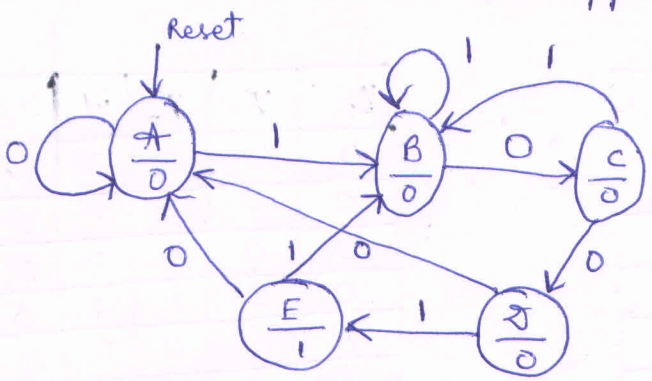
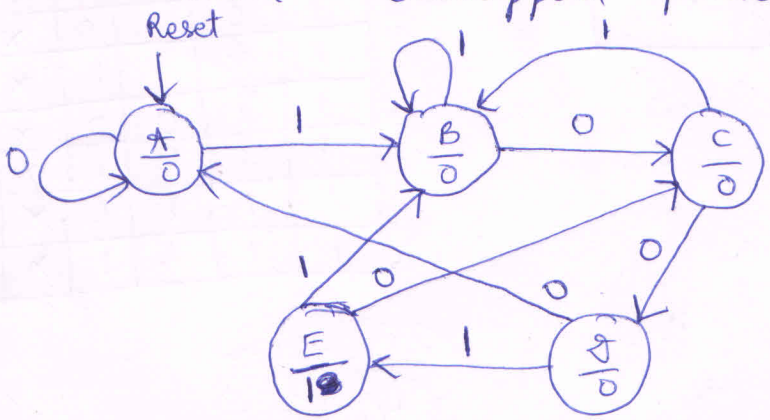
Tutorial - 5 Solutions

(1) (a) Moore machine - Non-overlapped pattern "1001"



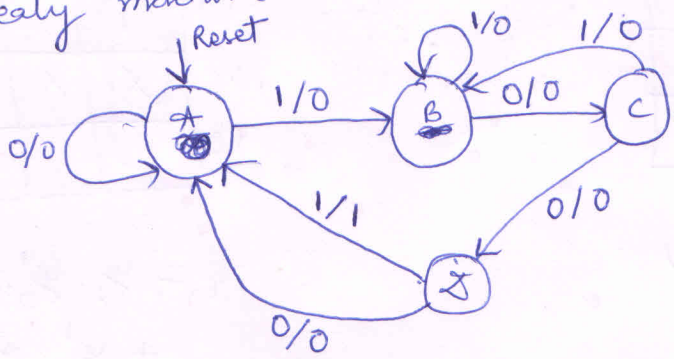
Reset → A
1 → B
10 → C
100 → D
1001 → E

(2) Moore machine - Overlapped pattern "1001"



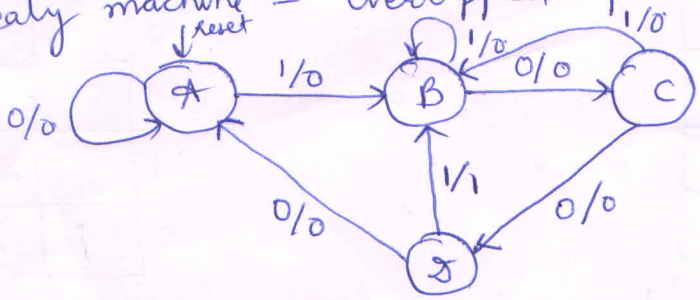
Reset → A
1 → B
10 → C
100 → D
1001 → E

(3) Mealy machine - Non-overlapped pattern "1001"



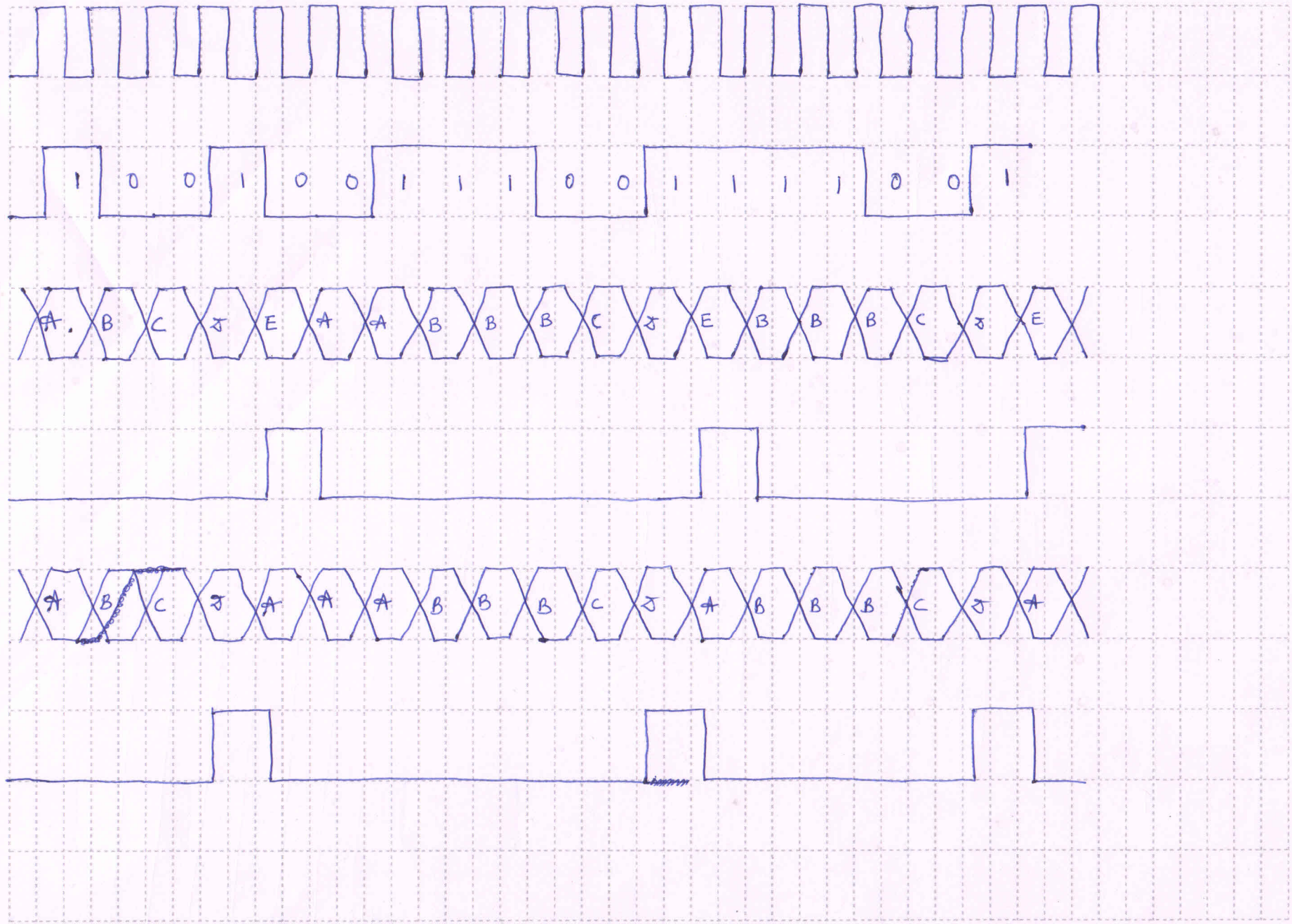
Reset → A
1 → B
10 → C
100 → D
1001 → A

(4) Mealy machine - Overlapped pattern "1001"



Reset → A
1 → B
10 → C
100 → D
1001 → B

(2) Problem - 2


Clock
Input
1 0 0 1 0 0 1 1 1 0 0 1 1 1 1 0 0 1
Moore - State Non-overlapped.
A B C D E A A B B B C D E B B B C D E
Moore - Output Non-overlapped
Mealy - State Non-overlapped
A B C D A A A B B B C D A B B B C D A
Mealy - Output Non-overlapped

(3) (i) Input, w
Output, z

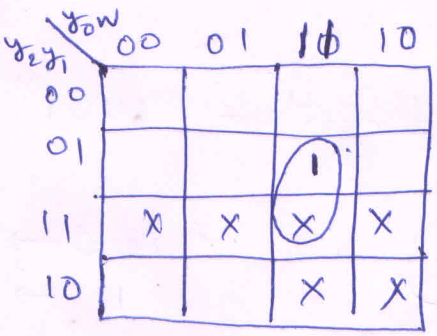
Present state, $y_2 y_1 y_0$
Next state, $Y_2 Y_1 Y_0$

	Present state			Next State w=0			Next State w=1			Output z
	y_2	y_1	y_0	Y_2	Y_1	Y_0	Y_2	Y_1	Y_0	
A →	0	0	0	0	0	0	0	0	1	0
B →	0	0	1	0	1	0	0	0	1	0
C →	0	1	0	0	1	1	0	0	1	0
D →	0	1	1	0	0	0	1	0	0	0
E →	1	0	0	0	1	0	0	0	1	1
	1	0	1	x	x	x	x	x	x	x
	1	1	0	x	x	x	x	x	x	x
	1	1	1	x	x	x	x	x	x	x

State Table

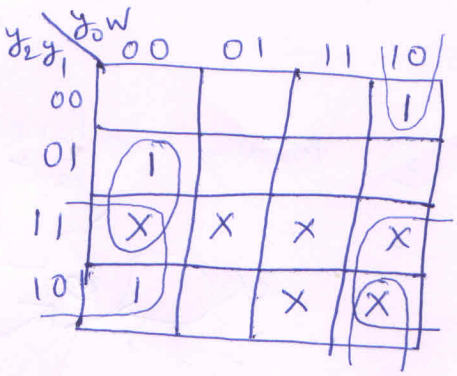
y_2	y_1	y_0	w	Y_2	Y_1	Y_0	z
0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0
0	0	1	0	0	1	0	0
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	0	1	0
0	1	1	0	0	0	0	0
0	1	1	1	1	0	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	0	1	1
1	0	1	0	x	x	x	x
1	0	1	1	x	x	x	x
1	1	0	0	x	x	x	x
1	1	0	1	x	x	x	x
1	1	1	0	x	x	x	x
1	1	1	1	x	x	x	x

(Y2)



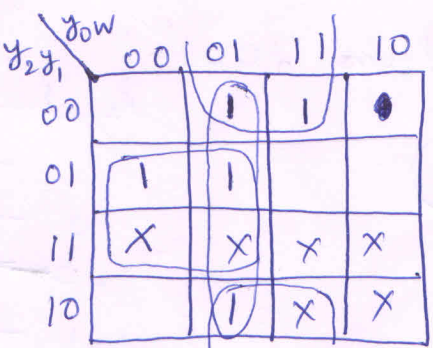
$Y_2 = y_1 \cdot y_0 \cdot w'$

(Y1)



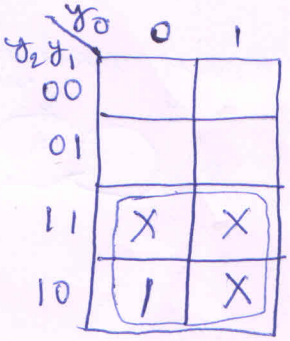
$Y_1 = y_1 \cdot y_0' \cdot w' + y_2 w' + y_1' \cdot y_0 \cdot w'$

(Y0)



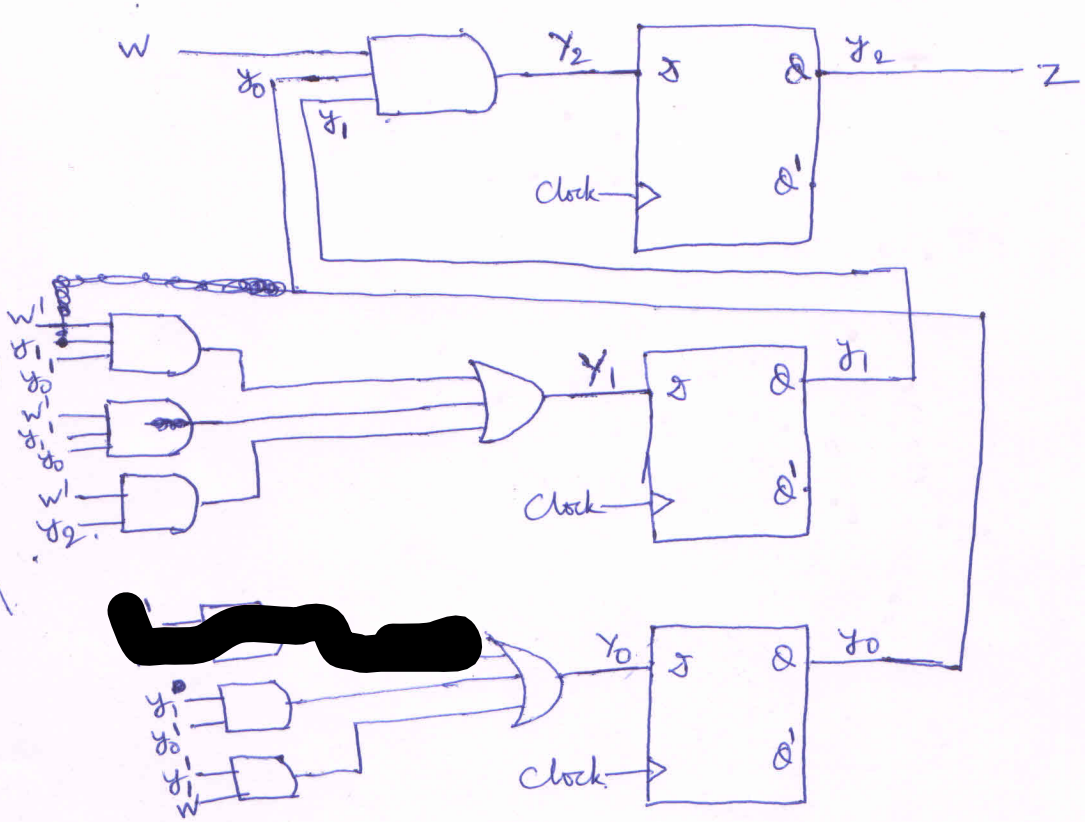
$Y_0 = [redacted]\, y_1 \cdot y_0' + y_1' \cdot w$

(z)

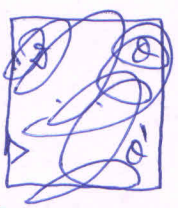


$z = y_2$

(3) (i)



The wires can be drawn. For simplicity I have removed them.



(2)

	Present State					Next State w=0					Next State w=1					Output z
	y_4	y_3	y_2	y_1	y_0	Y_4	Y_3	Y_2	Y_1	Y_0	Y_4	Y_3	Y_2	Y_1	Y_0	
A	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
B	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0
C	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
D	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
E	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1

Since the expressions are simple, we can figure out the expressions for the next state & output by observations.

$Y_4 = w \cdot y_3$

$Y_3 = w' \cdot y_2$

$Y_2 = w' \cdot (y_1 + y_4)$

$Y_1 = w y_3'$

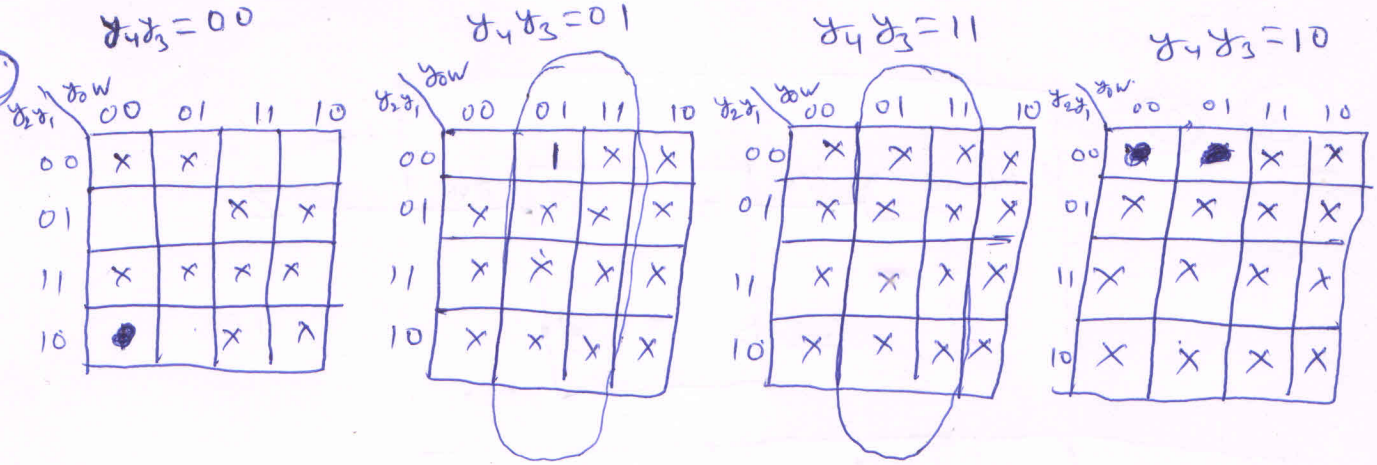
$Y_0 = w' (y_0 + y_3)$

$z = y_4$

These can be verified as shown in the following sheet.

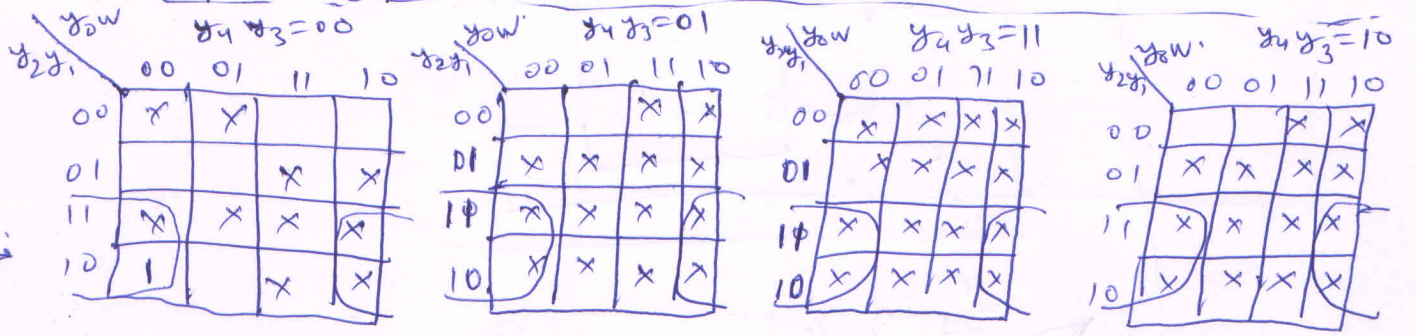
(3)(2)

$Y_4 \rightarrow$



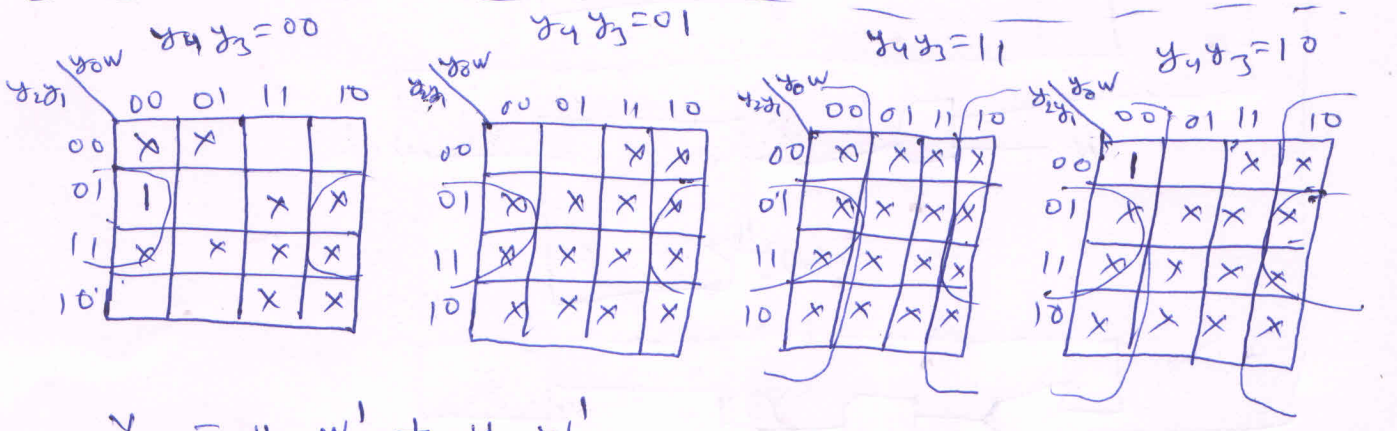
$$Y_4 = Y_3 \cdot w$$

$Y_3 \rightarrow$



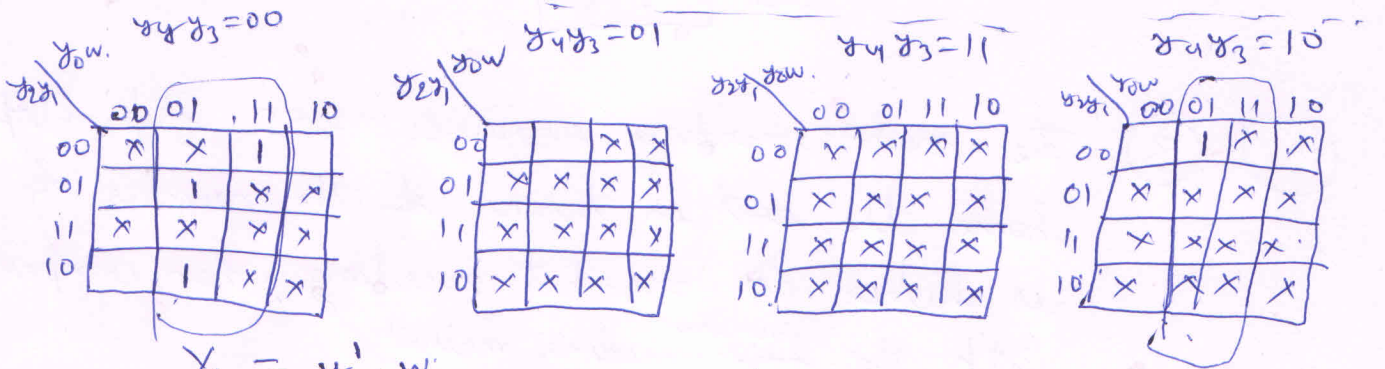
$$Y_3 = y_2 \cdot w'$$

$Y_2 \rightarrow$



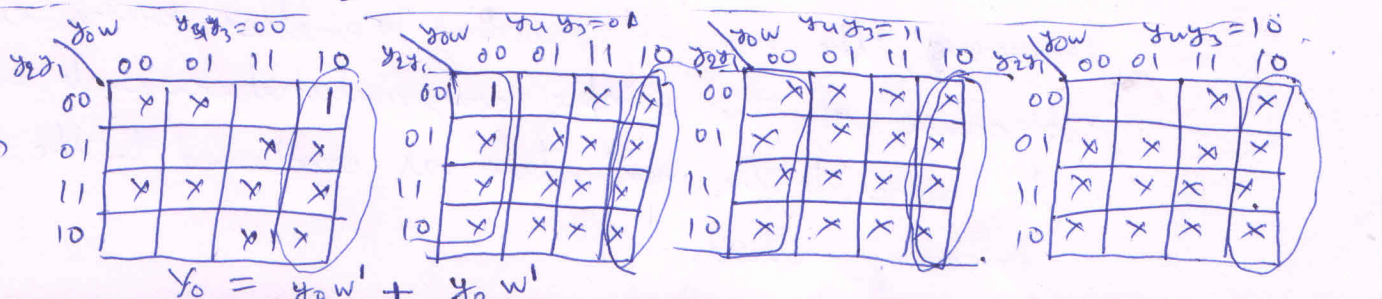
$$Y_2 = y_1 \cdot w' + y_4 w'$$

$Y_1 \rightarrow$



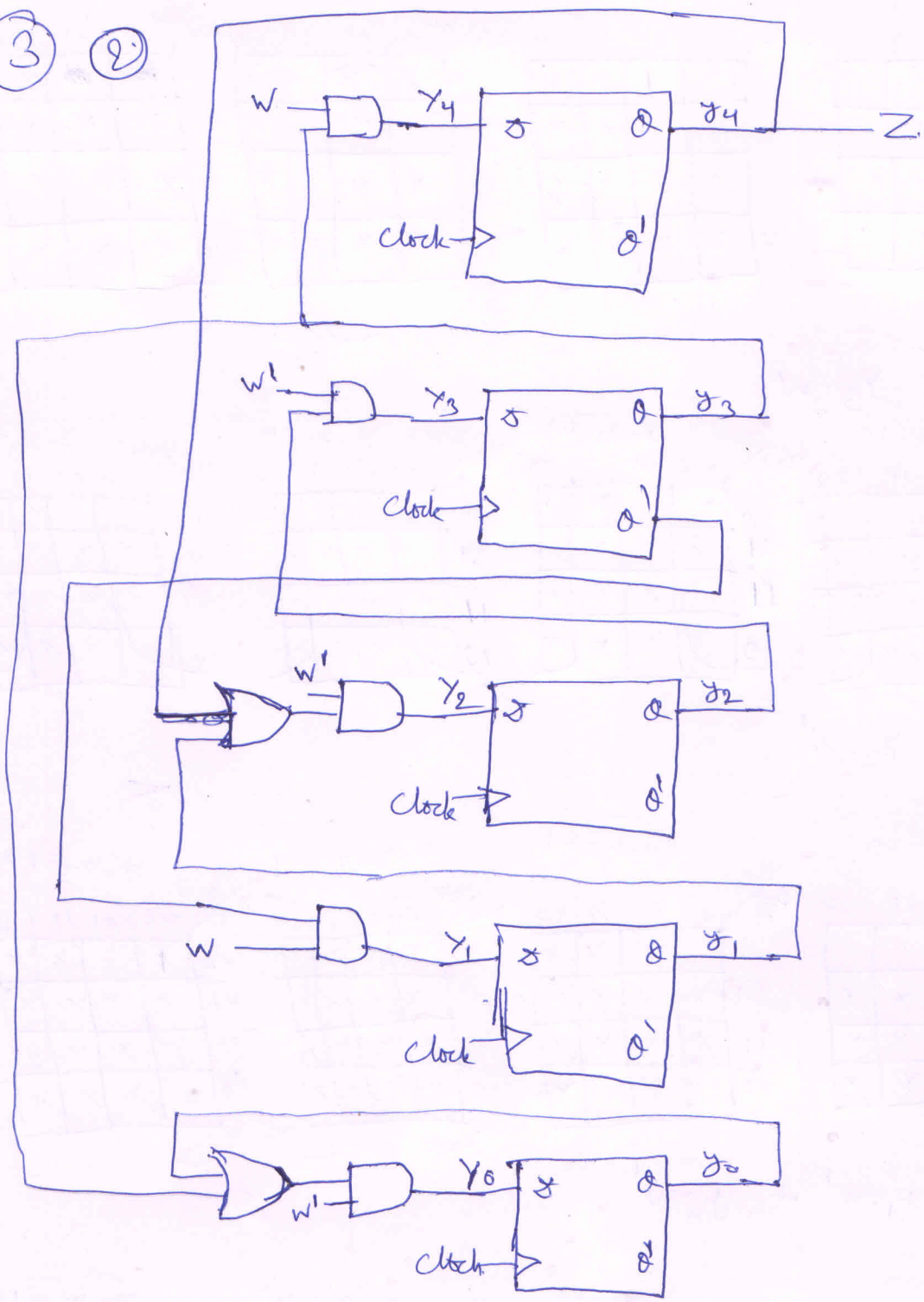
$$Y_1 = y_3' \cdot w$$

$Y_0 \rightarrow$



$$Y_0 = y_0 w' + y_0 w'$$

(3) (2)



(3) (3) The one-hot encoding requires more flip-flops & hence the cost in terms of the number of gates is higher for one-hot encoding when compared with the ~~fast~~ minimum encoding method.

However, the one-hot encoding enables faster circuit because of the simple combinational circuits required to generate the next state as compared to the minimum encoding method.