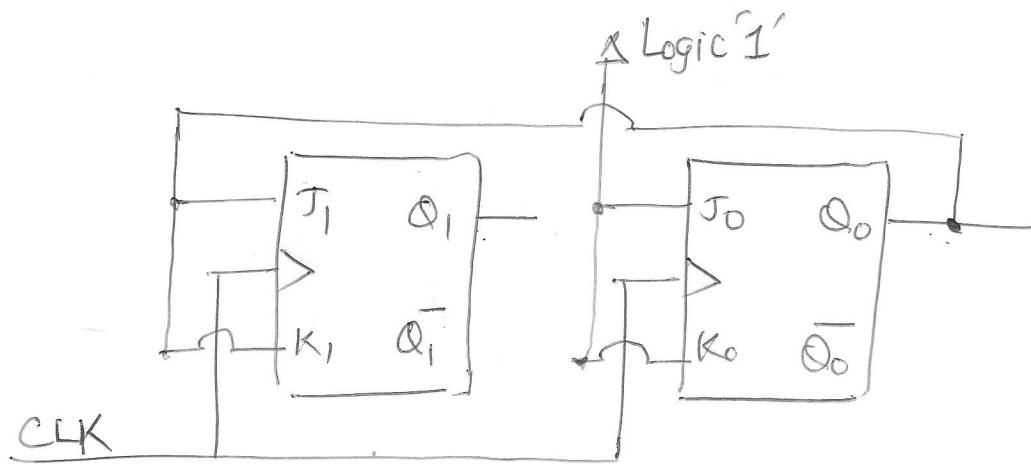
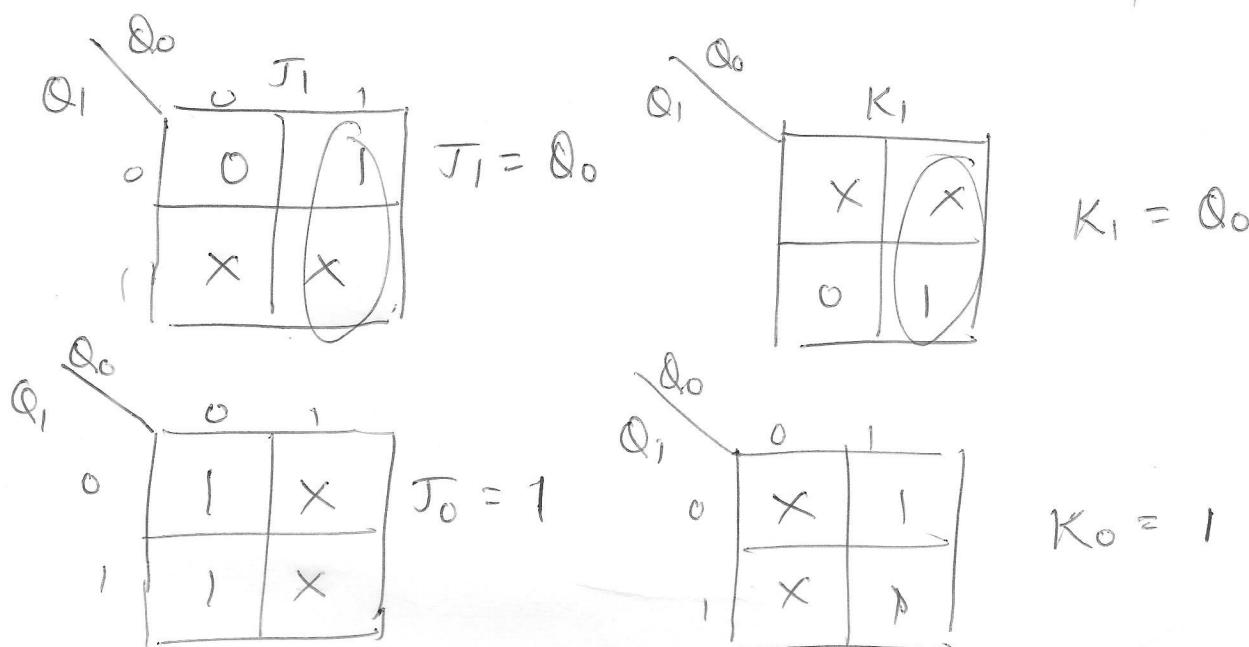


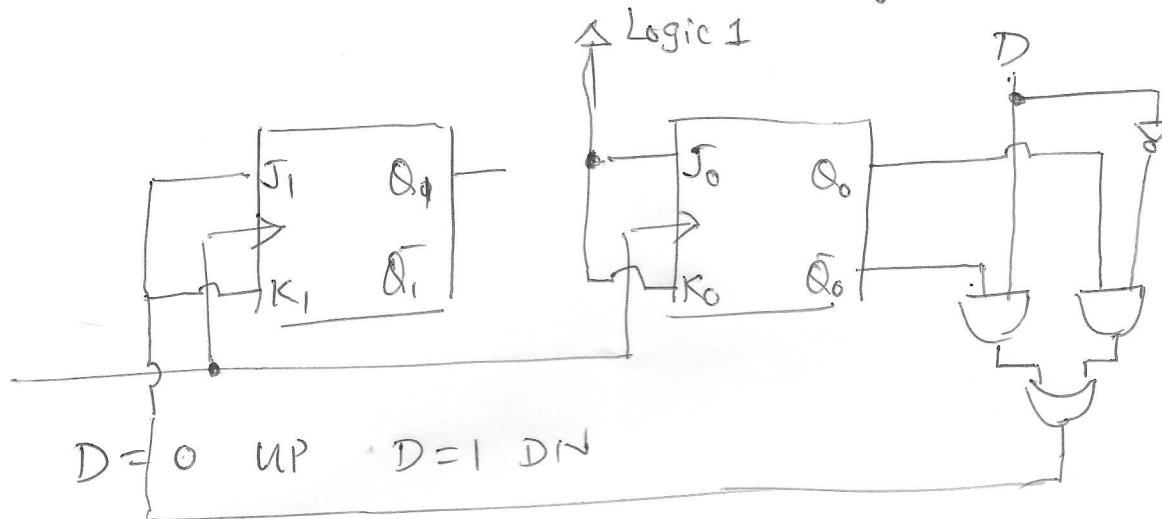
# Synchronous 2bit up counter using JK FF



Q <sub>1</sub>	Q <sub>0</sub>	Q <sub>1</sub> <sup>+</sup>	Q <sub>0</sub> <sup>+</sup>	J <sub>1</sub>	K <sub>1</sub>	J <sub>0</sub>	K <sub>0</sub>
0	0	0	1	0	X	1	X
0	1	1	0	1	X	X	1
1	0	1	1	X	0	1	X
1	1	0	0	X	1	X	1



# Synchronous 2 Bit up/DN counter using JK FF



$D$	$Q_1$	$Q_0$	$Q_1^+$	$Q_0^+$	$J_1$	$K_1$	$J_0$	$K_0$
0	0	0	0	1	0	X	1	X
0	0	1	1	0	1	X	X	1
0	1	0	1	1	X	0	1	X
0	1	1	0	0	X	1	X	X
1	0	0	1	1	0	X	1	X
1	0	1	0	0	0	X	X	1
1	1	0	0	1	X	1	1	X
1	1	1	1	0	X	0	X	1

$Q$	$Q^+$	$J$	$K$
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

$D$	$Q_1$	$Q_0$	$J_1$	$J_0$
0	0	0	0	1
1	0	1	1	0

$$J_1 = D'Q_0 + D \cdot Q_0'$$

$D$	$Q_1$	$Q_0$	$J_1$	$J_0$
0	X	X	1	0
1	X	X	0	1

$$K_1 = D'Q_0 + D \cdot Q_0'$$

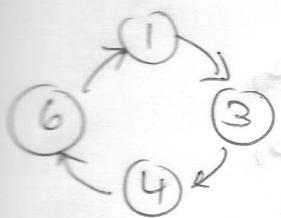
$D$	$Q_1$	$Q_0$	$J_0$
0	1	X	X
1	X	X	1

$$J_0 = 1$$

$D$	$Q_1$	$Q_0$	$K_0$
0	X	1	X
1	1	1	X

$$K_0 = 1$$

### 3 bit sequence generator using JK



$Q$	$Q^+$	$J$	$K$
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

$Q_2$	$Q_1$	$Q_0$	$Q_2^+$	$Q_1^+$	$Q_0^+$	$J_2$	$K_2$	$J_1$	$K_1$	$J_0$	$K_0$
0	0	0	.	.	.	.	.	.	.	.	.
0	0	1	0	1	1	0	x	1	x	x	0
0	1	0	.	.	.	.	.	.	.	.	.
0	1	1	1	1	0	0	1	x	x	1	x
1	0	0	1	1	1	0	x	0	1	x	0
1	0	1	.	.	.	.	.	.	.	.	.
1	1	0	0	0	0	1	x	1	x	1	0
1	1	1	1	.	.	.	.	.	.	.	.

$Q_2$	00	01	11	10
0	x 0	1	x	
1	x x	x x		

$$J_2 = Q_1$$

$Q_2$	00	01	11	10
0	x x	x x	x x	
1	0 x	x x		1

$$K_2 = Q_1$$

$Q_2$	00	01	11	10
0	x	x	x x	x x
1	1 x	x x	x x	x x

$$\bar{J}_1 = 1$$

$Q_2$	x	x	1	x
0	x x	x x	x x	x x

$$K_1 = 1$$

$Q_2$	00	01	11	10
0	x x	x x	x x	x x
1	0 x	x x	x x	0

$$J_0 = 0$$

$Q_2$	00	01	11	10
0	x 0	1	x	
1	x x	x x	x x	x x

$$K_0 = Q_1$$

$Q_2$	$Q_1$	$Q_0$	$Q_2^+$	$Q_1^+$	$Q_0^+$	
0	0	0	0	1	0	
0	0	1	0	1	1	
0	1	0	1	0	0	
0	1	1	1	0	0	
1	0	0	1	1	0	
1	0	1	1	1	1	
1	1	0	0	0	0	
1	1	1	0	0	0	

$$\bar{J}_2 = Q_1$$

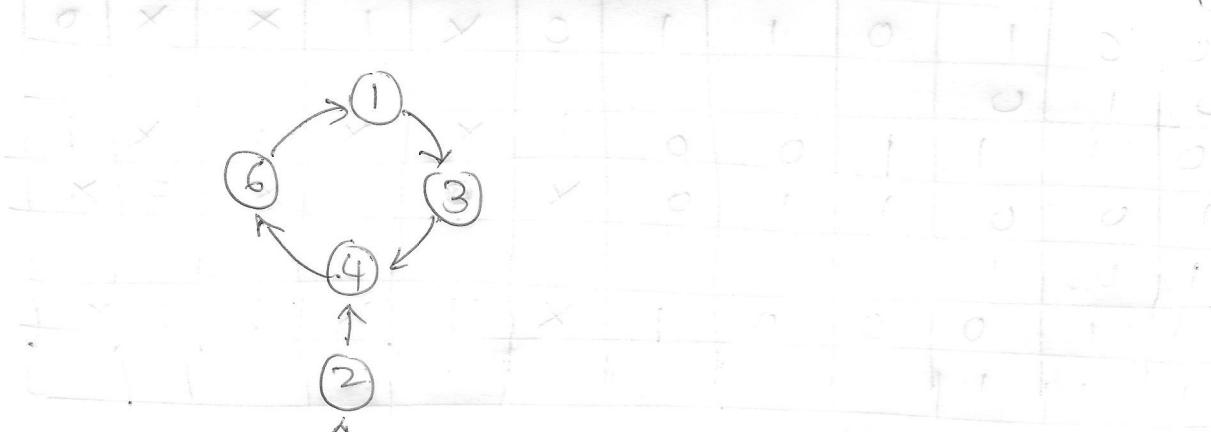
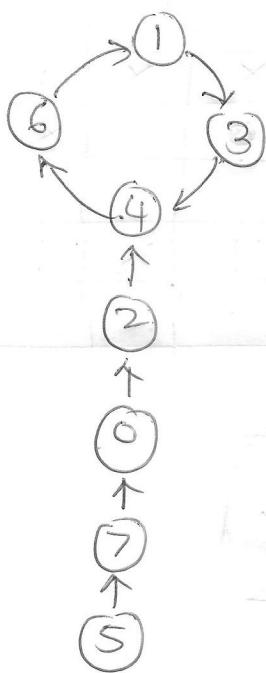
$$K_2 = \bar{Q}_1$$

$$\bar{J}_1 = 1$$

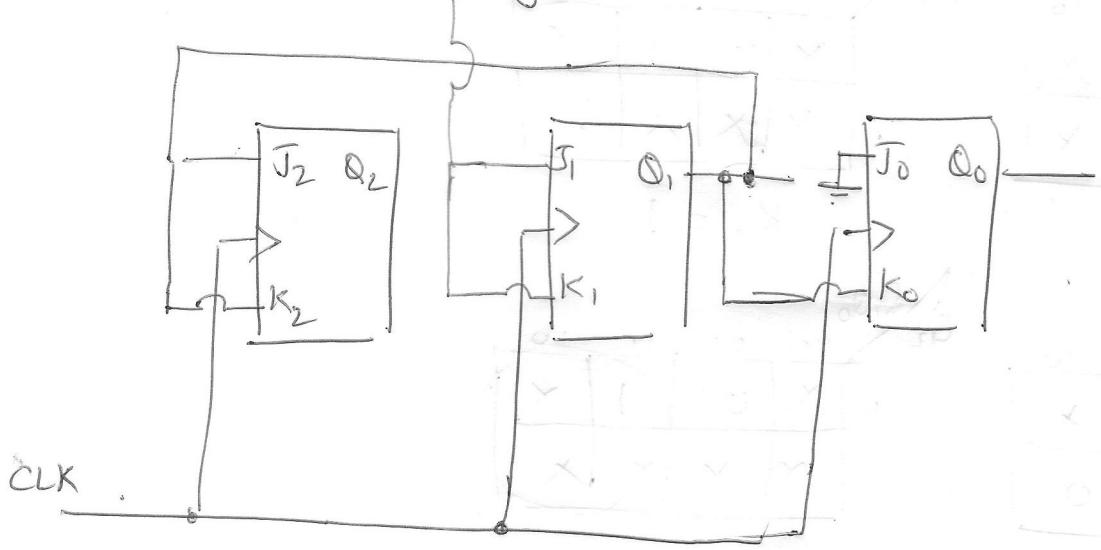
$$K_1 = 1$$

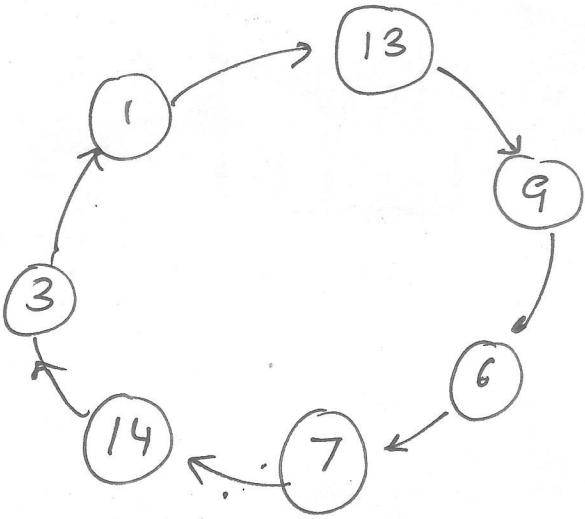
$$\bar{J}_0 = 0$$

$$K_0 = Q_1$$



↑ logic '1'





74 HC 76.

74 HC 32

74 HC 08

$Q_n$	$Q_{n+1}$	J	K
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

$Q_3$	$Q_2$	$Q_1$	$Q_0$	$J_3$	$K_3$	$J_2$	$K_2$	$J_1$	$K_1$	$J_0$	$K_0$
0	0	0	1	1	X	1	X	0	X	X	0
1	1	0	1	X	0	X	0	1	X	X	0
1	0	0	1	X	1	1	X	1	X	X	1
0	1	1	0	0	X	X	0	X	0	1	X
0	1	1	1	1	X	X	0	X	0	X	1
1	1	1	0	X	X	1	X	0	1	X	
0	0	1	1	0	X	0	X	X	1	X	0
0	0	0	1								

→

1

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$Q_3 Q_2$	$Q_1 Q_0$
00	10
01	11
10	11
11	11
10	11

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$$J_3 = \bar{Q}_1 + Q_0 Q_2$$

$$K_3 = Q_1 + \bar{Q}_2$$

$$J_2 = \bar{Q}_1$$

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$Q_3 Q_2$	$Q_1 Q_0$
00	01
01	11
10	11
11	11
10	11

$$K_2 = Q_3$$

$$J_1 = Q_3 \bar{Q}_2$$

$$K_1 = \bar{Q}_2$$

$$K_0 = \bar{Q}_3 Q_2 + Q_3 \bar{Q}_2$$

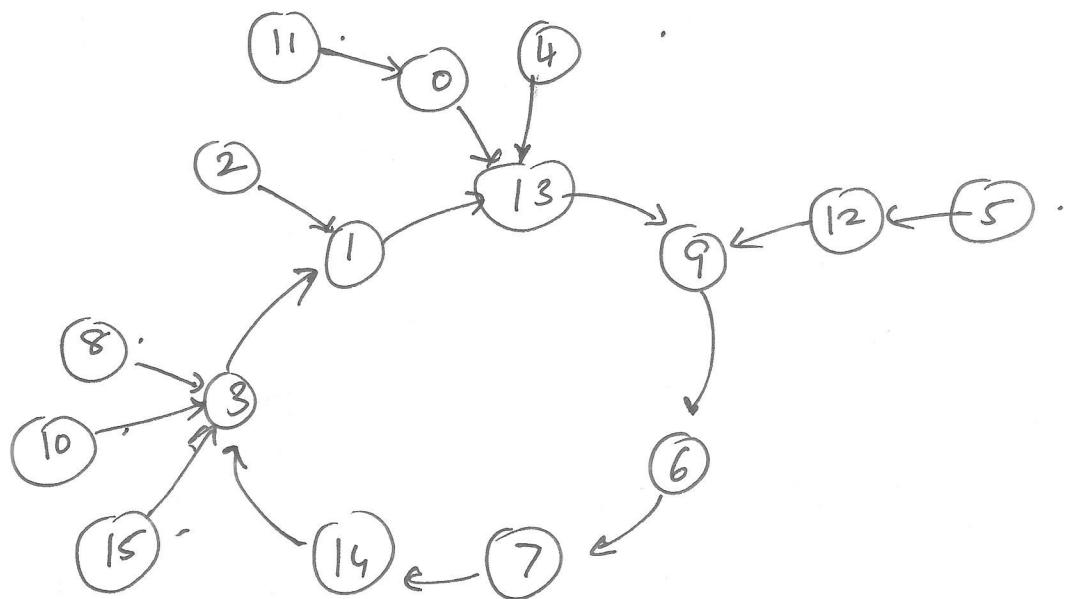
$$J_1 = 1$$

$$= Q_3^{\text{inv}} Q_2$$

$$J_3 = \bar{Q}_1 + Q_2 Q_0 \quad J_2 = \bar{Q}_1 \quad J_1 = Q_3 \cdot \bar{Q}_2 \quad J_0 = 1$$

$$K_3 = Q_1 + \bar{Q}_2 \quad K_2 = Q_3 \quad K_1 = \bar{Q}_2 \quad K_0 = Q_3 \wedge Q_2$$

$Q_3$	$Q_2$	$Q_1$	$Q_0$	$J_3$	$K_3$	$J_2$	$K_2$	$J_1$	$K_1$	$J_0$	$K_0$	$Q_3$	$Q_2$	$Q_1$	$Q_0$	$d_0$
0	0	0	0	1.	1	1	0	0	1	1	0	1	1	0	1	13
0	0	1.	0	0	1	0	0	0	1.	1	0	0	0	0	1	1
0	1.	0	0	1	0	1	0	0	0	1	1	1	0	1	1	13
0	1	0	1	1	0	1	0	0	0	1	1	1	0	0	0	12
1	0	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1
1	0	1	0	0	1	0	1	1	1	1	1	0	0	0	1	1
1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	0	0
1	1	0	0	1	0	1	1	0	0	1	0	1	0	0	1	9
1	1	1	1	1	1	0	1	0	0	1	0	0	0	1	1	3



mod 10 using JK

$Q_n$	$Q_{n+1}$	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

	01	Q <sub>0</sub>	01	11	10
00	0	0	0	0	0
01	0	0	1	0	0
11	X	X	X	X	X
10	X	X	X	X	X

$$J_3 = Q_2 Q_1 Q_0 .$$

	0	0	1	0
0	X	X	X	X
1	X	X	X	X
0	0	X	X	X
1	0	X	X	X

$$J_2 = Q_1 Q_0 .$$

	01	11		
00	X	X	X	X
01	X	X	X	X
11	X	X	X	X
00	0	1	X	X

$$K_3 = Q_0 .$$

	1			
00	X	X	X	X
01	0	1	0	0
11	X	X	X	X
00	X	X	X	X

$$K_2 = Q_1 Q_0 .$$

	01	11		
00	0	1	X	X
01	0	1	X	X
11	X	X	X	X
00	0	0	X	X

$$J_1 = \bar{Q}_3 Q_0 .$$

	01	11		
00	X	X	1	0
01	X	X	1	0
11	X	X	X	X
00	X	X	X	X

$$K_1 = Q_0 .$$

1	X	X	1
1	X	X	1
X	X	X	X
1	X	X	X

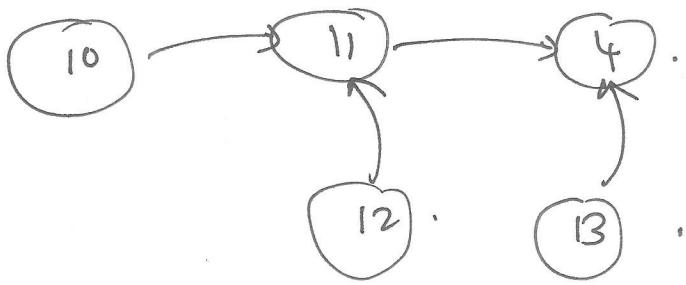
$$J_0 = 1$$

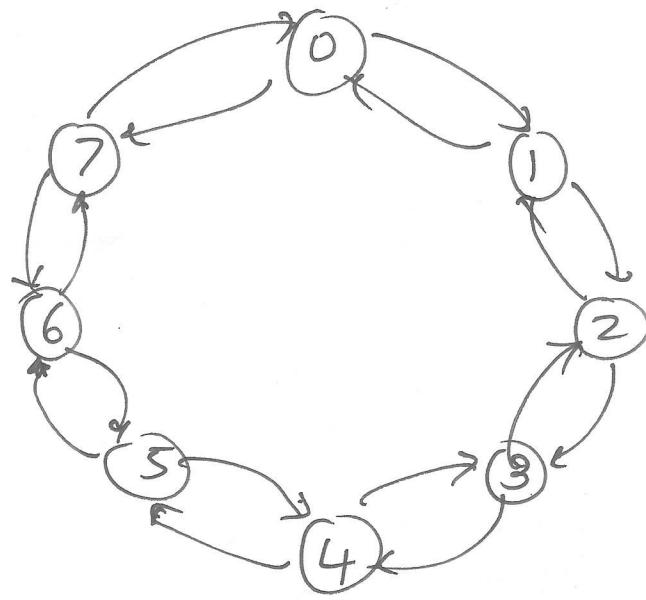
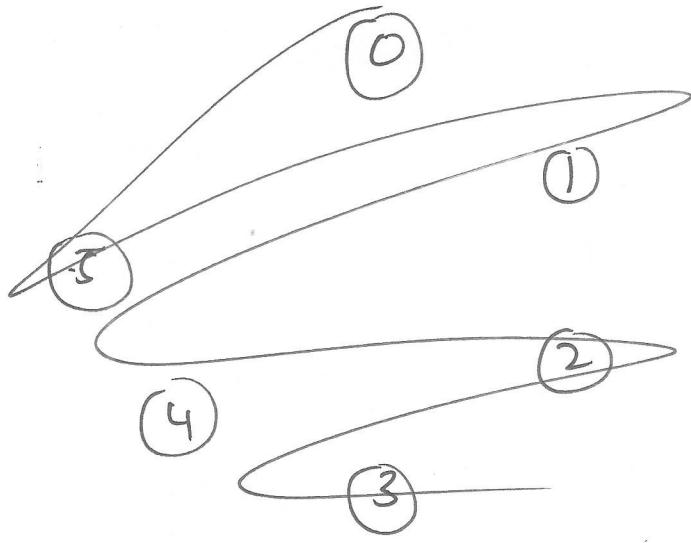
X	1	1	1	X
X	1	1	1	X
X	X	X	X	X
X	1	X	X	X

$$K_0 = 1$$

$$\begin{array}{l}
 J_3 = Q_2 Q_1 Q_0 \quad J_2 = Q_1 Q_0 \quad J_1 = \bar{Q}_3 Q_0 \quad J_0 = 1 \\
 K_2 = Q_0 \quad K_2 = Q_1 Q_0 \quad K_1 = Q_0 \quad K_0 = 1
 \end{array}$$

$Q_3$	$Q_2$	$Q_1$	$Q_0$	$J_3$	$K_3$	$J_2$	$K_2$	$J_1$	$K_1$	$J_0$	$K_0$
1	0	1	0	0	0	0	0	0	0	1	1
1	0	1	1	0	1	1	1	0	1	1	0
1	1	0	0	0	0	0	0	0	1	1	1
1	1	0	1	0	1	0	0	0	1	1	0
1	1	1	0	0	0	0	0	0	1	1	1
1	1	1	1	1	1	1	0	1	1	1	0
											.





D	Q <sub>2</sub>	Q <sub>1</sub>	Q <sub>0</sub>	J <sub>2</sub>	K <sub>2</sub>	J <sub>1</sub>	K <sub>1</sub>	J <sub>0</sub>	K <sub>0</sub>
0	0.	0.	0	1	x	1	x	1	x
0	0	0	1	0	x	0	x	x	1
0	c	1	0	0	x	x	1	1	x
0	0	1	1	0	x	x	0	x	1
0	1	0	0	x	1	1	x	1	x
0	1	0	1	x	0	0	x	x	1
0	1	1	0	x	c	x	1	1	x
0	1	1	1	x	0	x	0	x	1
1	0	0	0	0	x	0	x	1	x
1	0	0	1	0	x	1	x	x	1
1	0	1	0	0	x	x	0	1	x
1	0	1	1	1	x	x	1	x	1
1	1	0	0	x	0	0	x	1	x
1	1	0	1	x	0	1	x	x	1
1	1	0	0	x	0	x	0	1	x
1	1	1	1	x	x	1	x	1	1

$Q_0$	$Q_1$	$Q_2$	$Q_3$
00	1	0	0
01	X	X	X
11	X	X	X
10	0	0	1

$$J_2 = D \cdot Q_1 \cdot Q_0 + \bar{D} \cdot \bar{Q}_1 \cdot \bar{Q}_0$$

$Q_0$	$Q_1$	$Q_2$	$Q_3$
00	X	X	X
01	1	0	0
11	0	0	1
10	X	X	X

$$K_2 = \bar{D} \cdot \bar{Q}_1 \cdot \bar{Q}_0 + D \cdot Q_1 \cdot Q_0$$

$Q_0$	$Q_1$	$Q_2$	$Q_3$
00	1	0	X
01	0	X	X
11	0	1	X
10	0	1	X

$$J_1 = D Q_0 + \bar{D} \bar{Q}_0$$

$Q_0$	$Q_1$	$Q_2$	$Q_3$
00	X	X	0
01	X	X	0
11	X	X	1
10	X	X	0

$$K_1 = D Q_0 + \bar{D} \bar{Q}_0$$

1	X	X	1
(	X	X	)
1	X	X	1
1	X	X	X

X	1	1	X
X	1	1	X
X	1	1	X
X	1	1	X

$$J_0 = 1$$

$$K_0 = 1$$