Assignment 2: Finite state machines
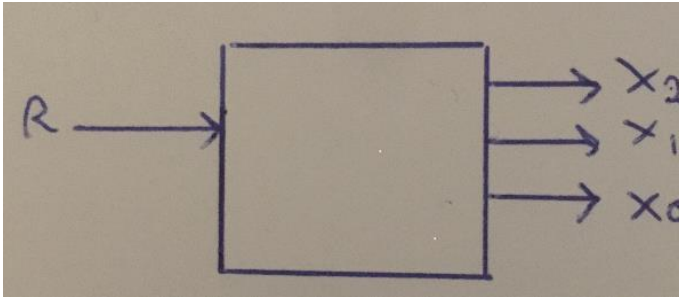
CSCI2121

Alex Manuele
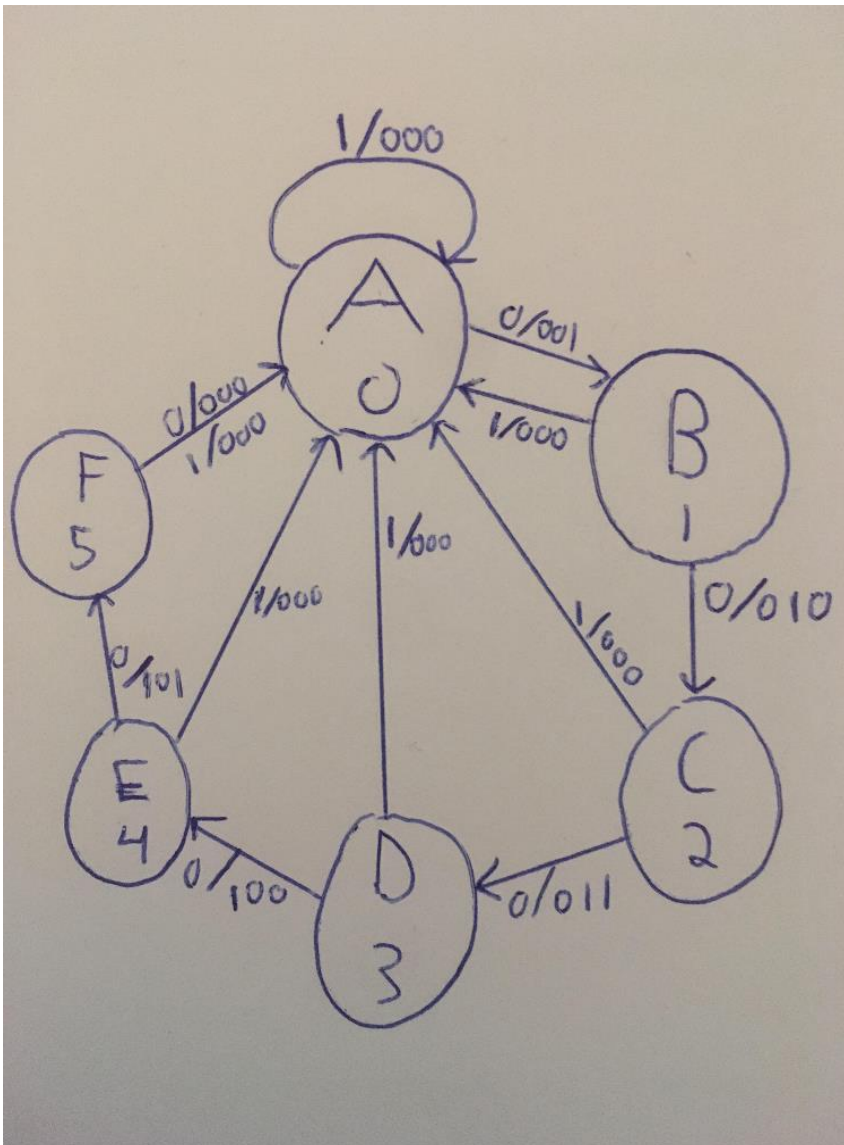
Dalhousie University

February 27, 2018

q1. Specification:

State Transition diagram:

State Table:

Current State	Reset	
	0	1
A	B/001	A/000
B	C/010	A/000
C	D/011	A/000
D	E/100	A/000
E	F/101	A/000
F	A/000	A/000

State Table with assignments:
Let A = 000, B = 001, … , F = 101

	Reset					
	0			1		
$S_2(t)S_1(t)S_0(t)$	$S_2(t)S_1(t)S_0(t)$			$S_2(t)S_1(t)S_0(t)$		
0 0 0	0	0	1	0	0	0
0 0 1	0	1	0	0	0	0
0 1 0	0	1	1	0	0	0
0 1 1	1	0	0	0	0	0
1 0 0	1	0	1	0	0	0
1 0 1	0	0	0	0	0	0

Truth Table:

R	$S_2(t)$	$S_1(t)$	$S_0(t)$	X_2	X_1	X_0	$S_2(t+1)$	$S_1(t+1)$	$S_0(t+1)$
0	0	0	0	0	0	1	0	0	1
0	0	0	1	0	1	0	0	1	0
0	0	1	0	0	1	1	0	1	1
0	0	1	1	1	0	0	1	0	0
0	1	0	0	1	0	1	1	0	1
0	1	0	1	0	0	0	0	0	0
0	1	1	0	φ	φ	φ	φ	φ	φ
0	1	1	1	φ	φ	φ	φ	φ	φ
1	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0
1	1	1	0	φ	φ	φ	φ	φ	φ
1	1	1	1	φ	φ	φ	φ	φ	φ

Minimized functions:

$X_2 = S_2(t+1) = 0120 + 0211$

$RS_2 \backslash S_1S_0$	00	01	11	10
00			1	
01	1		Dc	dc
11			dc	Dc
10				

$X_1 = S_1(t+1) = 0001 + 0210$

$RS_2 \backslash S_1S_0$	00	01	11	10
00		1		1
01			Dc	dc
11			Dc	Dc
10				

$X_0 = S_0(t+1) = 0020$

$RS_2 \backslash S_1S_0$	00	01	11	10
00	1			1
01			Dc	dc
11			dc	Dc
10				

$X_2 = S_2(t+1) = R'S_2(t)S_0(t)' + R'S_1(t)S_0(t)'$
$X_1 = S_1(t+1) = R'S_2(t)'S_1(t)'S_0(t) + R'S_1(t)S_0(t)'$
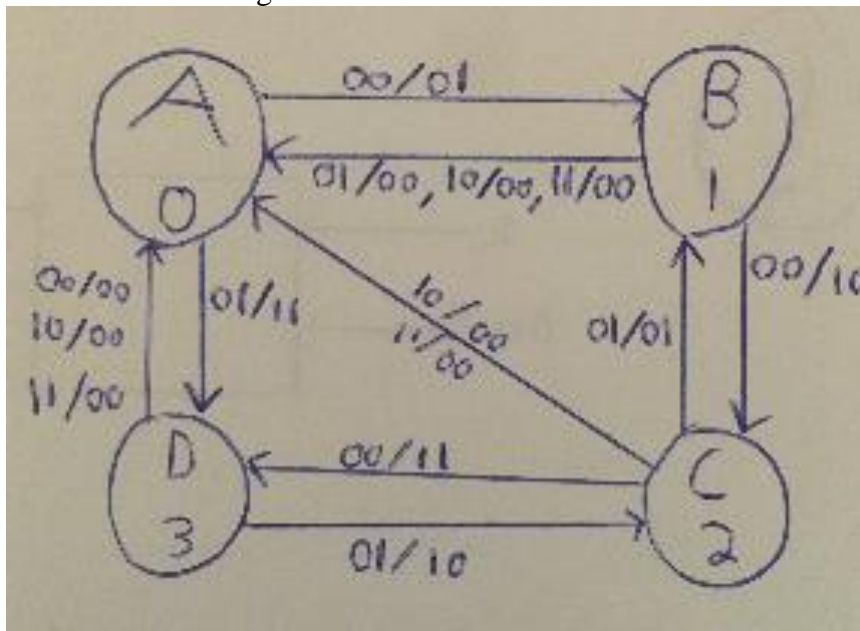**$X_0 = S_0(t+1) = R'S_2(t)'S_0(t)'$**

FSM Diagram:
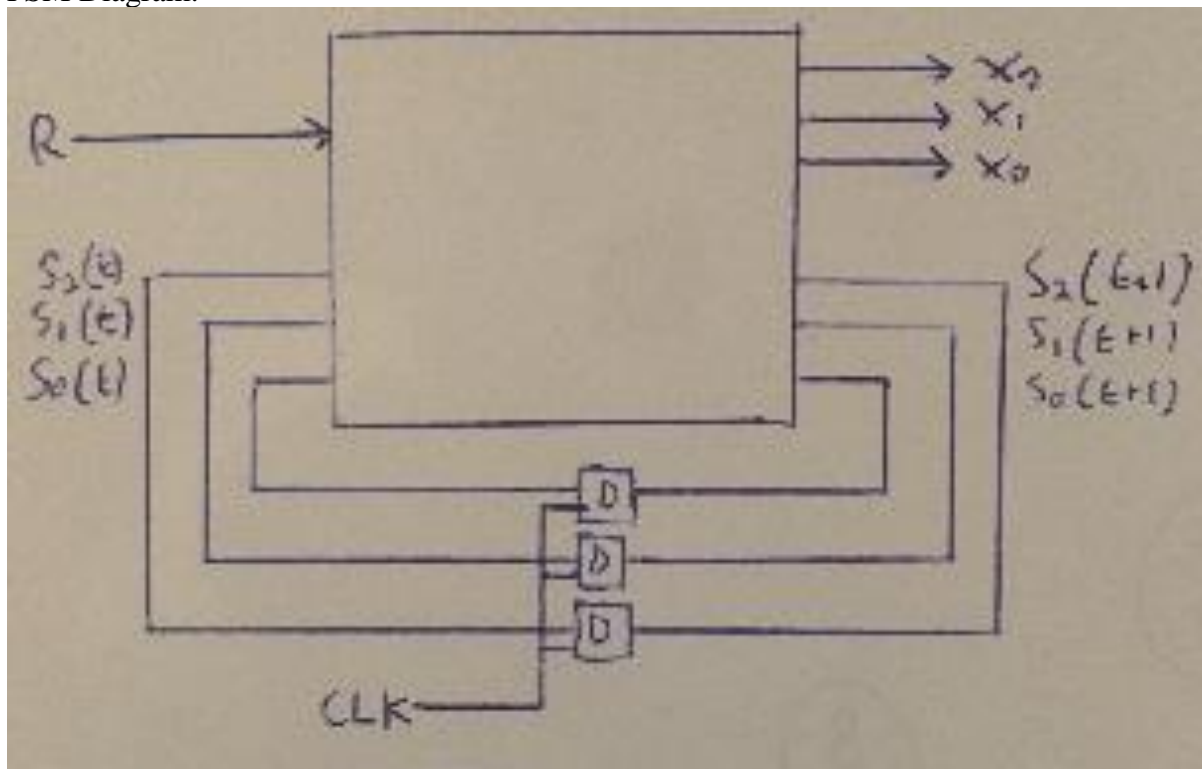
Q2.
Specification:

State Transition diagram:

State Table:

	Reset			
	0		1	
	Down		Down	
Current State	0	1	0	1
A	B/01	D/11	A/00	A/00
B	C/10	A/00	A/00	A/00
C	D/11	B/01	A/00	A/00
D	A/00	C/11	A/00	A/00

State Table with assignments:
Let A = 00, B = 01, C = 10, D = 11
Let the input R, Down be represented by the 2 bit string XX

$S_1(t)S_0(t)$	Input			
	00	01	10	11
A	B/01	D/11	A/00	A/00
B	C/10	A/00	A/00	A/00
C	D/11	B/01	A/00	A/00
D	A/00	C/11	A/00	A/00

Truth Table:

R	Down	$S_1(t)$	$S_0(t)$	X_1	X_0	$S_1(t+1)$	$S_0(t+1)$
0	0	0	0	0	1	0	1
0	0	0	1	1	0	1	0
0	0	1	0	1	1	1	1
0	0	1	1	0	0	0	0
0	1	0	0	1	1	1	1
0	1	0	1	0	0	0	0
0	1	1	0	0	1	0	1
0	1	1	1	1	1	1	1
1	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0
1	0	1	0	0	0	0	0
1	0	1	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	0	0
1	1	1	0	0	0	0	0
1	1	1	1	0	0	0	0

Minimized Functions (let D = Down):

$X_1 =$ 0100 + 0001 + 0111 + 0010

RD\S$_1$S$_0$	00	01	11	10
00		1		1
01	1		1	
11				
10				

$X_2 =$ 0220 + 0112

RS$_2$\S$_1$S$_0$	00	01	11	10
00	1			1
01	1		1	1
11				
10				

$X_1 = S_1(t) = R'(DS_1(t)'S_2(t)' + D'S_1(t)'S_2(t) + DS_1(t)S_2(t) + D'S_1(t)S_2(t))$

$X_2 = S_2(t) = R'(S_2(t)' + DS_1(t))$
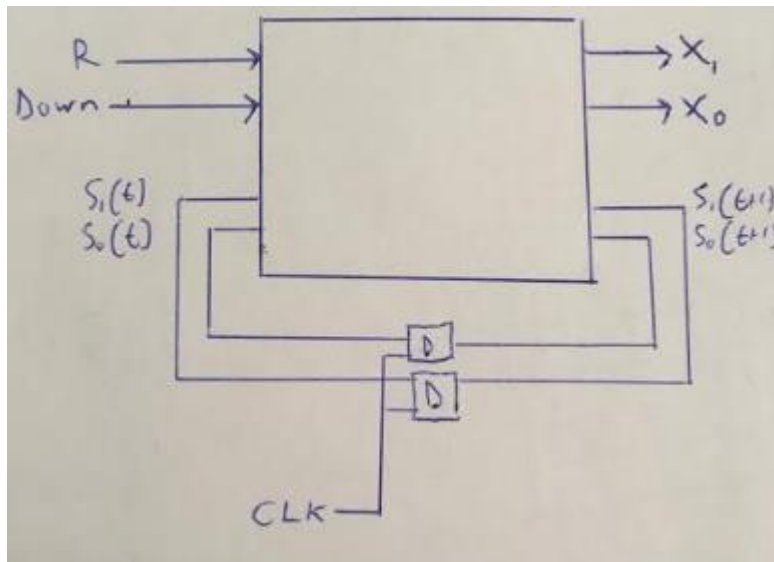
Q3. Specification :
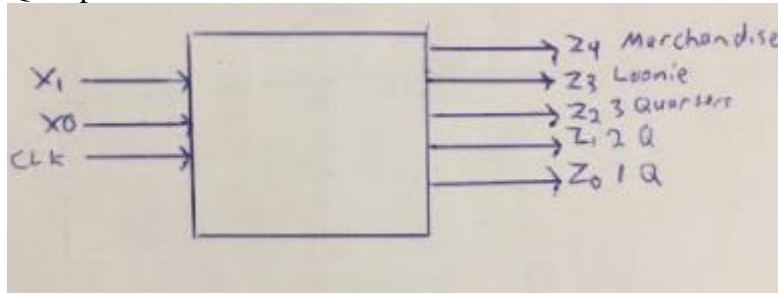
State Transition:
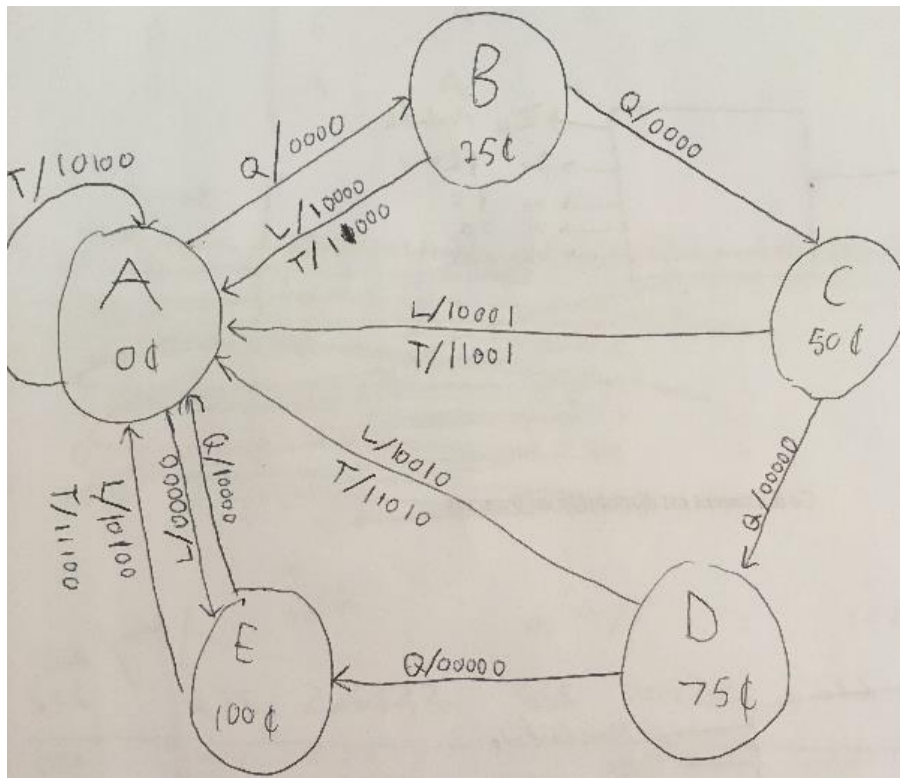
State Table:

Current State	Input		
	Q	L	T
A	B	D	A
B	C	A	A
C	D	A	A
D	E	A	A
E	A	A	A

State table with assignments:
Let input: One quarter = Q(00), one loonie = L(01), one Toonie = T(10)
    Output : Z4 = merchandise, Z3=loonie, Z2 = 3 Quarters, Z1 = 2 Quarters, Z0= 1 Quarter

$S_2(t)S_1(t)S_0(t)$	Input: Q(00) $S_2(t)S_1(t)S_0(t)$	$Z_4Z_3Z_2Z_1Z_0$	L(01) $S_2S_1S_0$	$Z_4Z_3Z_2Z_1Z_0$	T(10) $S_2S_1S_0$	$Z_4Z_3Z_2Z_1Z_0$
0 0 0	0 0 1	0 0 0 0 0	0 1 1	0 0 0 0 0	0 0 0	1 0 1 0 0
0 0 1	0 1 0	0 0 0 0 0	0 0 0	1 0 0 0 0	0 0 0	1 1 0 0 0
0 1 0	0 1 1	0 0 0 0 0	0 0 0	1 0 0 0 1	0 0 0	1 1 0 0 1
0 1 1	1 0 0	0 0 0 0 0	0 0 0	1 0 0 1 0	0 0 0	1 1 0 1 0
1 0 0	1 0 1	0 0 0 0 0	0 0 0	1 0 1 0 0	0 0 0	1 1 1 0 0

Truth Table: Let the binary string X_1X_0 Be the input value of the macine

X_1	X_0	$S_2(t)$	$S_1(t)$	$S_0(t)$	$Z_4Z_3Z_2Z_1Z_0$	$S_2(t+1)$	$S_1(t+1)$	$S_0(t+1)$
0	0	0	0	0	0 0 0 0 0	0	0	1
0	0	0	0	1	0 0 0 0 0	0	1	0
0	0	0	1	0	0 0 0 0 0	0	1	1
0	0	0	1	1	0 0 0 0 0	1	0	0
0	0	1	0	0	1 0 0 0 0	0	0	0
0	0	1	0	1	Φ	Φ	Φ	Φ
0	0	1	1	0	Φ	Φ	Φ	Φ
0	0	1	1	1	Φ	Φ	Φ	Φ
0	1	0	0	0	0 0 0 0 0	0	1	1
0	1	0	0	1	1 0 0 0 0	0	0	0
0	1	0	1	0	1 0 0 0 1	0	0	0
0	1	0	1	1	1 0 0 1 0	0	0	0
0	1	1	0	0	1 0 1 0 0	0	0	0
0	1	1	0	1	Φ	Φ	Φ	Φ
0	1	1	1	0	Φ	Φ	Φ	Φ
0	1	1	1	1	Φ	Φ	Φ	Φ
1	0	0	0	0	1 0 1 0 0	0	0	0
1	0	0	0	1	1 1 0 0 0	0	0	0
1	0	0	1	0	1 1 0 0 1	0	0	0
1	0	0	1	1	1 1 0 1 0	0	0	0
1	0	1	0	0	1 1 1 0 0	0	0	0
1	0	1	0	1	Φ	Φ	Φ	Φ
1	0	1	1	0	Φ	Φ	Φ	Φ

All values below are don't care
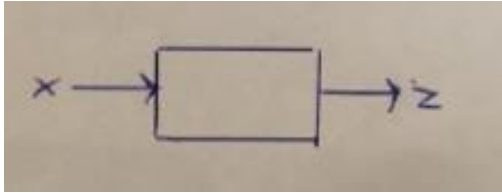
Minimization:
(*Professor Sampalli has excused the class from the 5 bit minimization*)

FSM Diagram:
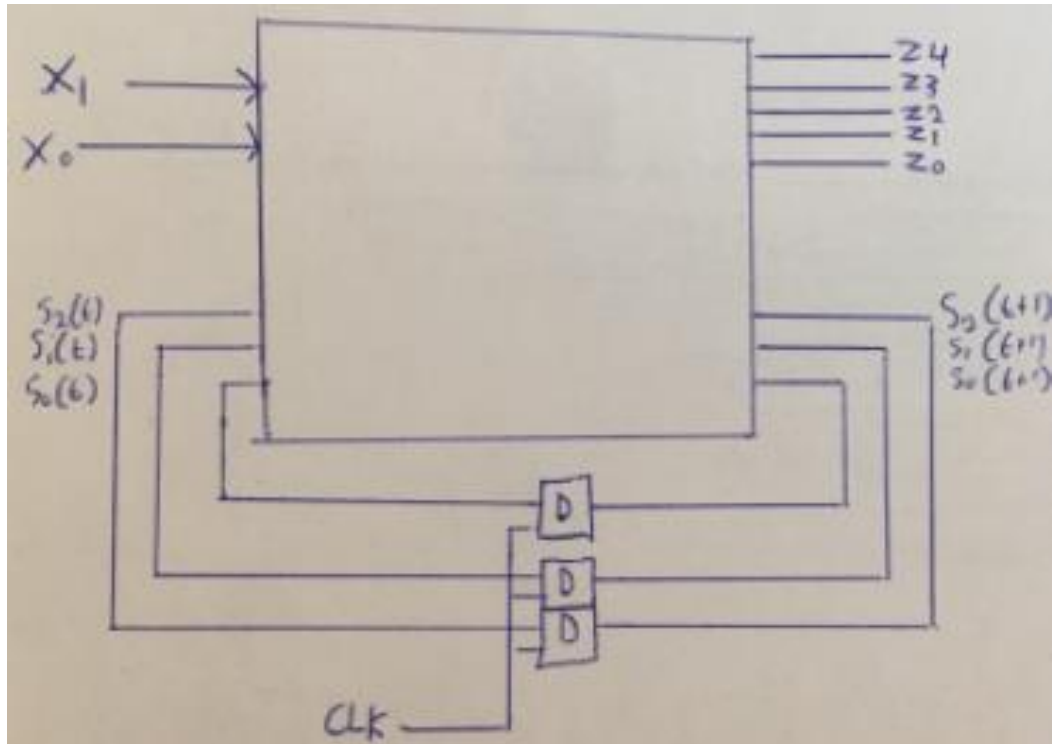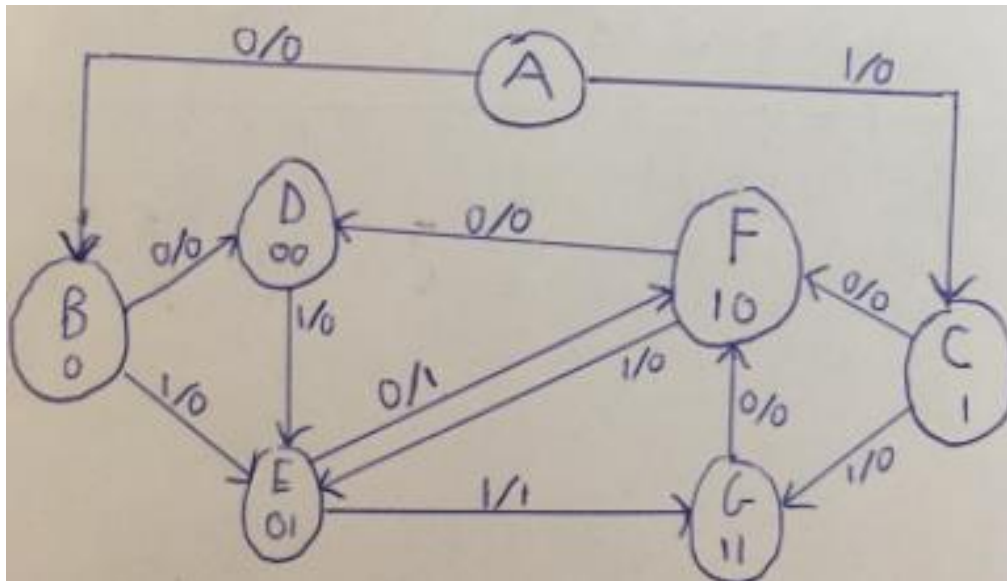
Q4.
Specification:

State Transition Diagram:

State Table:

Current State	Input	
	0	1
A	B/0	C/0
B	D/0	E/0
C	F/0	G/0
D	D/0	E/0
E	F/1	G/1
F	D/0	E/0
G	F/0	G/0

State Table with Assignments:
Let A = 000, B = 001, C = 010…. G = 110

			Input (X)							
			0				1			
$S_2(t)$	$S_1(t)$	$S_0(t)$	$S_2(t)$	$S_1(t)$	$S_0(t)$	Z	$S_2(t)$	$S_1(t)$	$S_0(t)$	Z
0	0	0	0	0	1	0	0	1	0	0
0	0	1	0	1	1	0	1	0	0	0
0	1	0	1	0	1	0	1	1	0	0
0	1	1	0	1	1	0	1	0	0	0
1	0	0	1	0	1	1	1	1	0	1
1	0	1	0	1	1	0	1	0	0	0
1	1	0	1	0	1	0	1	1	0	0

Truth Table:

X	$S_2(t)$	$S_1(t)$	$S_0(t)$	Z	$S_2(t+1)$	$S_1(t+1)$	$S_0(t+1)$
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	1
0	0	1	0	0	1	0	1
0	0	1	1	0	0	1	1
0	1	0	0	1	1	0	1
0	1	0	1	0	0	1	1
0	1	1	0	0	1	0	1
0	1	1	1	Φ	Φ	Φ	Φ
1	0	0	0	0	0	1	0
1	0	0	1	0	1	0	0
1	0	1	0	0	1	1	0
1	0	1	1	0	1	0	0
1	1	0	0	1	1	1	0
1	1	0	1	0	1	0	0
1	1	1	0	0	1	1	0
1	1	1	1	Φ	Φ	Φ	Φ

Minimizations:

Z = 0021

XS$_2$\S$_1$S$_0$	00	01	11	10
00				
01	1		Φ	
11	1		Φ	
10				

S$_2$(t+1) = 2210 + 1221 + 2120

XS$_2$\S$_1$S$_0$	00	01	11	10
00				1
01	1		Φ	1
11	1	1	Φ	1
10		1	1	1

S$_1$(t+1) = 0221 + 1220

XS$_2$\S$_1$S$_0$	00	01	11	10
00		1	1	1
01		1	Φ	
11	1		Φ	1
10	1			1

S$_0$(t+1) = 0222

XS$_2$\S$_1$S$_0$	00	01	11	10
00	1	1	1	1
01	1	1	Φ	1
11			Φ	
10				

Z = X'S$_2$(t)'S$_0$(t)
S$_2$(t+1) = S$_1$S$_0$' + XS$_0$ + S$_2$S$_0$'
S$_1$(t+1) = X'S$_0$ + XS$_0$'
S$_0$(t+1) = X'

FSM Diagram: