S_0 a$$

N1

S2,S1 \ S0,A	.00	10	11	10
0 0	0	0	1	0
0 1	1	1	0	1
1 1	1	0	0	0
1 0	0	0	1	0

$$n_1 = S_1' S_0 a + S_2' S_1 S_0' + S_2' S_1 a' + S_1 S_0' a'$$

N0

S2,S1 \ S0,A	.00	10	11	10
0 0	0	1	0	1
0 1	0	1	0	1
1 1	0	0	0	0
1 0	0	1	0	1

$$n_0 = S_2' S_0' a + S_1' S_0' a + S_2' S_0' a' + S_1' S_0 a'$$

X

S2,S1 \ S0,A	.00	10	11	10
0 0	0	0	0	0
0 1	1	1	0	0
1 1	1	1	0	0
1 0	0	0	1	1

$$X = S_1 S_0' + S_2 S_1' S_0$$

Y

S2,S1 \ S0,A	.00	10	11	10
0 0	0	0	1	1
0 1	1	1	1	1
1 1	0	0	0	0
1 0	0	0	0	0

$$y = S_2' S_1 + S_2' S_0$$

Z

S2,S1 \ S0,A	.00	10	11	10
0 0	0	0	1	1
0 1	1	1	0	0
1 1	0	0	0	0
1 0	1	1	1	1

$$z = S_2 S_1' + S_1' S_0 + S_2' S_1 S_0'$$