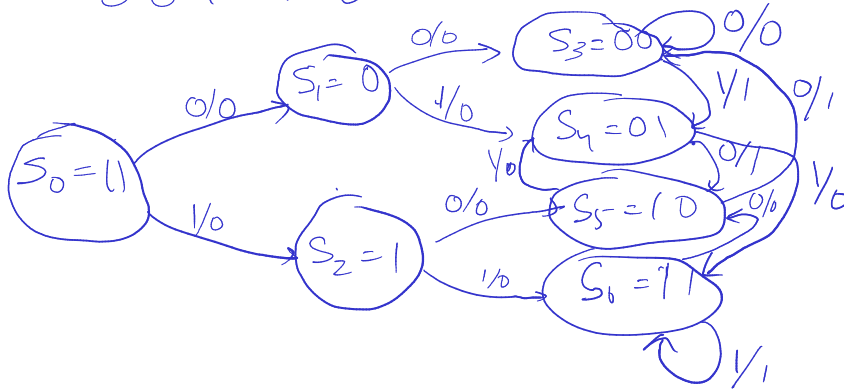


# HW 8

## 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		Output (p)	
		w=0	w=1	w=0	w=1
"1"	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	0	0
"0"	S <sub>1</sub>	S <sub>3</sub>	S <sub>4</sub>	0	0
"1"	S <sub>2</sub>	S <sub>5</sub>	S <sub>6</sub>	0	0
"00"	S <sub>3</sub>	S <sub>3</sub>	S <sub>4</sub>	0	1
"01"	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>	1	0
"10"	S <sub>5</sub>	S <sub>3</sub>	S <sub>4</sub>	1	0
"11"	S <sub>6</sub>	S <sub>5</sub>	S <sub>6</sub>	0	1

# Problem 2

Moore modulo 6 counter

State assigned table (Not optimal)

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	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	

$y_2$

	$w$	
	0	1
$y_0$	0	1
$y_1$	0	1
$y_2$	0	1

$y_1$

	$w$	
	0	1
$y_0$	0	1
$y_1$	0	1
$y_2$	0	1

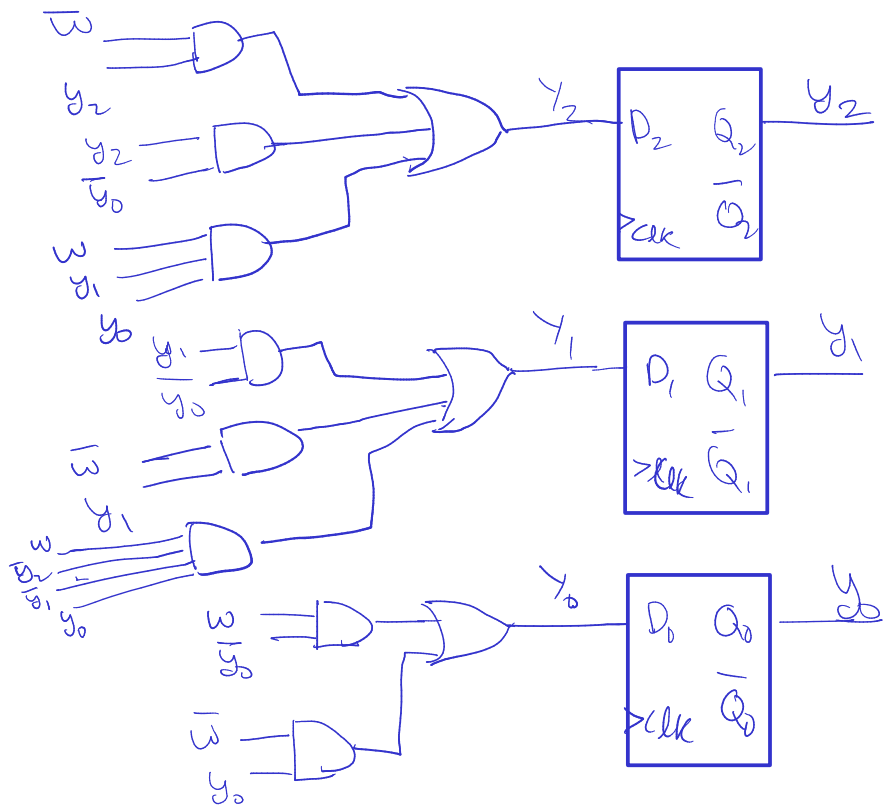
$y_0$

	$w$	
	0	1
$y_0$	0	1
$y_1$	0	1
$y_2$	0	1

$$y_2 = \bar{w}y_2 + y_2\bar{y}_0 + wy_1y_0$$

$$y_1 = y_1\bar{y}_0 + \bar{w}y_1 + wy_2\bar{y}_1y_0$$

$$y_0 = wy_0 + \bar{w}y_0$$



Problem 3      3-bit counter like circuit (Moore)

3-bit counter like circuit (Moore)

State assigned table

Present State	Next State		Output
	$w=0$ $y_2 y_1 y_0$	$w=1$ $y_2 y_1 y_0$	
0 0 0	1 1 1	0 1 0	$Z_2 = y_2 \quad Z_1 = y_1 \quad Z_0 = y_0$
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	

1 <sup>0</sup>	1 <sup>4</sup>	1 <sup>12</sup>	1 <sup>8</sup>
0	0	1	0
0 <sup>1</sup>	1 <sup>5</sup>	1 <sup>13</sup>	0 <sup>9</sup>
0	1	1	0
0 <sup>3</sup>	1 <sup>7</sup>	0 <sup>15</sup>	1 <sup>11</sup>
0	1	0	1
0 <sup>2</sup>	1 <sup>6</sup>	0 <sup>14</sup>	1 <sup>10</sup>
0	1	0	1

			<u>w</u>		
1 <sup>0</sup>	d <sup>4</sup>	d <sup>12</sup>	0 <sup>8</sup>		
0 <sup>1</sup>	d <sup>5</sup>	d <sup>13</sup>	0 <sup>9</sup>		
0 <sup>3</sup>	d <sup>7</sup>	d <sup>15</sup>	1 <sup>11</sup>		
0 <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	1 <sup>10</sup>		

Handwritten 4x4 grid for the 8-puzzle problem. The grid contains numbers 1 through 15 and a blank space (0). The top row is circled in green, and the bottom row is circled in red. The grid is labeled 'w' at the top and 'h' on the right.

d <sup>6</sup>	1 <sup>4</sup>	0 <sup>12</sup>	d <sup>8</sup>
d <sup>1</sup>	0 <sup>5</sup>	0 <sup>13</sup>	d <sup>9</sup>
d <sup>3</sup>	0 <sup>7</sup>	1 <sup>15</sup>	d <sup>11</sup>
d <sup>2</sup>	0 <sup>6</sup>	1 <sup>14</sup>	d <sup>10</sup>

$$\overline{J}_2 = \overline{w} \overline{y}_1 \overline{y}_0 + w y_1$$

$$K_{zz} \bar{w} \bar{y}_1 \bar{y}_0 + w y_1$$

$y_1$ 

$w$				
$1^6$	$1^4$	$1^{12}$	$1^8$	
1	1	1	1	
$0^1$	$0^5$	$1^{13}$	$1^9$	$y_0$
0	0	1	1	
$1^3$	$1^7$	$0^{15}$	$0^{11}$	
1	1	0	0	
$0^2$	$0^6$	$0^{14}$	$0^{10}$	
0	0	0	0	$y_2$

 $J_1$ 

$w$				
$1^6$	$1^4$	$1^{12}$	$1^8$	
1	1	1	1	
0	0	1	1	$y_0$
$d^3$	$d^7$	$d^{15}$	$d^{11}$	
$d^2$	$d^6$	$d^{14}$	$d^{10}$	
1	1	0	0	
$d^1$	$d^5$	$d^{13}$	$d^9$	
d	d	d	d	$y_2$

 $K_1$ 

$w$				
$d^6$	$d^4$	$d^{12}$	$d^8$	
d	d	d	d	
d	d	d	d	$y_0$
$0^3$	$0^7$	$1^{15}$	$1^{11}$	
1	1	1	1	
$1^2$	$1^6$	$1^{14}$	$1^{10}$	
1	1	1	1	
$d^1$	$d^5$	$d^{13}$	$d^9$	$y_2$

$$\bar{J}_1 = \bar{w} y_0$$

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

$$\bar{K}_1 = \bar{w} y_0$$

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

 $y_0$ 

$w$				
$1^6$	$1^4$	$0^{12}$	$0^8$	
1	1	0	0	
0	0	1	1	$y_0$
$0^3$	$0^7$	$1^{15}$	$1^{11}$	
1	1	1	1	
$1^2$	$1^6$	$0^{14}$	$0^{10}$	
1	1	0	0	
$d^1$	$d^5$	$d^{13}$	$d^9$	$y_2$

 $J_0$ 

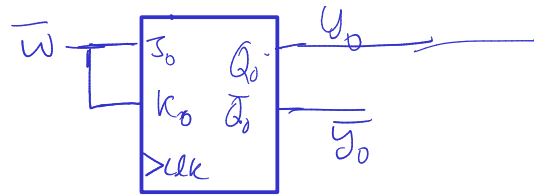
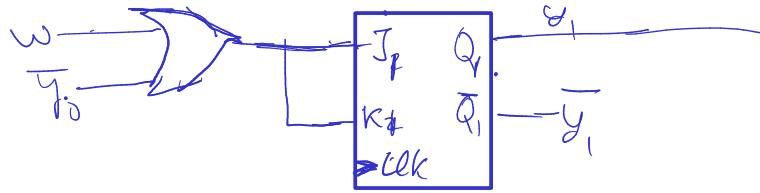
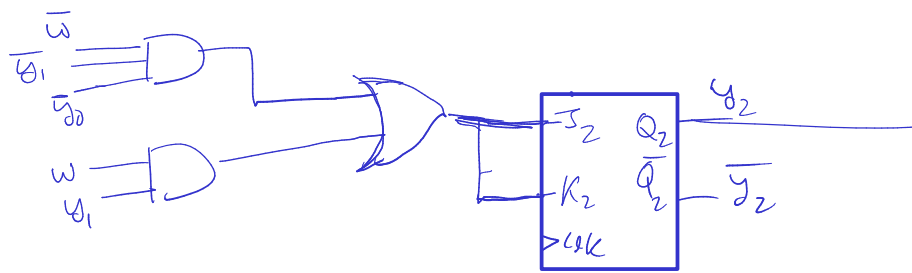
$w$				
$1^6$	$1^4$	$0^{12}$	$0^8$	
1	1	0	0	
d	d	d	d	$y_0$
$d^3$	$d^7$	$d^{15}$	$d^{11}$	
$d^2$	$d^6$	$d^{14}$	$d^{10}$	
1	1	0	0	
$d^1$	$d^5$	$d^{13}$	$d^9$	
d	d	d	d	$y_2$

$$J_0 = \bar{w}$$

 $K_0$ 

$w$				
$d^6$	$d^4$	$d^{12}$	$d^8$	
d	d	d	d	
1	1	0	0	$y_0$
$1^3$	$1^7$	$0^{15}$	$0^{11}$	
1	1	1	1	
$1^2$	$1^6$	$d^{14}$	$d^{10}$	
d	d	d	d	
$d^1$	$d^5$	$d^{13}$	$d^9$	$y_2$

$$K_0 = \bar{w}$$



# Problem 4

X = Due to mismatching output

X = Due to  $e \neq i$

X = Due to  $c \neq i$

a									
b	$e \equiv c$ ①								
c	X	X							
d	$h \equiv e$ ⑤ $a \equiv e$	$h \equiv c$ $a \equiv c$	X						
e	X	X	$f \equiv h$ ⑦	X					
f	X	X	$g \equiv h$ $g \equiv f$	X	$c \equiv i$ $g \equiv f$				
g	$h \equiv e$ $b \equiv e$	$h \equiv c$ $b \equiv c$	X	$b \equiv a$ ④	X	X			
h	X	X	$d \equiv h$ ⑥	X	$c \equiv i$ $d \equiv f$	$c \equiv e$ $d \equiv g$ ②	X		
i	$h \equiv e$ $b \equiv e$	$h \equiv c$ $b \equiv c$	X	$f \equiv h$ $b \equiv a$	X	X	$f \equiv h$	X	
	a	b	c	d	e	f	g	h	i

Possible

$a \equiv b$   
 $y \quad c \equiv c$  ①  
 if  $f \equiv h$  ②  
 $y \quad c \equiv c$  ③  
 $d \equiv g$   
 if  $a \equiv b$  ④  
 also  $d \equiv c$

$a \equiv d$

if  $h \equiv e$  ⑤ —  $y \quad c \equiv i$  X  
 $a \equiv h$   $d \equiv f$

Not possible

$b \equiv d$

if  $h \equiv c$  X because of ⑥  
 $a \equiv c$

Not possible

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

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

# Problem 5.1

$\times$  = Due to mismatching output

$\times$  = Due to  $S_3 \neq *$

$\times$  = Due to  $S_6 \neq *$

$S_0$							
$S_1$	$S_1 \equiv S_6$						
$S_2$	$S_2 \equiv S_5$	$S_2 \equiv S_5$					
$S_3$	$\times$	$\times$	$\times$				
$S_4$	$S_4 \equiv S_5$ $S_3 \equiv S_1$	$S_4 \equiv S_5$ $S_3 \equiv S_6$	$S_5 \equiv S_6$	$\times$			
$S_5$	$\checkmark$	$S_5 \equiv S_5$ $S_1 \equiv S_6$	$S_5 \equiv S_2$ $S_1 \equiv S_6$	$\times$	$S_5 \equiv S_4$ $S_1 \equiv S_3$		
$S_6$	$\times$	$\times$	$\times$	$S_6 \equiv S_5$	$\times$	$\times$	
	$S_0$	$S_1$	$S_2$	$S_3$	$S_4$	$S_5$	$S_6$

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.

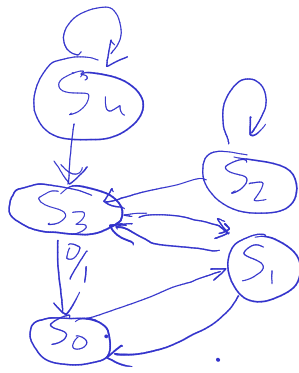
FL Tfflop's state table has only 3 states.

Mr Tfflop is not correct.

PS	NS		Output	
	$X=0$	$X=1$	$X=0$	$X=1$
$S_0$	$S_0$	$S_1$	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 Iflop'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									
B	X								
C	<del>A=F</del> <del>B=E</del>	X							
D	X	<del>E=A</del>	X						
E	<del>A=I</del> <del>B=G</del>	X	<del>F=I</del>	X					
F	<del>A=H</del> <del>B=I</del>	X	<del>F=H</del> <del>G=I</del>	X	<del>I=H</del> <del>G=I</del>				
G	X	<del>E=H</del>	X	<del>A=I</del>	X	X			
H	<del>A=F</del> <del>G=B</del>	X	<del>I=B</del>	X	<del>I=F</del> <del>G=B</del>	<del>I=B</del>	X		
I	X	<del>B=I</del>	X	<del>A=E</del>	X	X	<del>E=F</del>	X	
	A	B	C	D	E	F	G	H	I

$A \equiv H \equiv F$

$B \equiv I$

Replace Hand F with A  
I with B

PS	NS		Z
	X=D	1	
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

$(A, \check{C}), (B, \check{D}), (B, \check{D})$

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

	$y_2$		
	$A^0$	$B^2$	$C^4$
$y_0$	$G^1$	$D^3$	$E^5$
	$y_1$		

$y_2$	$y_1$	$y_0$	
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)		
	$y_2$	$y_1$	$y_0$	$x=0$	$x=1$				
	$y_2$	$y_1$	$y_0$	$y_2$	$y_1$	$y_0$	$y_2$	$y_1$	$y_0$
A $\equiv$ H $\equiv$ F	0	0	0	0	0	0	0	1	1
G	0	0	1	1	0	0	0	0	0
	0	1	0	d	d	d	d	d	d
B $\equiv$ I	0	1	1	1	0	0	1	0	1
C	1	0	0	0	0	0	0	0	1
E	1	0	1	0	1	1	0	0	1
	1	1	0	d	d	d	d	d	d
D	1	1	1	1	0	0	0	0	0

$D_2$ 

	X				
	0 <sup>0</sup>	0 <sup>4</sup>	0 <sup>12</sup>	0 <sup>8</sup>	
	1 <sup>1</sup>	0 <sup>5</sup>	0 <sup>13</sup>	0 <sup>9</sup>	
y	1 <sup>3</sup>	1 <sup>7</sup>	0 <sup>15</sup>	1 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$D_2 = \bar{x}y_1 + \bar{y}_2y_1 + \bar{x}\bar{y}_2y_0$$

 $D_1$ 

	X				
	0 <sup>0</sup>	0 <sup>4</sup>	0 <sup>12</sup>	1 <sup>8</sup>	
	0 <sup>1</sup>	1 <sup>5</sup>	0 <sup>13</sup>	0 <sup>9</sup>	
y	0 <sup>3</sup>	0 <sup>7</sup>	0 <sup>15</sup>	0 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$D_1 = \bar{x}y_2\bar{y}_1y_0 + x\bar{y}_2\bar{y}_0$$

 $D_0$ 

	X				
	0 <sup>0</sup>	0 <sup>4</sup>	1 <sup>12</sup>	1 <sup>8</sup>	
	0 <sup>1</sup>	1 <sup>5</sup>	1 <sup>13</sup>	0 <sup>9</sup>	
y	0 <sup>3</sup>	0 <sup>7</sup>	0 <sup>15</sup>	1 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$D_0 = x\bar{y}_0 + x\bar{y}_2y_1 + y_2\bar{y}_1y_0$$

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

	X				
	0 <sup>0</sup>	d <sup>4</sup>	d <sup>12</sup>	0 <sup>8</sup>	
	1 <sup>1</sup>	d <sup>5</sup>	d <sup>13</sup>	0 <sup>9</sup>	
y	1 <sup>3</sup>	d <sup>7</sup>	d <sup>15</sup>	1 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$J_1 = \bar{x}y_2y_0 + x\bar{y}_2\bar{y}_0$$

	X				
	0 <sup>0</sup>	0 <sup>4</sup>	0 <sup>12</sup>	1 <sup>8</sup>	
	0 <sup>1</sup>	1 <sup>5</sup>	0 <sup>13</sup>	0 <sup>9</sup>	
y	d <sup>3</sup>	d <sup>7</sup>	d <sup>15</sup>	d <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$J_0 = x$$

	X				
	0 <sup>0</sup>	0 <sup>4</sup>	1 <sup>12</sup>	1 <sup>8</sup>	
	d <sup>1</sup>	d <sup>5</sup>	d <sup>13</sup>	d <sup>9</sup>	
y	d <sup>3</sup>	d <sup>7</sup>	d <sup>15</sup>	d <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

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

	X				
	d <sup>0</sup>	1 <sup>4</sup>	1 <sup>12</sup>	d <sup>8</sup>	
	d <sup>1</sup>	1 <sup>5</sup>	1 <sup>13</sup>	d <sup>9</sup>	
y	d <sup>3</sup>	0 <sup>7</sup>	1 <sup>15</sup>	d <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

$$K_1 = 1$$

	X				
	d <sup>0</sup>	d <sup>4</sup>	d <sup>12</sup>	d <sup>8</sup>	
	d <sup>1</sup>	d <sup>5</sup>	d <sup>13</sup>	d <sup>9</sup>	
y	1 <sup>3</sup>	1 <sup>7</sup>	1 <sup>15</sup>	1 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				

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

	X				
	d <sup>0</sup>	d <sup>4</sup>	d <sup>12</sup>	d <sup>8</sup>	
	1 <sup>1</sup>	0 <sup>5</sup>	0 <sup>13</sup>	1 <sup>9</sup>	
y	1 <sup>3</sup>	1 <sup>7</sup>	1 <sup>15</sup>	1 <sup>11</sup>	y <sub>0</sub>
	d <sup>2</sup>	d <sup>6</sup>	d <sup>14</sup>	d <sup>10</sup>	
	y <sub>2</sub>				