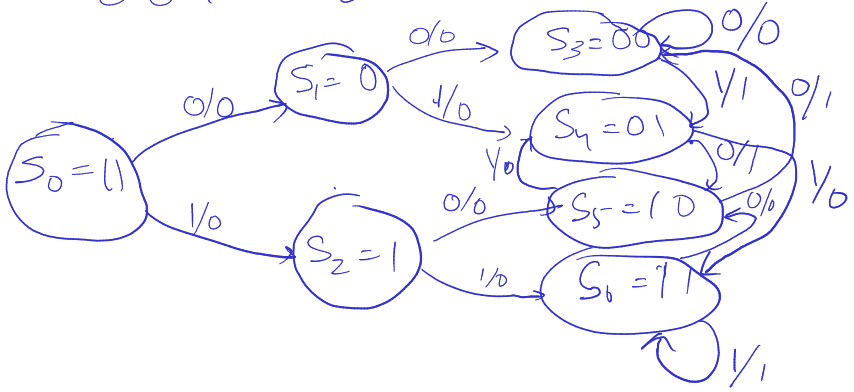
HW 8

Problem 1 Example sequence (Mealy)

t	0	1	2	3	4	5	6	7	8	9
w	0	0	1	0	1	1	0	0	0	1
p	0	0	1	1	0	0	0	1	0	1



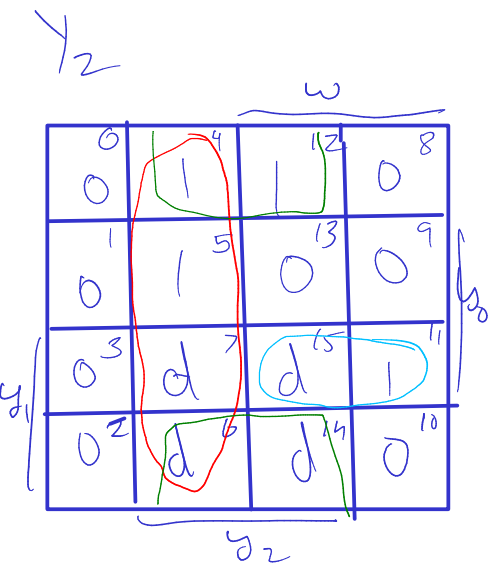
State table

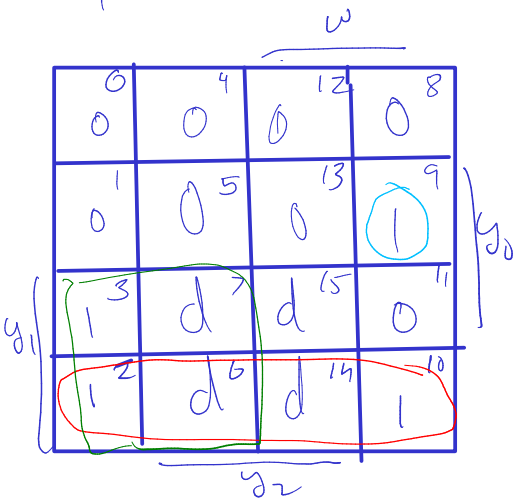
Seq	Present state	Next State w=0	Next State w=1	Output (p) w=0	Output (p) w=1
""	S_0	S_1	S_2	0	0
"0"	S_1	S_3	S_4	0	0
"1"	S_2	S_5	S_6	0	0
"00"	S_3	S_3	S_4	0	1
"01"	S_4	S_5	S_6	1	0
"10"	S_5	S_3	S_4	1	0
"11"	S_6	S_5	S_6	0	1

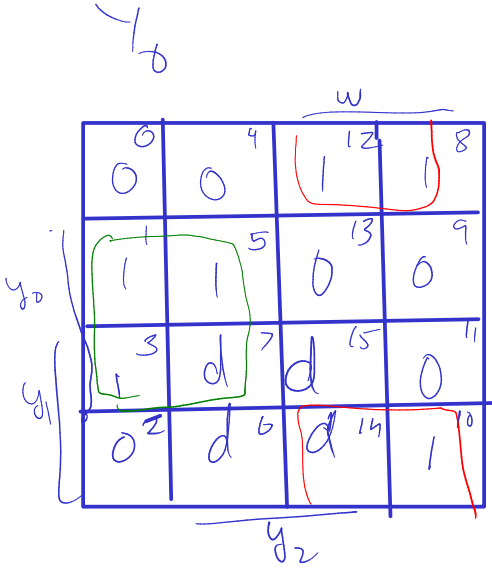
Problem 2 — Moore modulo 6 counter

State assigned table (Not optimal)

Present State $y_2\ y_1\ y_0$	Next State $w=0$: $Y_2\ Y_1\ Y_0$	Next State $w=1$: $Y_2\ Y_1\ Y_0$	Output $Z_2=y_2,\ Z_1=y_1,\ Z_0=y_0$
0 0 0	0 0 0	0 0 1	
0 0 1	0 0 1	0 1 0	
0 1 0	0 1 0	0 1 1	
0 1 1	0 1 1	1 0 0	
1 0 0	1 0 0	1 0 1	
1 0 1	1 0 1	0 0 0	
1 1 0	d d d	d d d	
1 1 1	d d d	d d d	



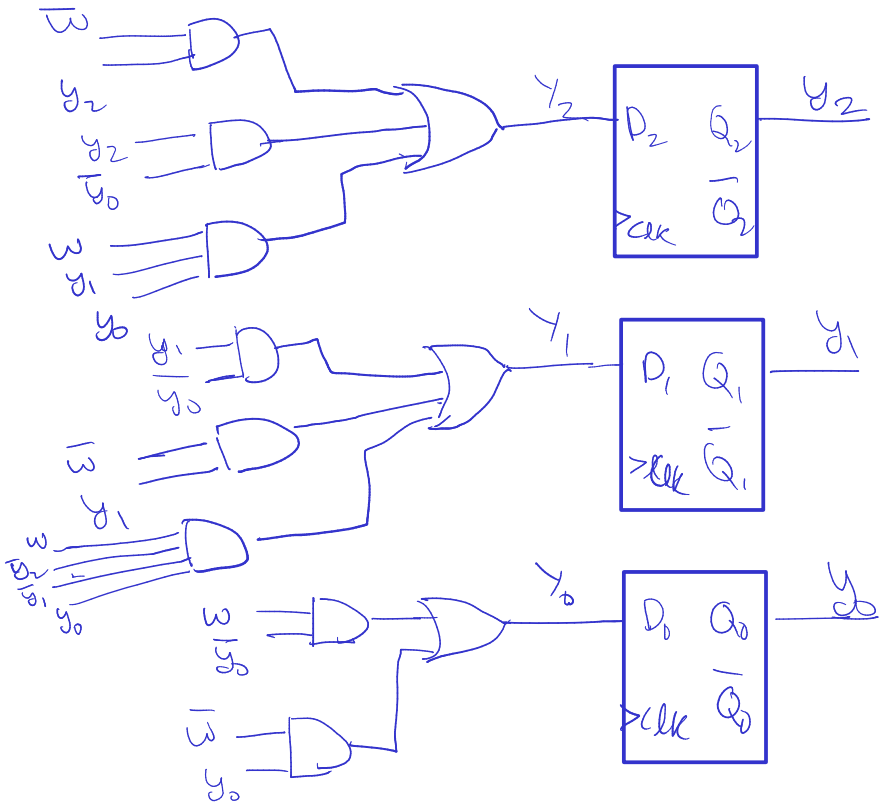




$Y_2 = \bar{w}\, y_2 + y_2 \bar{y}_0 + w y_1 y_0$

$Y_1 = y_1 \bar{y}_0 + \bar{w}\, y_1 + w \bar{y}_2 \bar{y}_1 y_0$

$Y_0 = w \bar{y}_0 + \bar{w}\, y_0$


Y_2
D_2
Q_2
$\overline{Q_2}$
clk
y_2
Y_1
D_1
Q_1
$\overline{Q_1}$
clk
y_1
Y_0
D_0
Q_0
$\overline{Q_0}$
clk
y_0

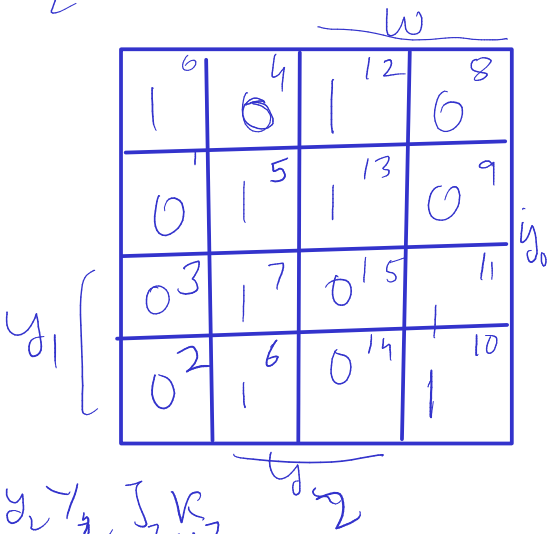
Problem 3

3-bit counter like circuit (Moore)

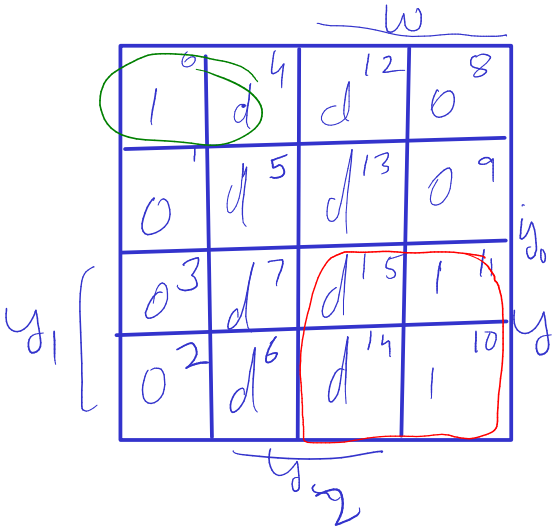
State assigned table

Present State	Next State		Output
	$w=0$	$w=1$	
$y_2\ y_1\ y_0$	$Y_2\ Y_1\ Y_0$	$Y_2\ Y_1\ Y_0$	$z_2=y_2\ \ z_1=y_1\ \ z_0=y_0$
0 0 0	1 1 1	0 1 0	
0 0 1	0 0 0	0 1 1	
0 1 0	0 0 1	1 0 0	
0 1 1	0 1 0	1 0 1	
1 0 0	0 1 1	1 1 0	
1 0 1	1 0 0	1 1 1	
1 1 0	1 0 1	0 0 0	
1 1 1	1 1 0	0 0 1	

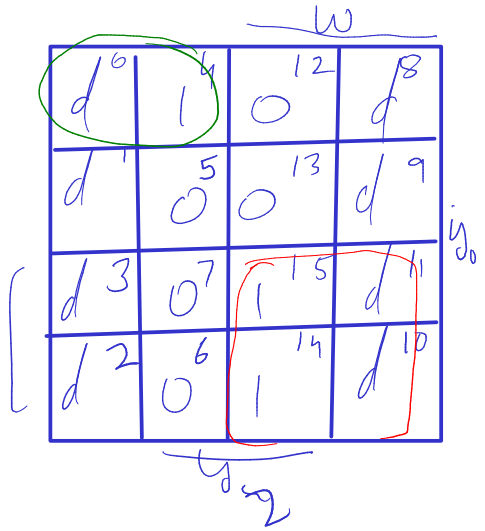
Y_2



J_2



K_2

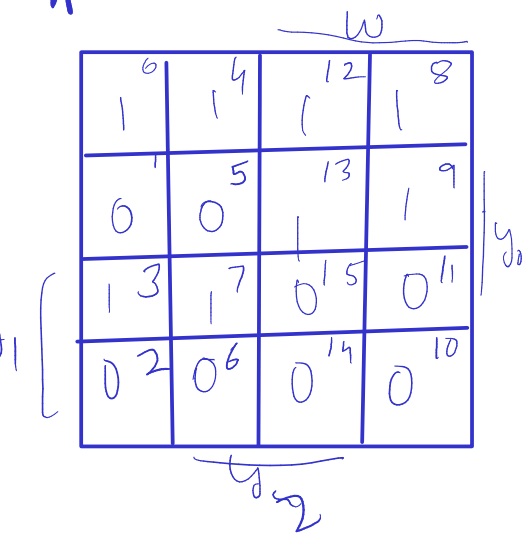


$y_2\ Y_2$	$J_2\ K_2$
0 0	0 d
0 1	1 d
1 0	d 1
1 1	d 0

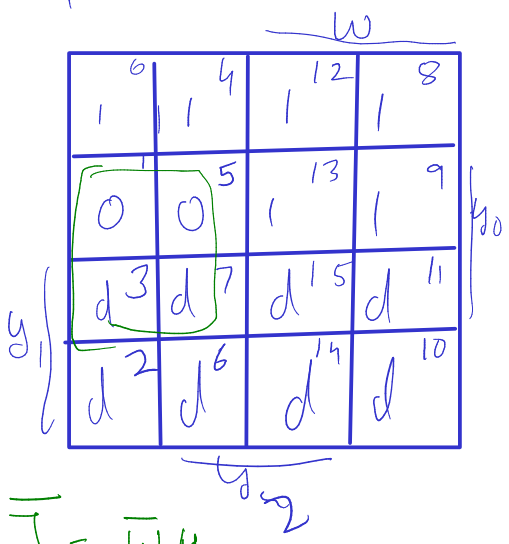
$J_2 = \bar{w} y_1 \bar{y}_0 + w y_1$

$K_2 = \bar{w} y_1 \bar{y}_0 + w y_1$

Y_1



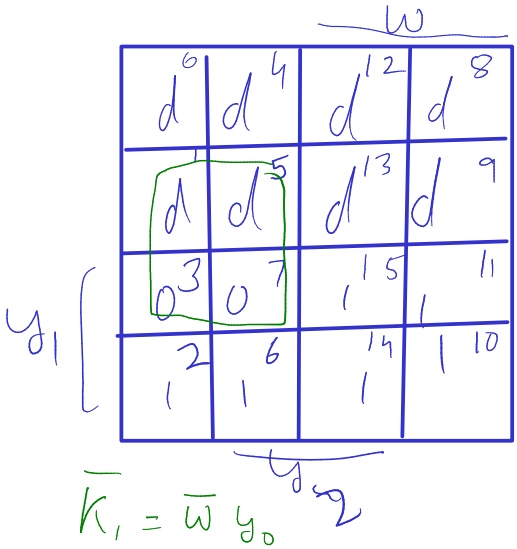
J_1



$\overline{J_1} = \bar{w}\, y_0$

$\Rightarrow J_1 = w + \bar{y}_0$

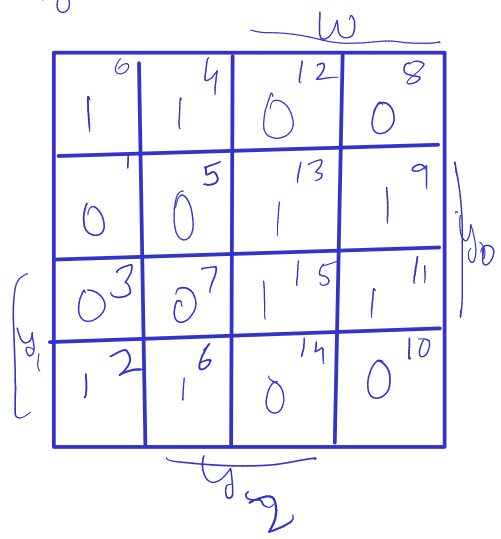
K_1



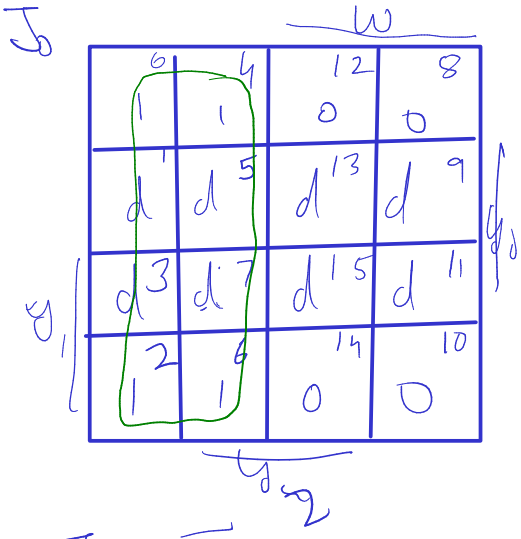
$\overline{K_1} = \bar{w}\, y_0$

$\Rightarrow K_1 = w + \bar{y}_0$

Y_0

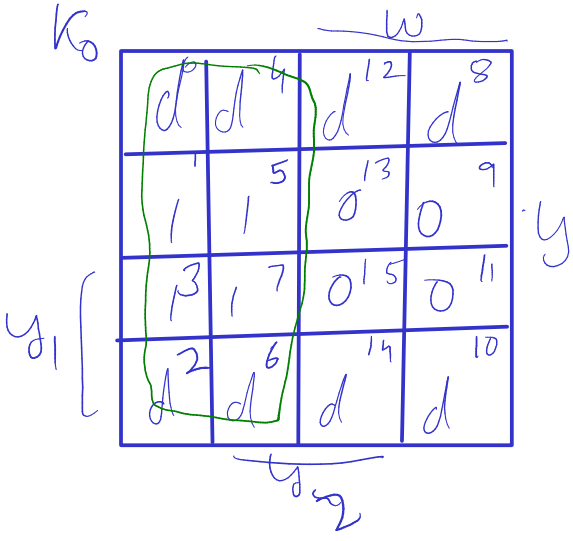


J_0

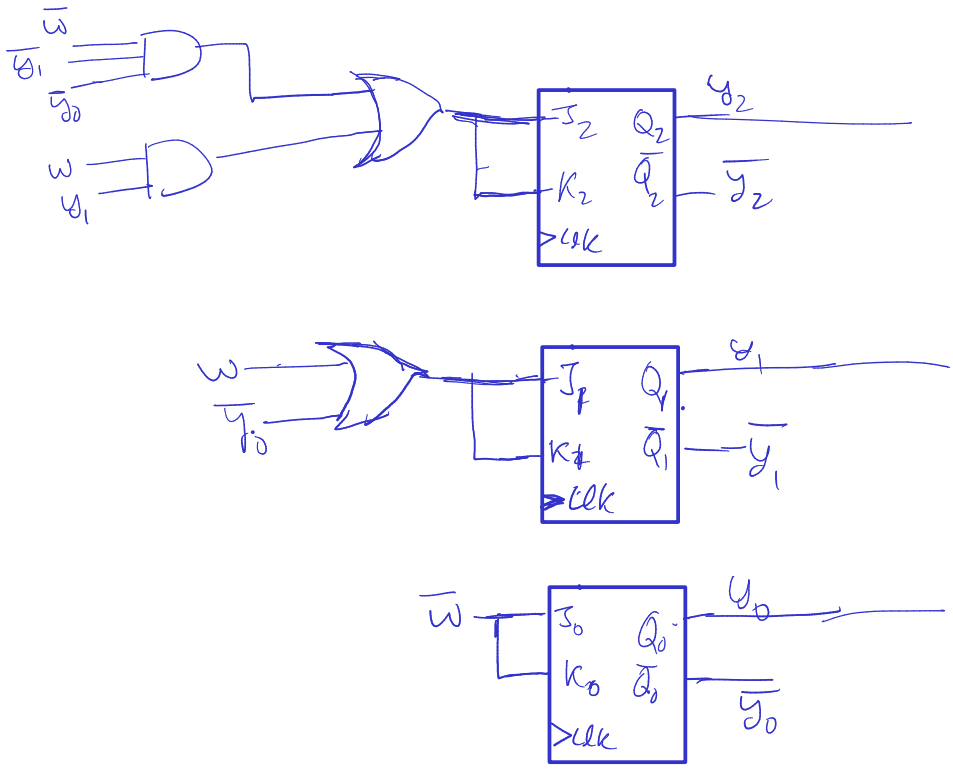


$J_0 = \bar{w}$

K_0



$K_0 = \bar{w}$

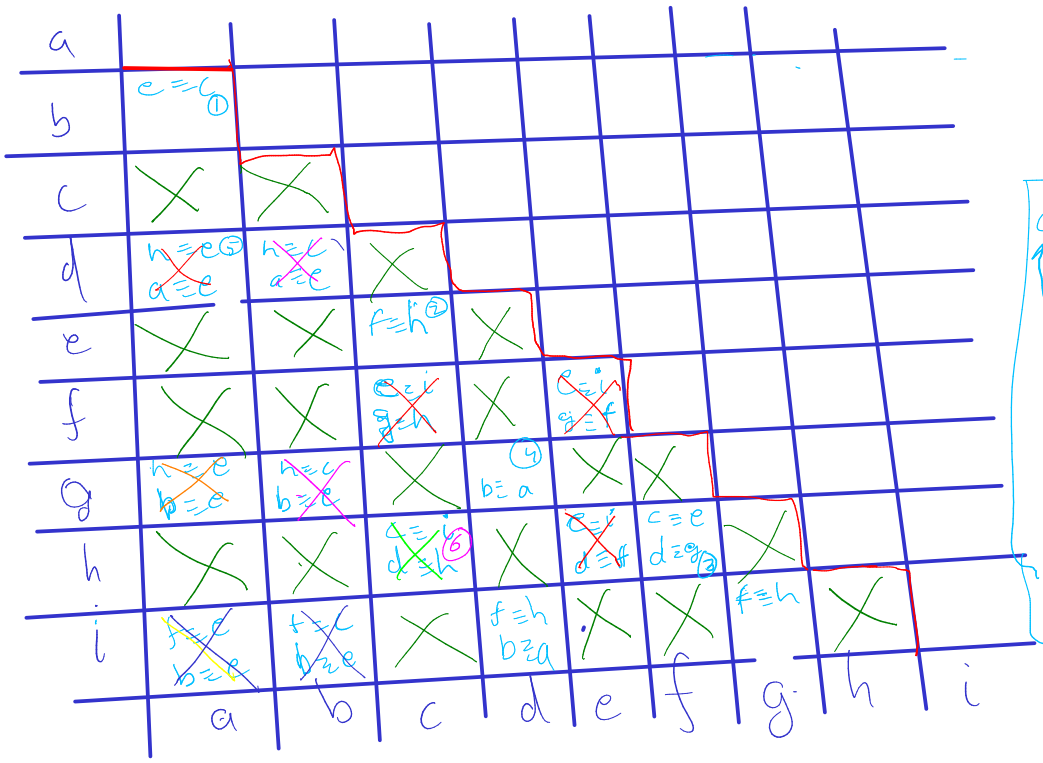

$\bar{w}$
$\bar{y}_1$
$\bar{y}_0$
w
y_1
J_2
K_2
>clk
Q_2
$\bar{Q}_2$
y_2
$\bar{y}_2$
w
y_0
J_1
K_1
>clk
Q_1
$\bar{Q}_1$
y_1
$\bar{y}_1$
$\bar{w}$
J_0
K_0
>clk
Q_0
$\bar{Q}_0$
y_0
$\bar{y}_0$

Problem 4

X = Due to mismatching output

X = Due to $e \neq i$

X = Due to $c \neq i$



Possible

$a=b$ if $c=c$ ①

if $f=h$ ②

if $c=e$ ③

$d=g$

if $a=b$ ④

also $d=i$ ⑥

$a=d$

if $h=e$ ⑤ — if $e=i$ ✗

$a=h$ $d=f$

Not possible

$b=d$

if $h=c$ ✗ because of ⑥

$a=e$

Not possible

Replace b with a, e with c, h with f, g and i with d,

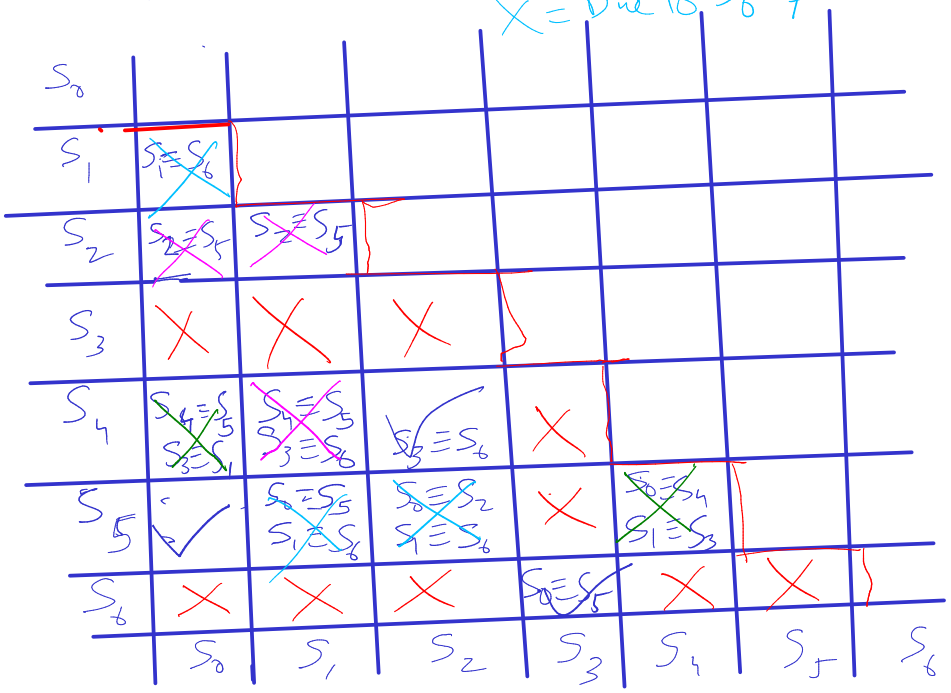
PS	NS $x=0$	NS $x=1$	Z
a	c	c	1
c	d	f	0
d	f	a	1
f	c	d	0

Problem 5.1

X = Due to mismatching output

X = Due to $S_3 \neq *$

X = Due to $S_6 \neq *$



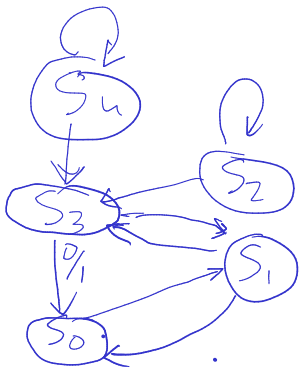
Replace S_5 with S_0, S_6 with S_3. State reduction of BINary state table still leaves us with 5 states instead of 7.

FL Ipflop's state table has only 3 states.

Mr Ipflop is not correct.

PS	NS $X=0$	NS $X=1$	Output $X=0$	Output $X=1$
S_0	S_0	S_1	0	0
S_1	S_0	S_3	0	0
S_2	S_2	S_3	0	0
S_3	S_0	S_1	1	0
S_4	S_4	S_3	0	0

Problem 5.2



If S_0 is the start state S_2, S_4 are unreachable.

Remove S_2, S_4 from the state table

Combining with $S_5 \equiv S_0$, $S_3 \equiv S_6$ we get:

PS	NS		Output	
	X=0	1	X=0	1
S_0	S_0	S_1	0	0
S_1	S_0	S_3	0	0
S_3	S_0	S_1	1	0

Comparing with Ipflop's table

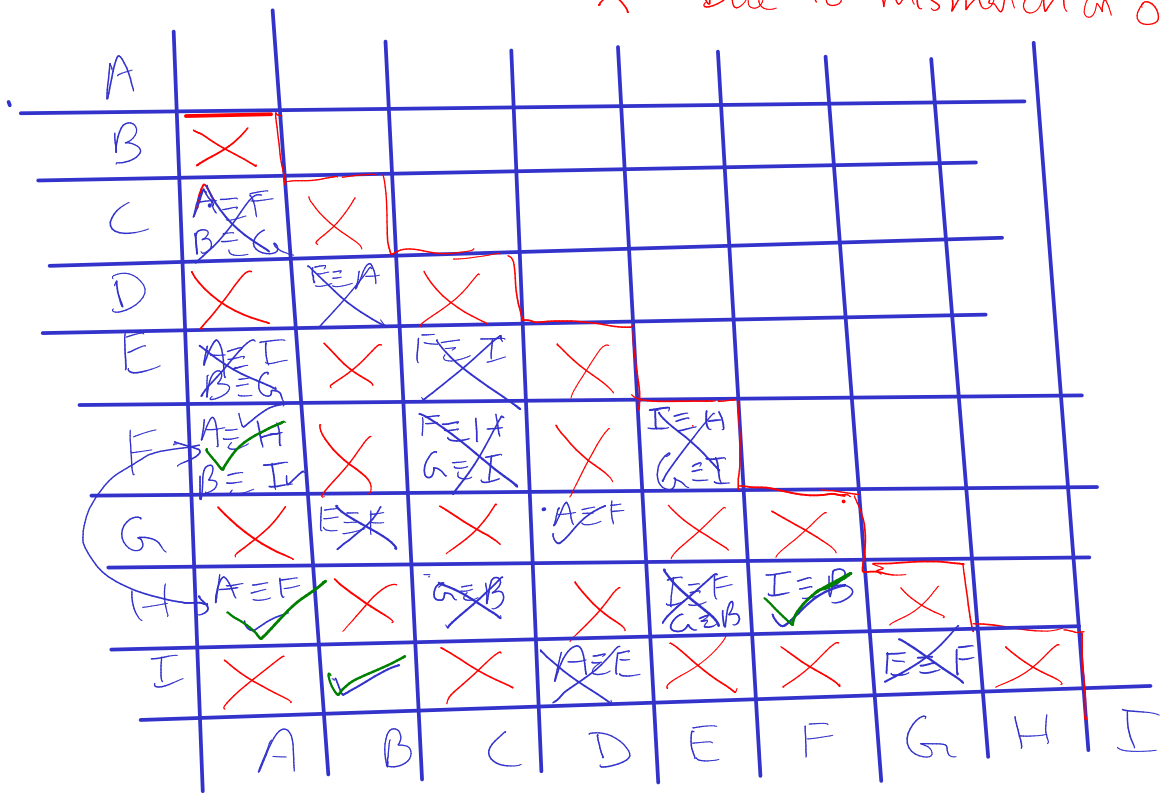
$S_3 \equiv c$ because output (1,0) is unique

$S_1 \equiv b$

$S_0 \equiv a$

Problem 6

X = Due to mismatch in output



A ≡ H ≡ F B ≡ I

Replace H and F with A
I with B

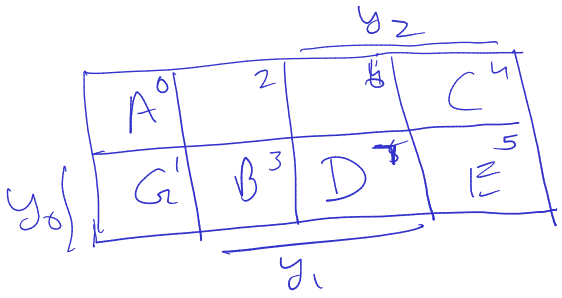
PS	NS X=0	NS X=1	Z
A	A	B	1
B	C	E	0
C	A	G	1
D	C	A	0
E	B	G	1
G	C	A	0

Problem 6.2

Guideline 1 $(A, C), (B, D, G), (B, D),$

Guideline 2 $(A, B), (C, E), (A, G), (C, A) \times 2$

(B, G);



y_2	y_1	y_0	
0	0	0	A
0	0	1	G
0	1	0	
0	1	1	B
1	0	0	C
1	0	1	E
1	1	0	
1	1	1	D

	PS			NS						Output (Z)
				X = 0			X = 1			
	y_2	y_1	y_0	Y_2	Y_1	Y_0	Y_2	Y_1	Y_0	
A≡H≡F	0	0	0	0	0	0	0	1	1	1
G	0	0	1	1	0	0	0	0	0	0
	0	1	0	d	d	d	d	d	d	d
B≡I	0	1	1	1	0	0	1	0	1	0
C	1	0	0	0	0	0	0	0	1	1
E	1	0	1	0	1	1	0	1	1	1
	1	1	0	d	d	d	d	d	d	d
D	1	1	1	1	0	0	0	0	0	0

D_2

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	0 (4)	0 (12)	0 (8)
1	1 (1)	0 (5)	0 (13)	0 (9)
1	1 (3)	1 (7)	0 (15)	1 (11)
d	d (2)	d (6)	d (14)	d (10)

$D_2 = \bar{x} y_1 + \bar{y}_2 y_1 + \bar{x} \bar{y}_2 y_0$

D_1

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	0 (4)	0 (12)	1 (8)
0	1 (1)	0 (5)	0 (13)	0 (9)
0	0 (3)	0 (7)	0 (15)	0 (11)
d	d (2)	d (6)	d (14)	d (10)

$D_1 = \bar{x} y_2 \bar{y}_1 y_0 + x \bar{y}_2 \bar{y}_0$

D_0

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	0 (4)	1 (12)	1 (8)
0	1 (1)	1 (5)	1 (13)	0 (9)
0	0 (3)	0 (7)	0 (15)	1 (11)
d	d (2)	d (6)	d (14)	d (10)

$D_0 = x \bar{y}_0 + x \bar{y}_2 y_1 + y_2 \bar{y}_1 y_0$

$J_2 = \bar{x} y_0 + y_1$

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	d (4)	d (12)	0 (8)
1	d (1)	d (5)	d (13)	0 (9)
1	d (3)	d (7)	d (15)	1 (11)
d	d (2)	d (6)	d (14)	d (10)

$J_1 = \bar{x} y_2 y_0 + x \bar{y}_2 \bar{y}_0$

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	0 (4)	0 (12)	1 (8)
0	1 (1)	0 (5)	0 (13)	0 (9)
d	d (3)	d (7)	d (15)	d (11)
d	d (2)	d (6)	d (14)	d (10)

$J_0 = x$

$y_1 \backslash y_0 y_2$	00	01	11	10
0	0 (0)	0 (4)	1 (12)	1 (8)
d	d (1)	d (5)	d (13)	d (9)
d	d (3)	d (7)	d (15)	d (11)
d	d (2)	d (6)	d (14)	d (10)

$\bar{K}_2 = \bar{x} y_1 \Rightarrow K_2 = x + \bar{y}_1$

$y_1 \backslash y_0 y_2$	00	01	11	10
d	d (0)	1 (4)	1 (12)	d (8)
d	d (1)	1 (5)	1 (13)	d (9)
d	d (3)	0 (7)	1 (15)	d (11)
d	d (2)	d (6)	d (14)	d (10)

$K_1 = 1$

$y_1 \backslash y_0 y_2$	00	01	11	10
d	d (0)	d (4)	d (12)	d (8)
d	d (1)	d (5)	d (13)	d (9)
1	1 (3)	1 (7)	1 (15)	1 (11)
d	d (2)	d (6)	d (14)	d (10)

$\bar{K}_0 = y_2 \bar{y}_1 \Rightarrow K_0 = \bar{y}_2 + y_1$

$y_1 \backslash y_0 y_2$	00	01	11	10
d	d (0)	d (4)	d (12)	d (8)
1	0 (1)	0 (5)	0 (13)	1 (9)
1	1 (3)	1 (7)	1 (15)	1 (11)
d	d (2)	d (6)	d (14)	d (10)