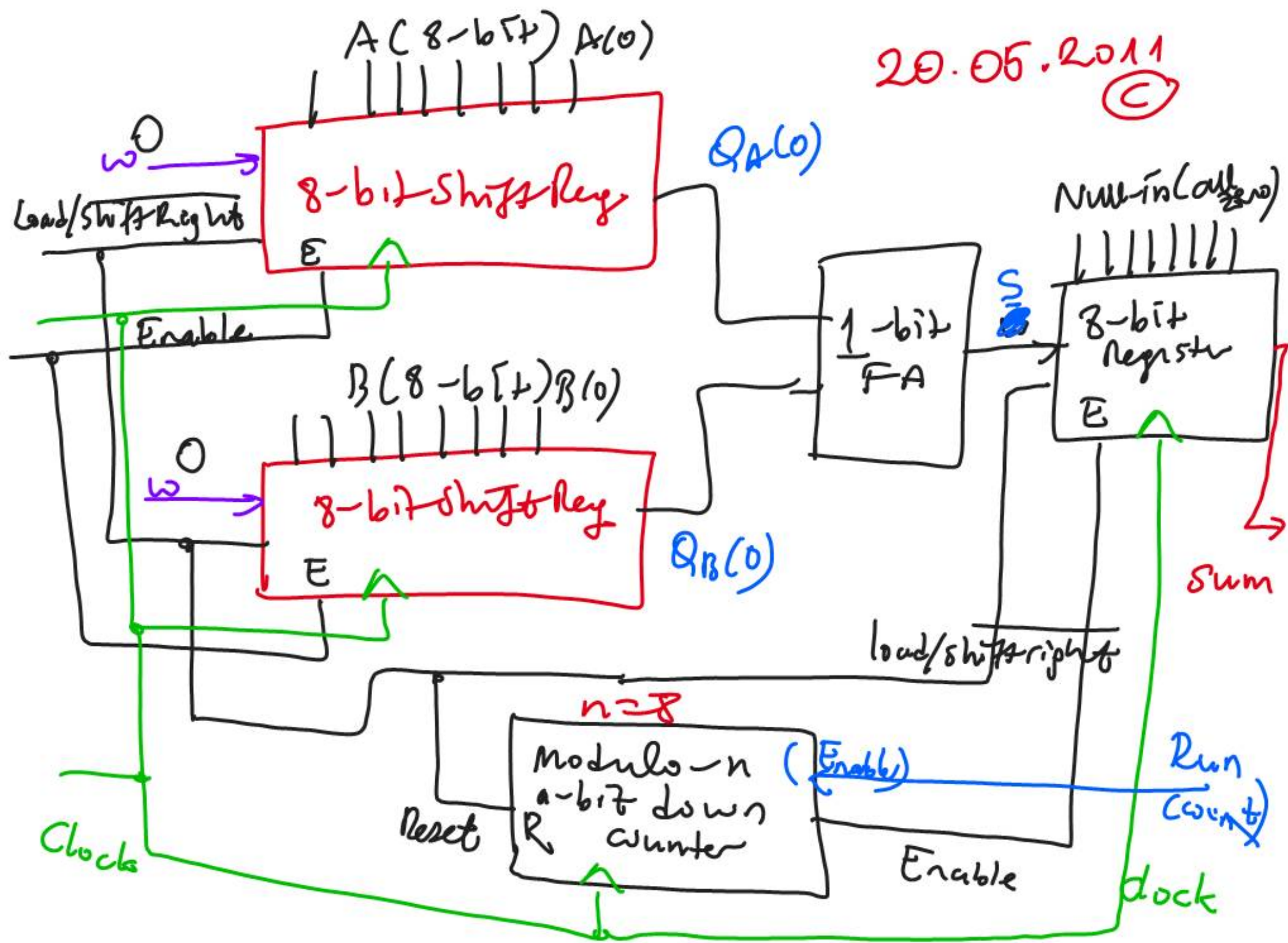


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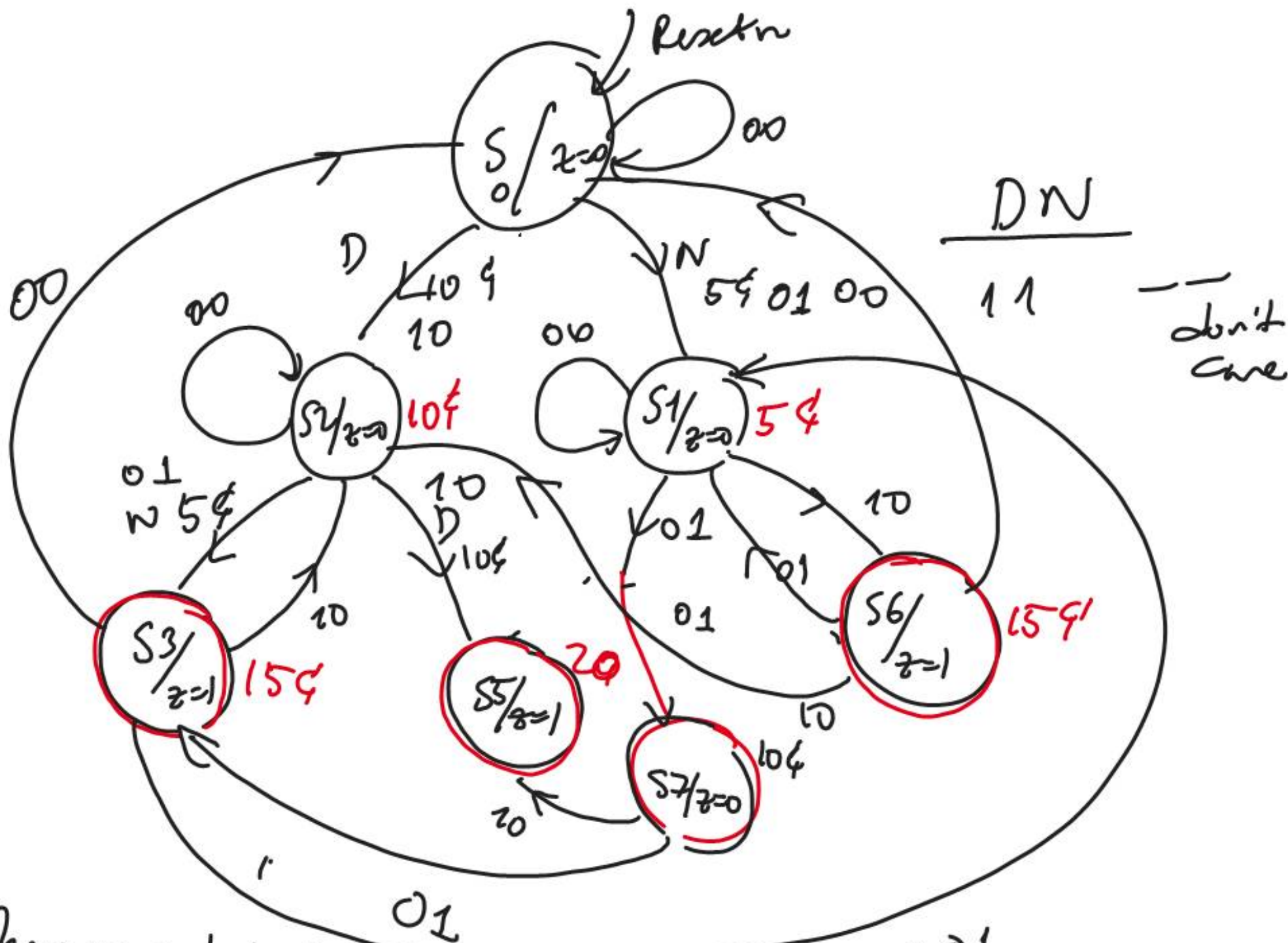
VENDING MACHINE example:

1 Dime = D = 10 cents

1 Nickel = N = 5 cents

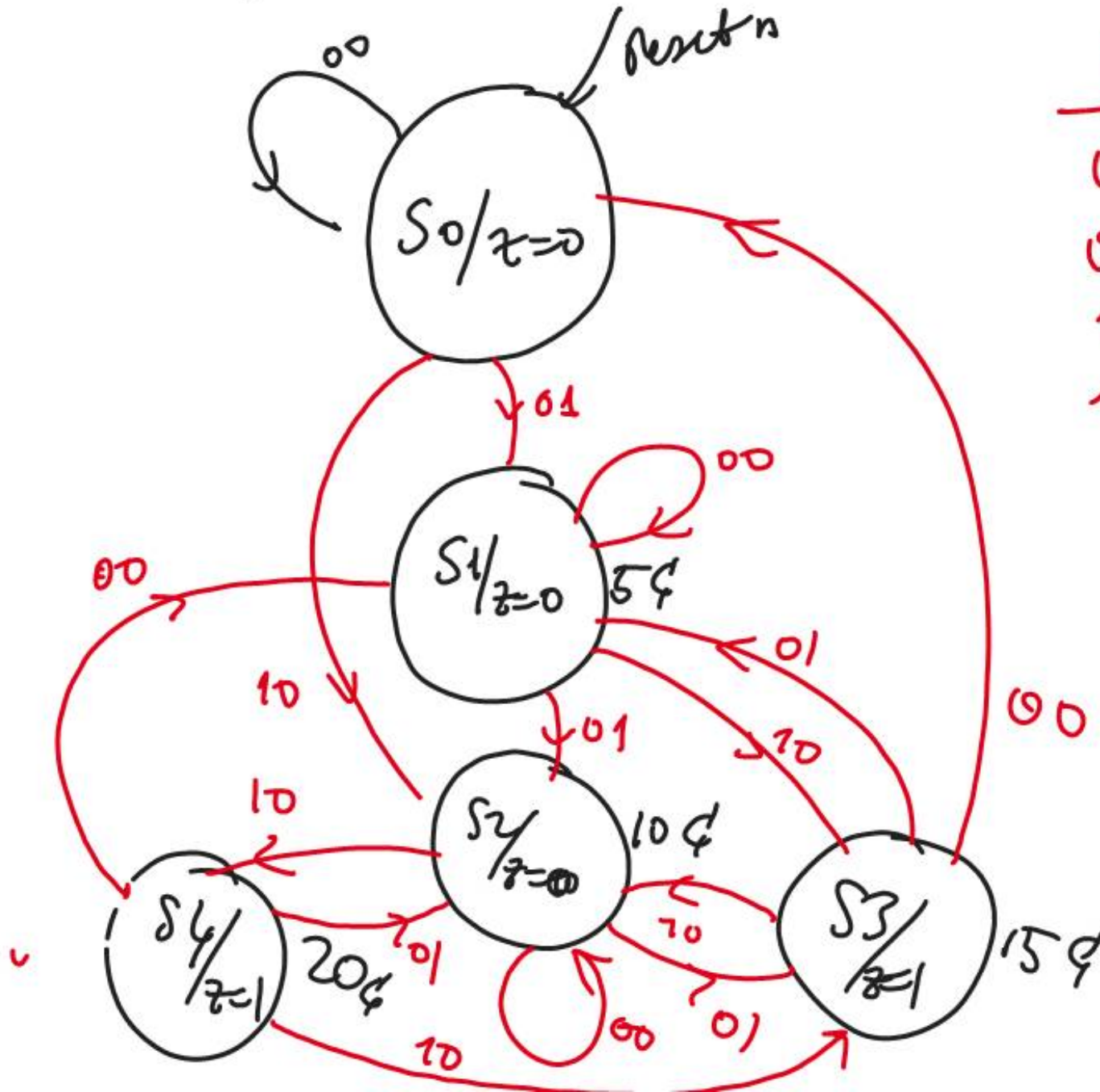
- When 15¢ is deposited the machine gives a CANDY.
- If 20¢ is deposited, the machine will not return the change, but it will credit the buyer with 5¢ and wait for the buyer to make a second purchase.
- Clock $T = 100ns$.

Design this machine as a Moore type machine.



There are a lot of repeated states, (not needed) 01

Design the same machine again:

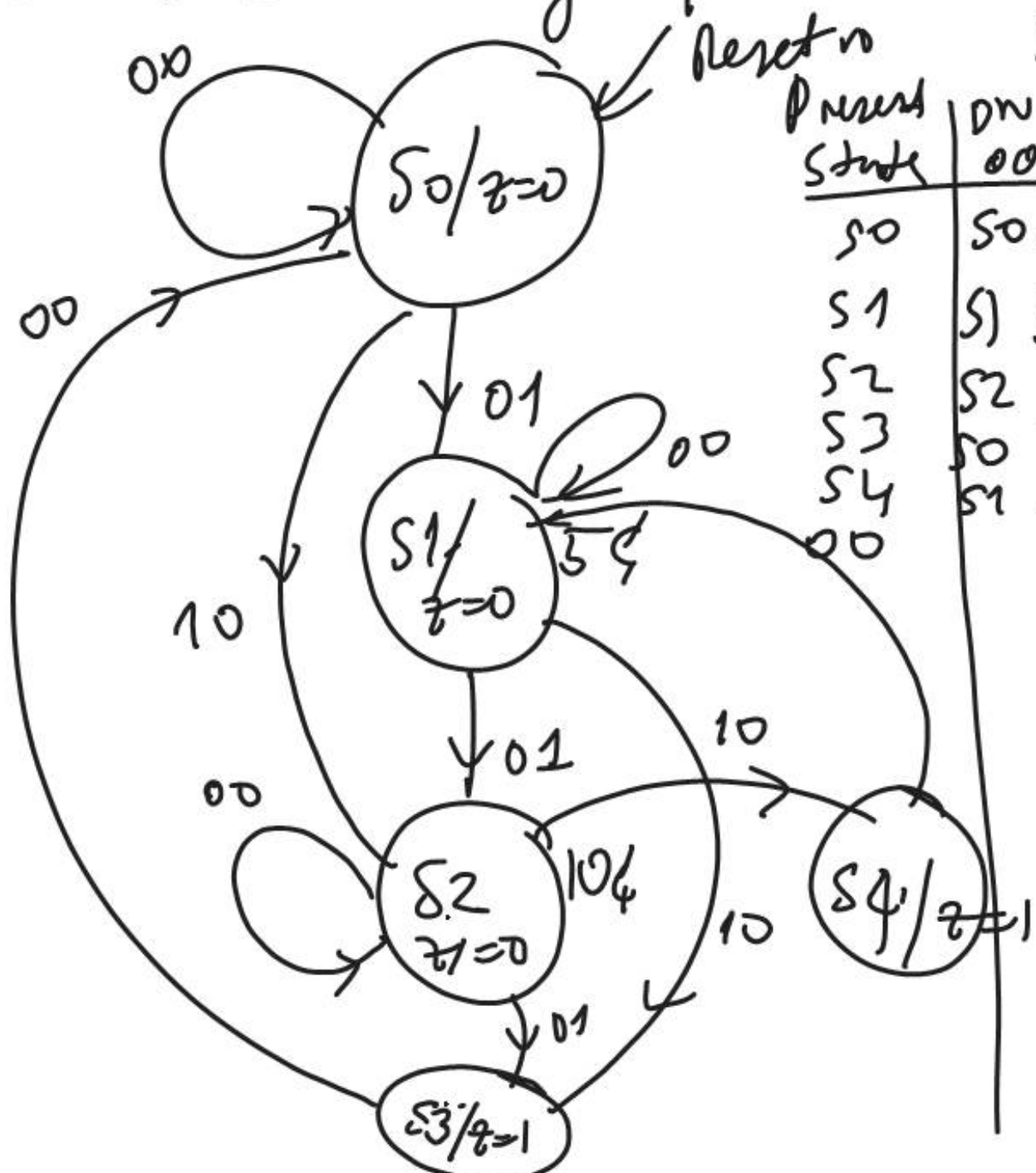


<u>DN</u>	
00	00
01	50
10	100
11	--

Present State	Next State				Output Z
	00	01	10	11	
S0	S0	S1	S2	--	0
S1	S1	S2	S3	--	0
S2	S2	S3	S4	--	0
S3	S0	S1	S2	--	1
S4	S1	S2	S3	--	1

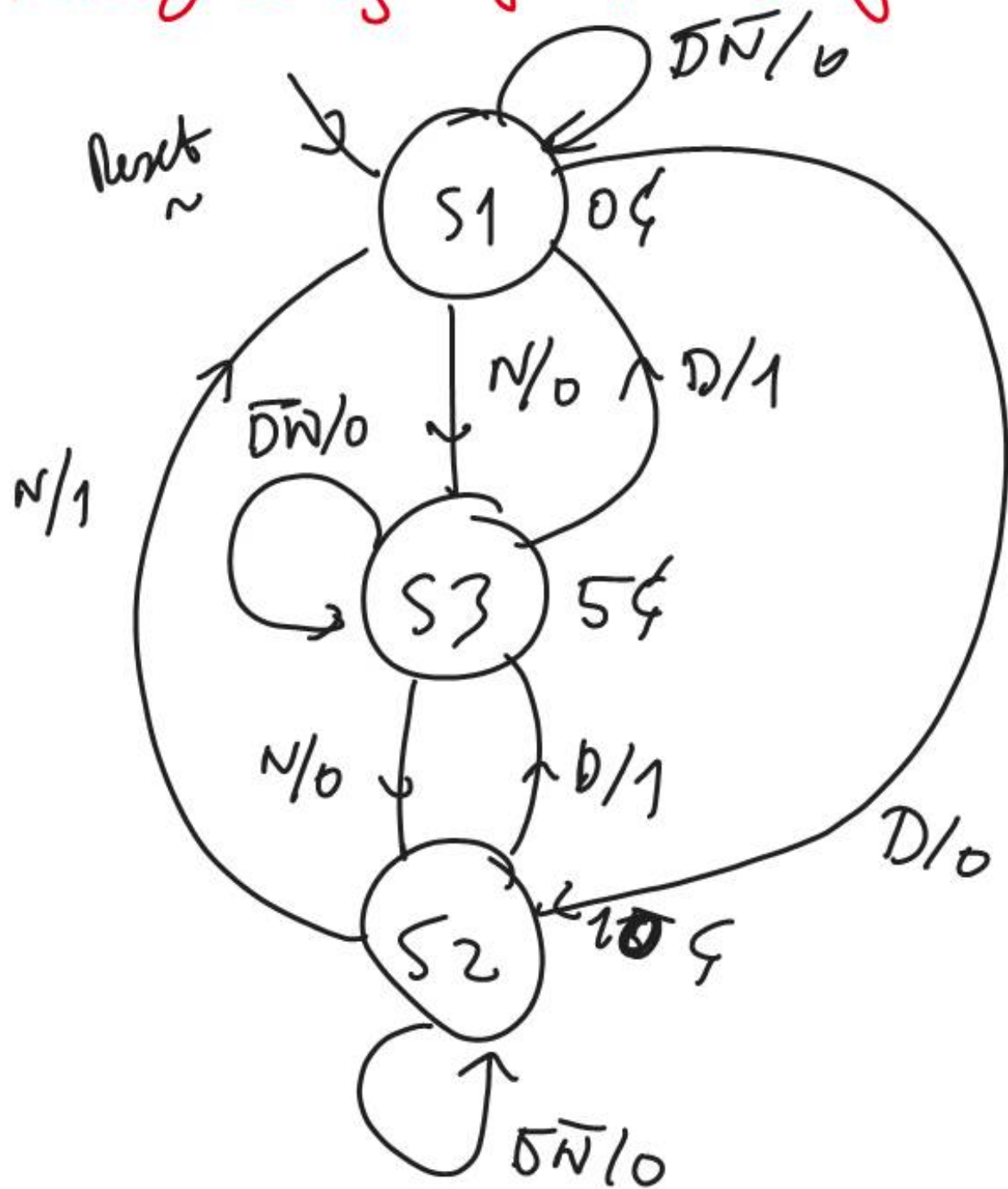
This is when clock signal is longer than the time it takes when the buyer deposits another coin.

But our clock is very quick $T=100\text{ ns}$.



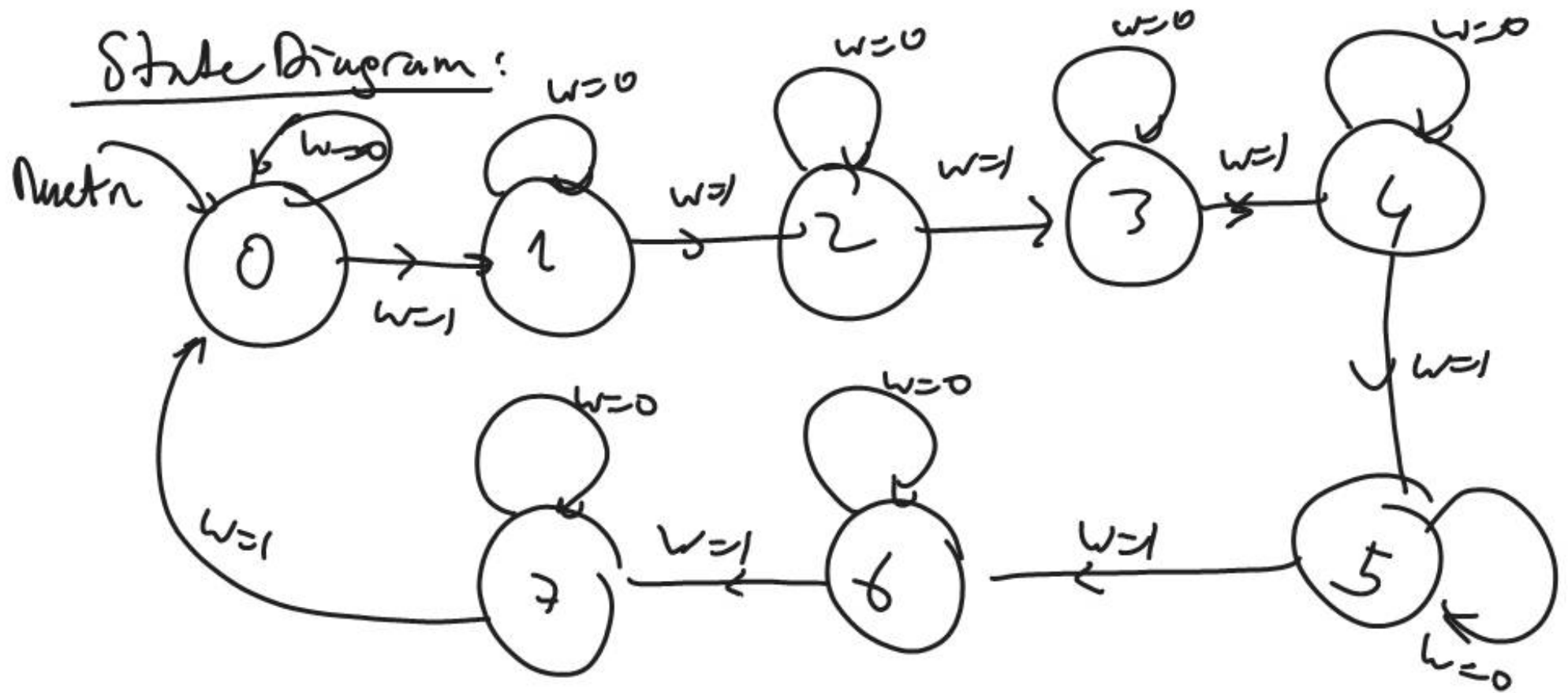
Present State	Next State				z output
	00	01	10	11	
S_0	S_0	S_1	S_2	--	0
S_1	S_1	S_2	S_3	--	0
S_2	S_2	S_3	S_4	--	0
S_3	S_0	--	--	--	1
S_4	S_1	--	--	--	1

Mealy Design of Vending Machine



COUNTER DESIGN:

Example: Designing a counter that counts the sequence 0, 1, 2, 3, 4, 5, 6, 7, 0, ... when $w=1$, and waits when $w=0$



STATE TABLE

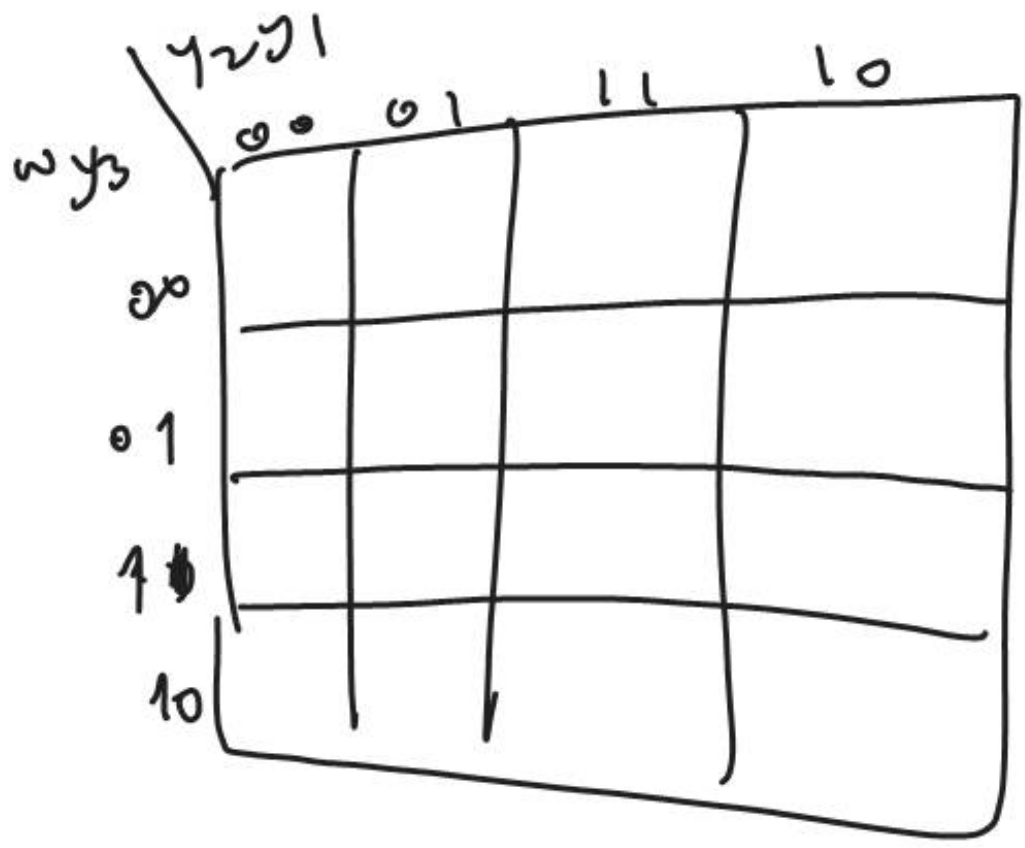
Present State	Next State		Output z
	$w=0$	$w=1$	
A	A	B	A
B	B	C	B
C	C	D	C
D	D	E	D
E	E	F	E
F	F	G	F
G	G	H	G
H	H	I	H

$0, \dots, 7$
 3 ffs.
 Combinations = 8
 $2^3 = 8$

State-Assigned Table

Present State	Next State		Output
	w=0	w=1	
y ₃ y ₂ y ₁	Y ₃ Y ₂ Y ₁	Y ₃ Y ₂ Y ₁	z ₃ z ₂ z ₁
000	000	001	000
001	001	010	001
010	010	011	010
011	011	100	011
100	100	101	100
101	101	110	101
110	110	111	110
111	111	000	111

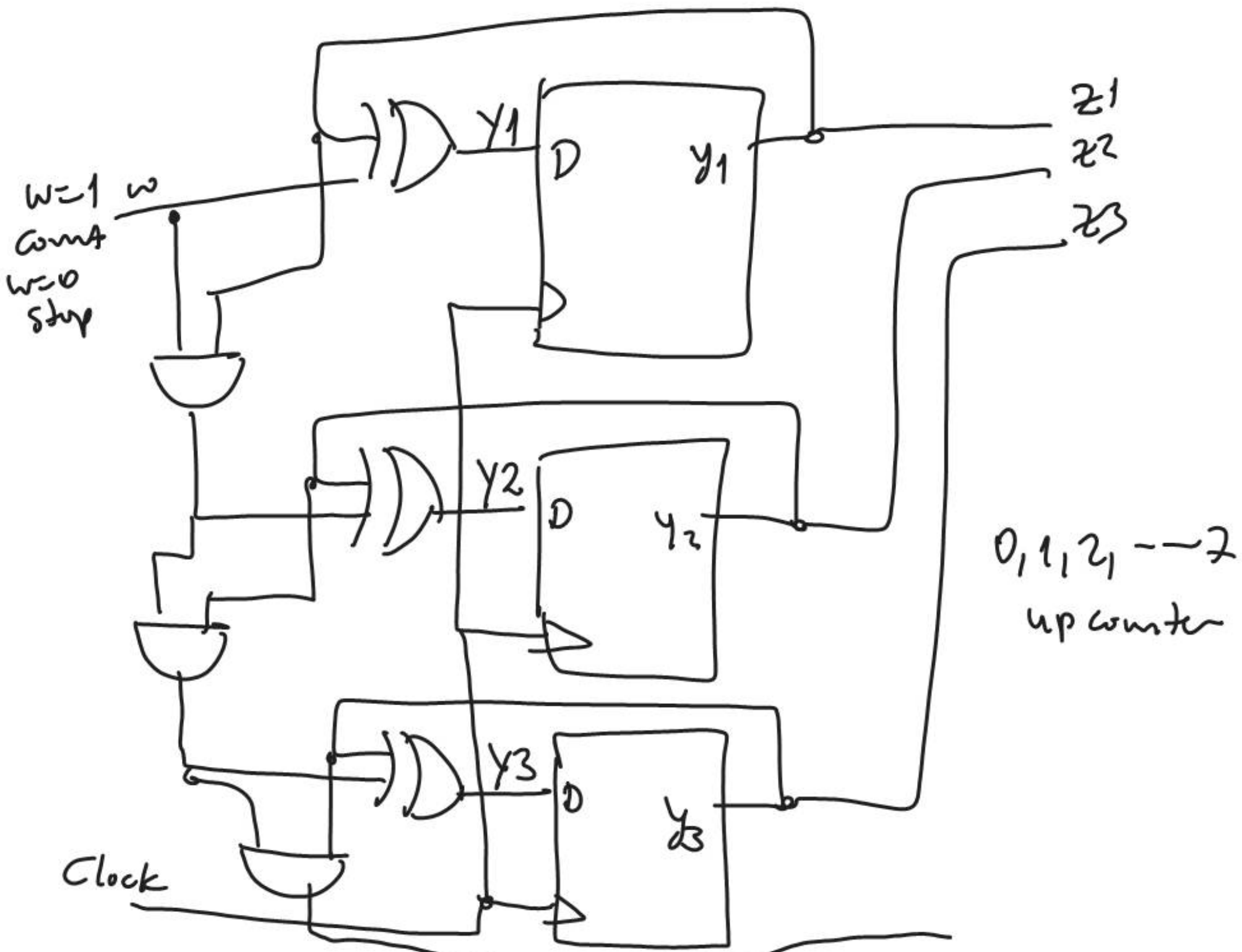
Reduction with Carnough map



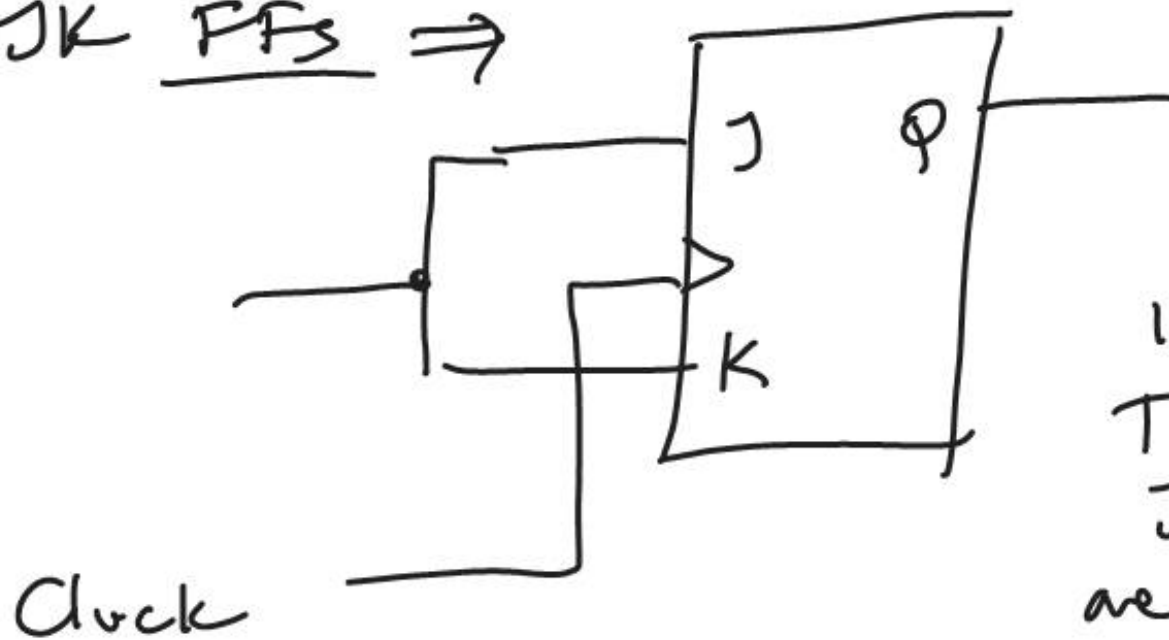
$$D1 = y_1 = w \oplus y_1$$

$$D2 = y_2 = w y_1 \oplus y_2$$

$$D3 = y_3 = w y_1 y_2 \oplus y_3$$



with JK FFs \Rightarrow



It becomes a
T FF when
J and K inputs
are unconnected.

Counter that counts any sequence

(Actually we do not need a w input, the counter changes state when clock signal comes.)

ex: Design a counter to count the sequence

0, 4, 2, 6, 1, 5, 3, 7, 0, 4, ... and so on

a) with D FF

b) with JK FF

⋮

Present State	Next State	Output $Z_2 Z_1 Z_0$
A	B	000
B	C	100
C	D	010
D	E	110
E	F	001
F	G	101
G	H	011
H	A	111

0
4
2
6
1
5
3
7

a) Designing with D FF:

Present State			Next State			output		
y_2	y_1	y_0	Y_2	Y_1	Y_0	z_2	z_1	z_0
0	0	0	1	0	0	0	0	0
1	0	0	0	1	0	1	0	0
0	1	0	1	1	0	0	1	0
1	1	0	0	0	1	1	1	0
0	0	1	1	0	1	0	0	1
1	0	1	0	1	1	1	0	1
0	1	1	1	0	1	0	1	1
1	1	1	0	1	0	1	1	1

$$Y_0 = D_0 = y_0 \oplus y_1 \oplus y_2$$

$$D_1 = Y_1 = y_1 \oplus y_2$$

$$D_2 = Y_2 = \overline{y_2}$$

$\rightarrow K$

0	\rightarrow	0	0X
0	\rightarrow	1	1X
1	\rightarrow	0	X1
1	\rightarrow	1	X0