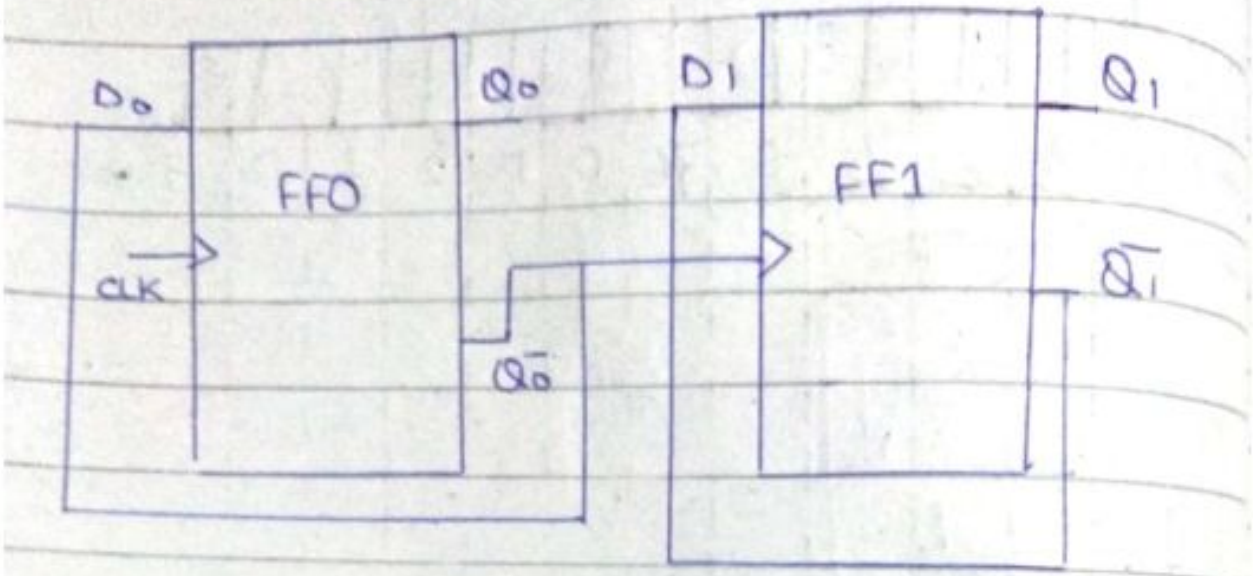
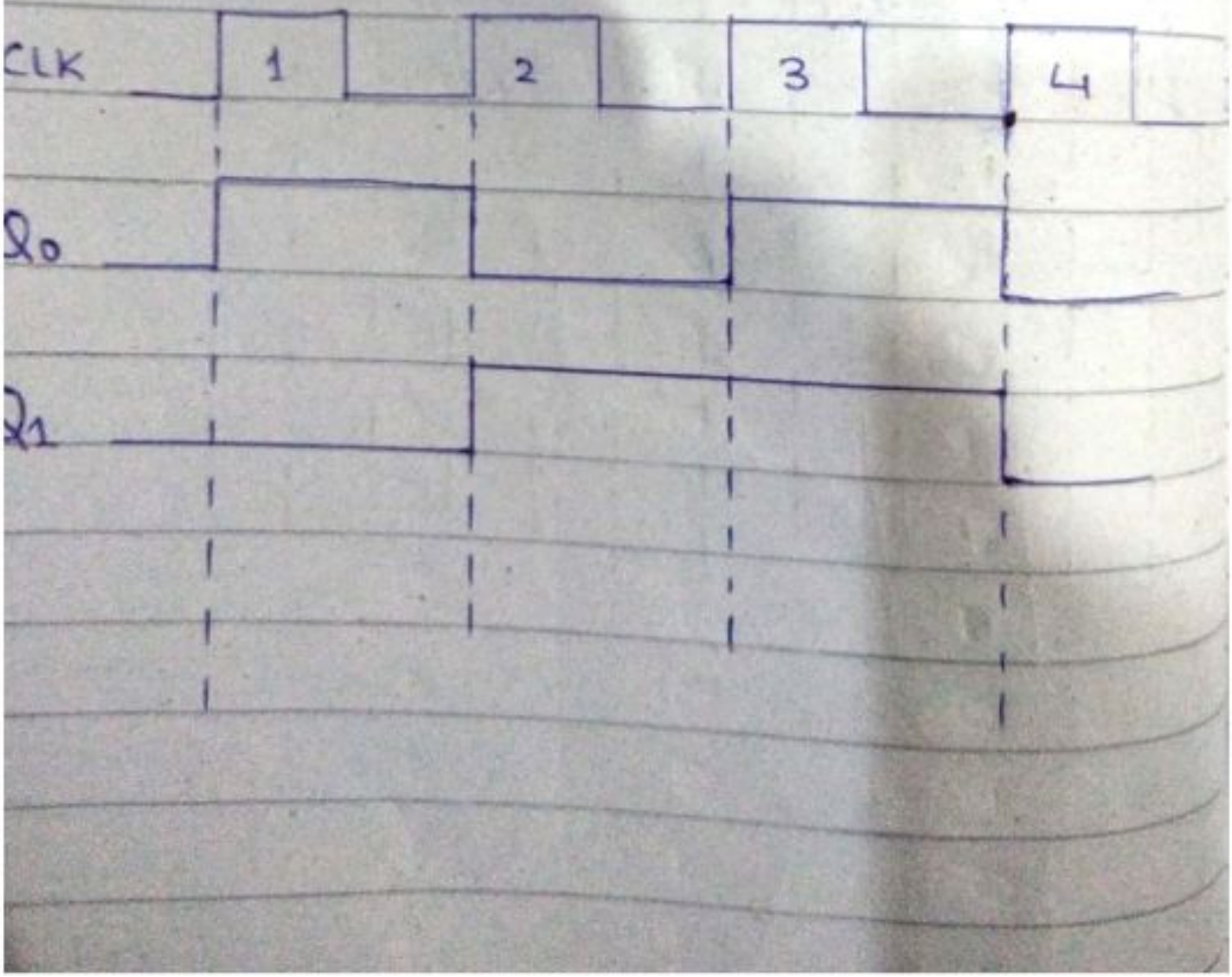
⇒ Asynchronous Counter :-

⇒ 2 bit :



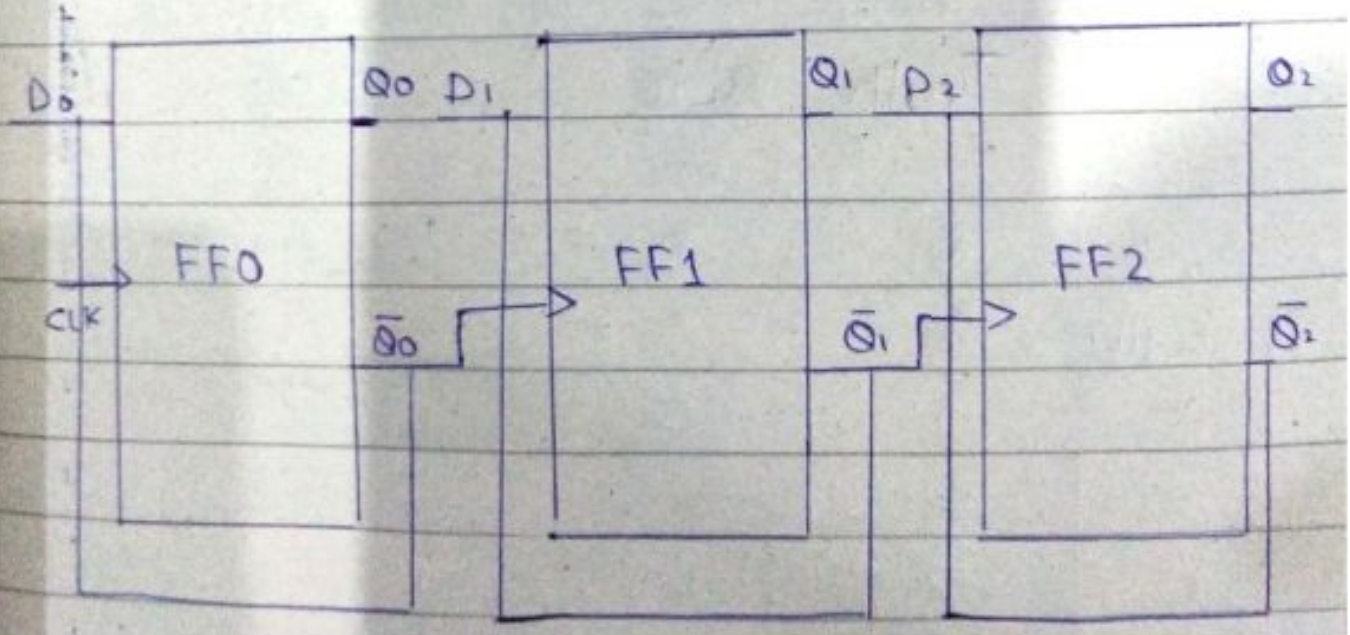


Scanned with CamScanner

Truth table

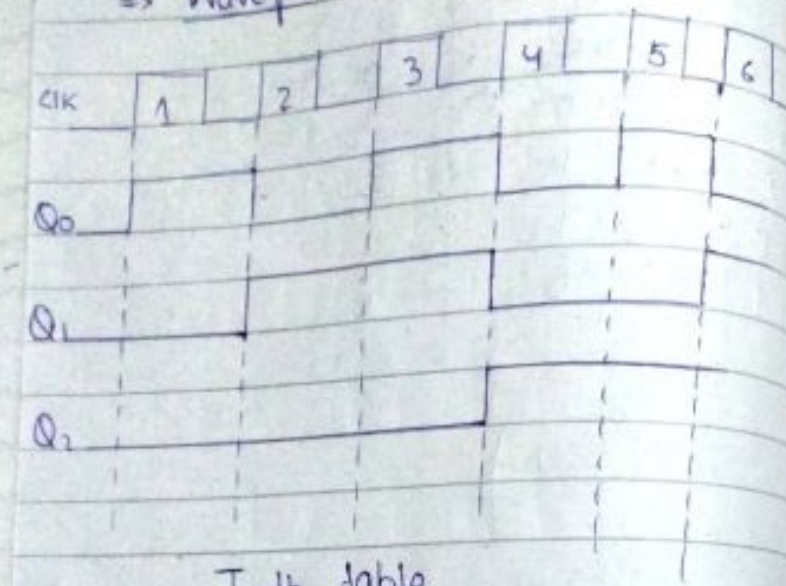
clock	Q_1 → M·S·B	Q_0 → L·S·B
Initially	0	0
1 ↑	0	1
2 ↑	1	0
3 ↑	1	1
4 ↑	0	0

3 bit



Scanned with CamScanner

=> Waveform:-

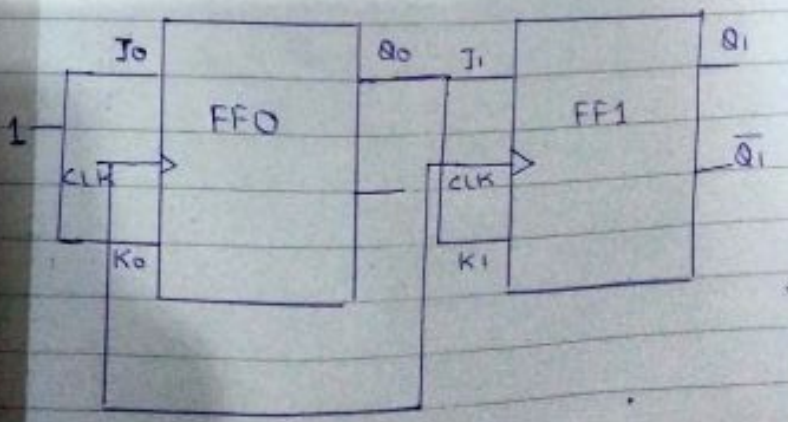


Truth table

Clock	Q_2	Q_1	Q_0
Initially	0	0	0
1↑	0	0	1
2↑	0	1	0
3↑	0	1	1
4↑	1	0	0
5↑	1	0	1
6↑	1	1	0
7↑	1	1	1
8↑	0	0	0

Synchronous counter

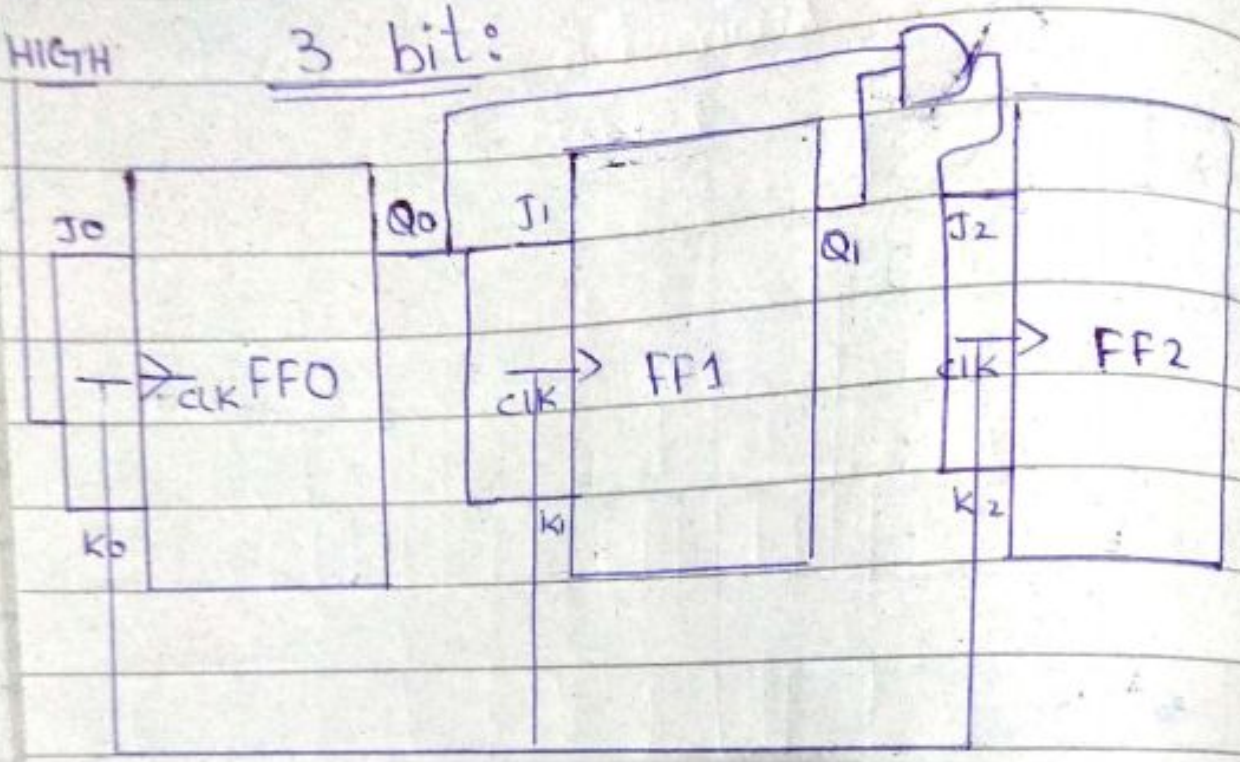
2-bit:



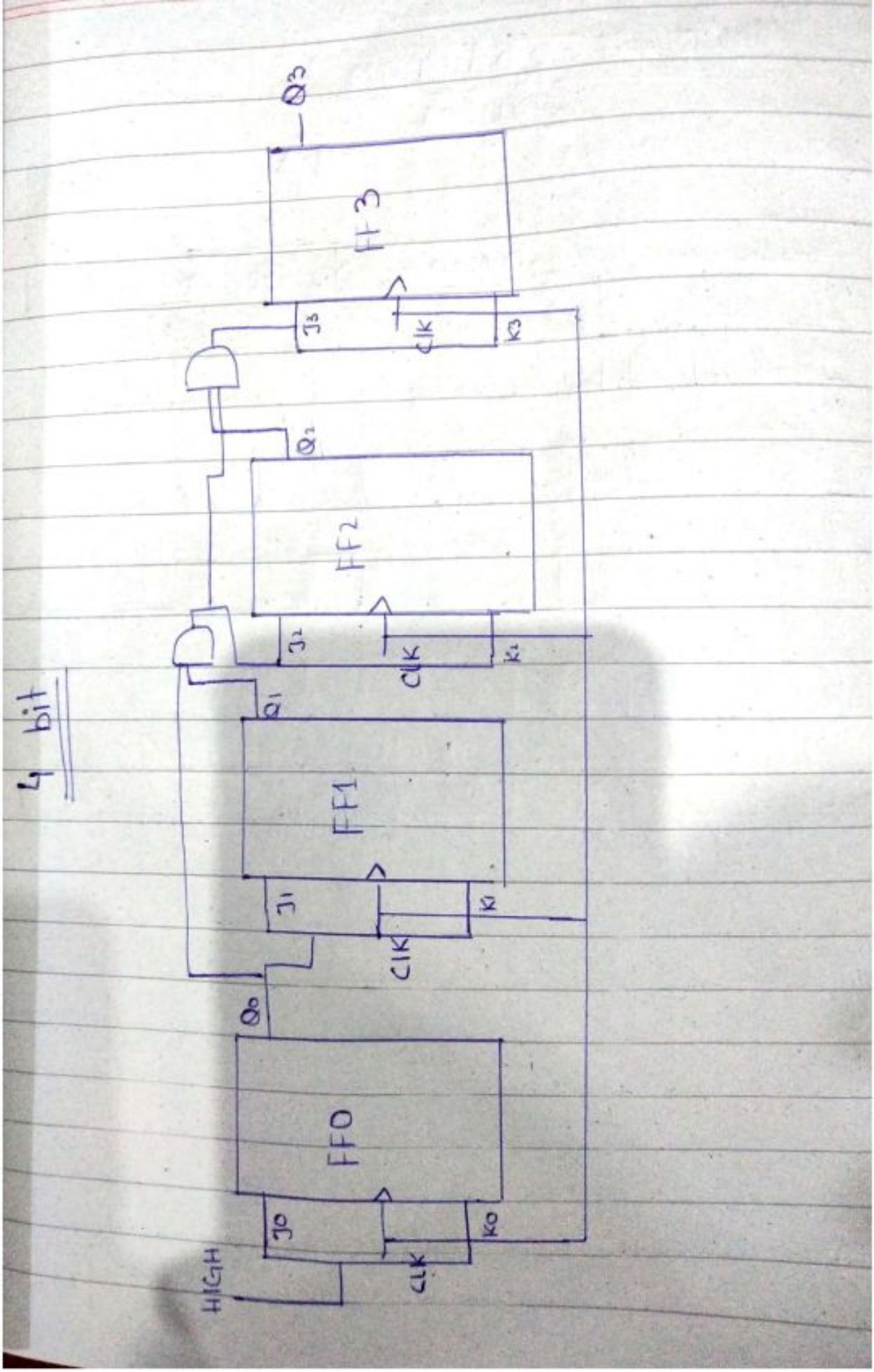
Scanned with CamScanner

HIGH

3 bit:



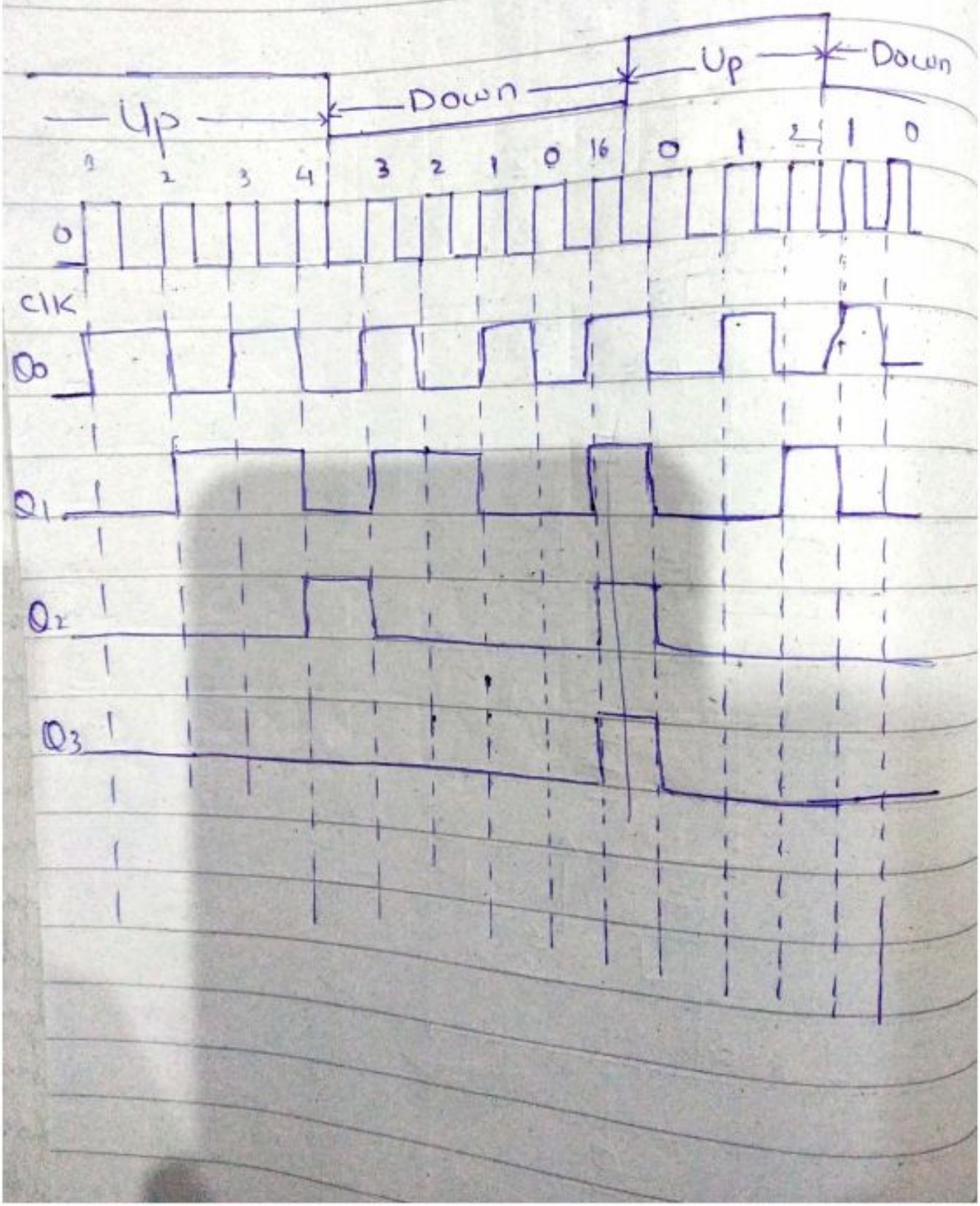
Scanned with CamScanner



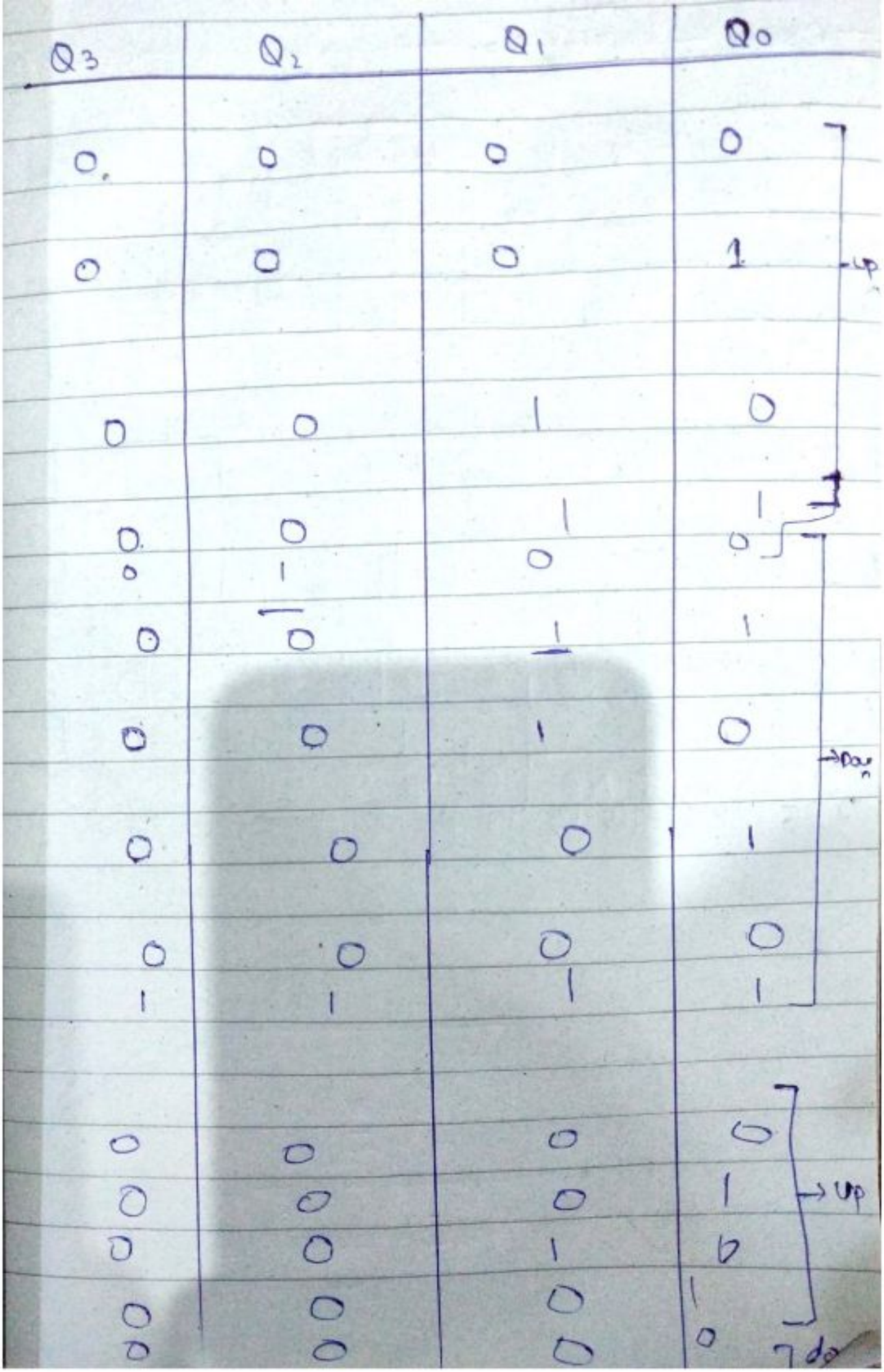
Scanned with CamScanner

Up/Down synchronous counter

9.3

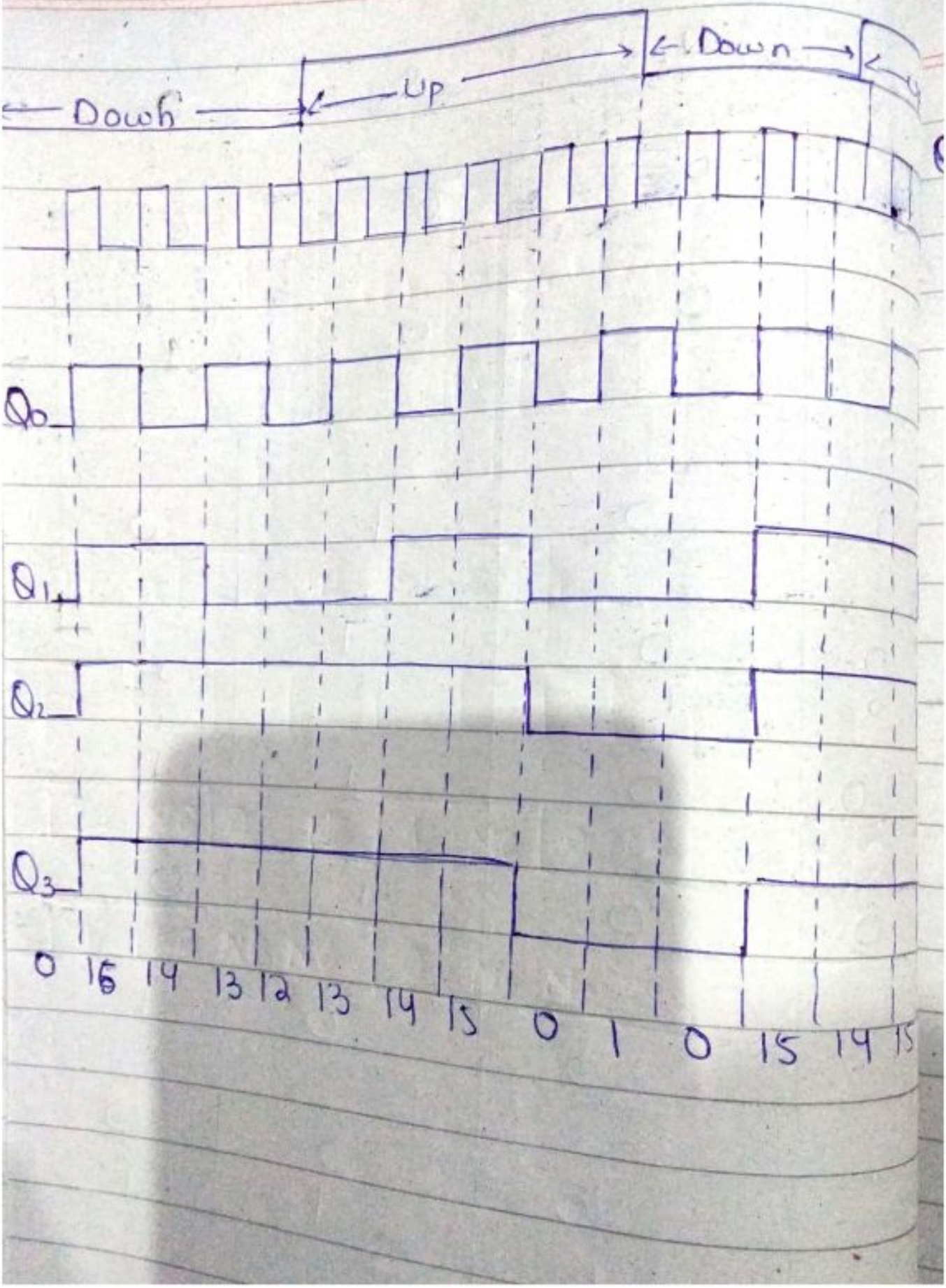


Scanned with CamScanner



Scanned with CamScanner

Related problem



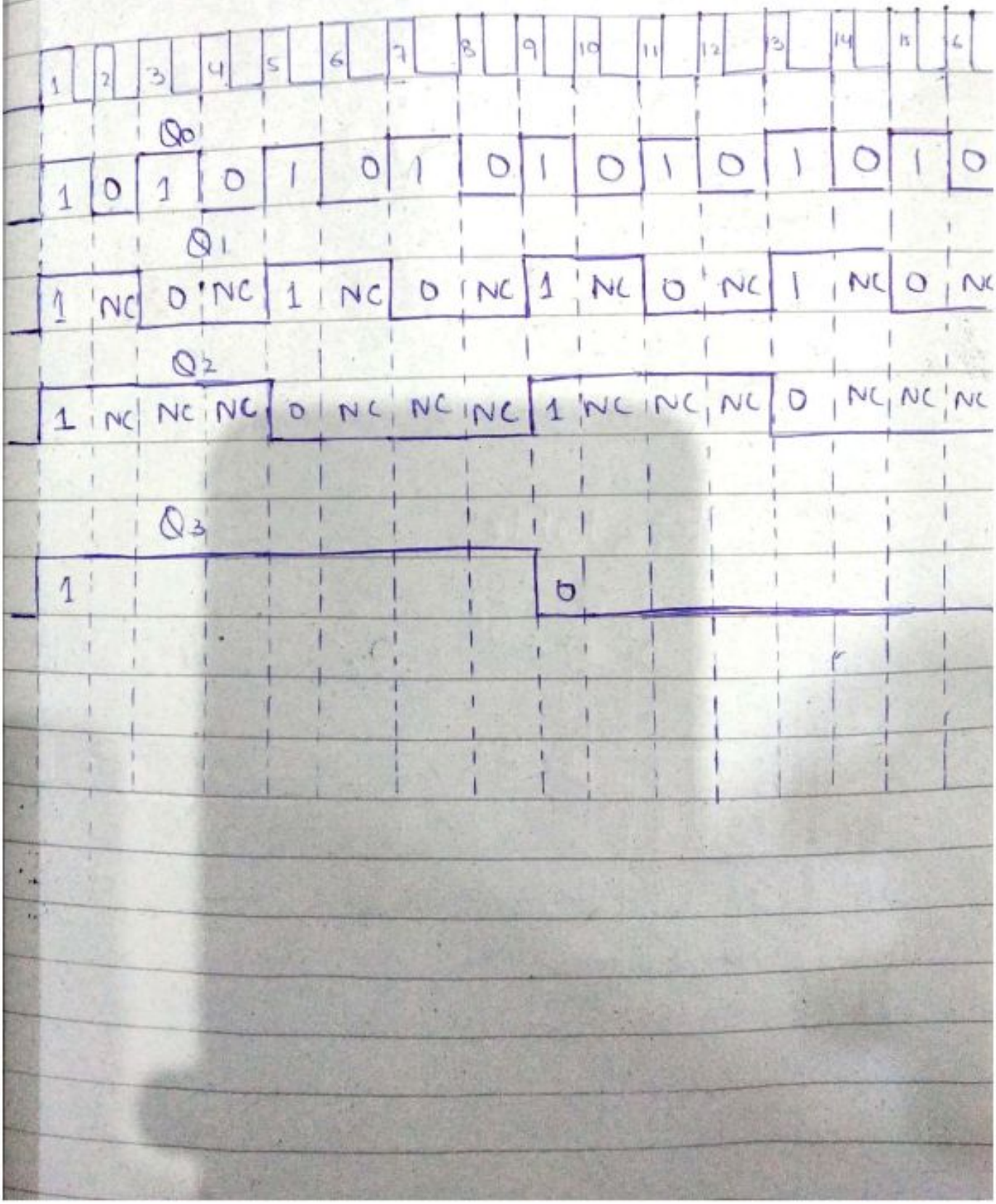
Scanned with CamScanner

Truth table

Q_3	Q_2	Q_1	Q_0	
0	0	0	0	Down
1	1	1	1	
1	1	1	0	
1	1	0	1	
1	1	0	0	
1	1	0	1	up
1	1	1	0	
1	1	1	1	
0	0	0	0	
0	0	0	1	
0	0	0	0	down
1	1	1	1	
1	1	1	0	
1	1	1	1	up
0	0	0	0	

Scanned with CamScanner

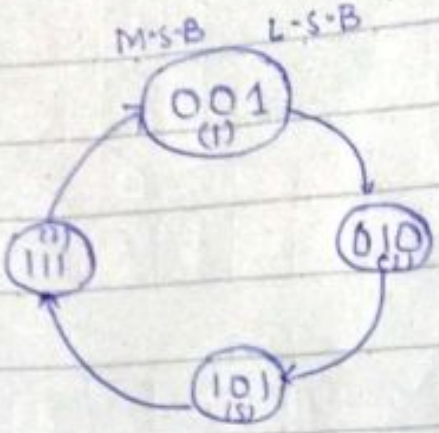
9.1 Related problem



Scanned with CamScanner

Example: 9.4

Sol:-



Step: 01

=> Next state table

Q_2	Q_1	Q_0	Q_2'	Q_1'	Q_0'
0	0	1	0	1	0
0	1	0	1	0	1
1	0	1	1	1	1
1	1	1	0	0	1

Scanned with CamScanner

⇒ step : 02

⇒ Excitation table

Q_2	Q_2'	D_2
0	0	0
0	1	1
1	1	1
1	0	0

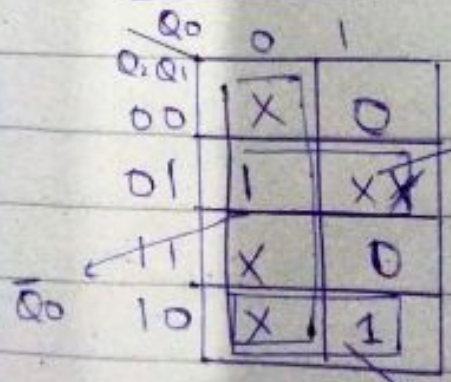
Q_1	Q_1'	D_1
0	1	1
1	0	0
0	1	1
1	0	0

Q_0	Q_0'	D_0
1	0	0
0	1	1
1	1	1
1	1	1

Step : 03

Using K-map

For D_2

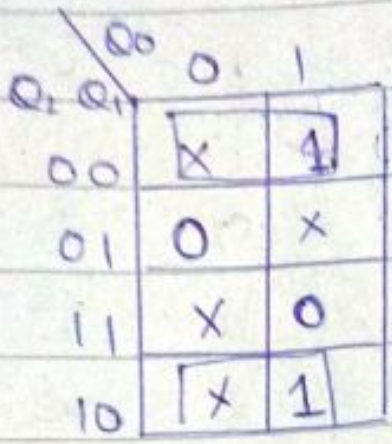


$D_2 = \bar{Q_0} + Q_1\bar{Q_1} + Q_2\bar{Q_1}$

$Q_2\bar{Q_1}$ $D_2 = \bar{Q_0} + Q_2\bar{Q_1}$

Scanned with CamScanner

For D_1



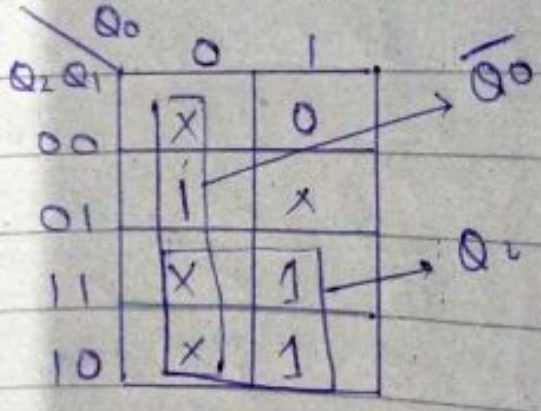
Q_2Q_1 \ Q_0	0	1
00	X	1
01	0	X
11	X	0
10	X	1

$D_1 = \bar{Q}_1\bar{Q}_2 + Q_2\bar{Q}_1$

$= \bar{Q}_1(Q_2 + \bar{Q}_2)$

$= \bar{Q}_1$

For D_0

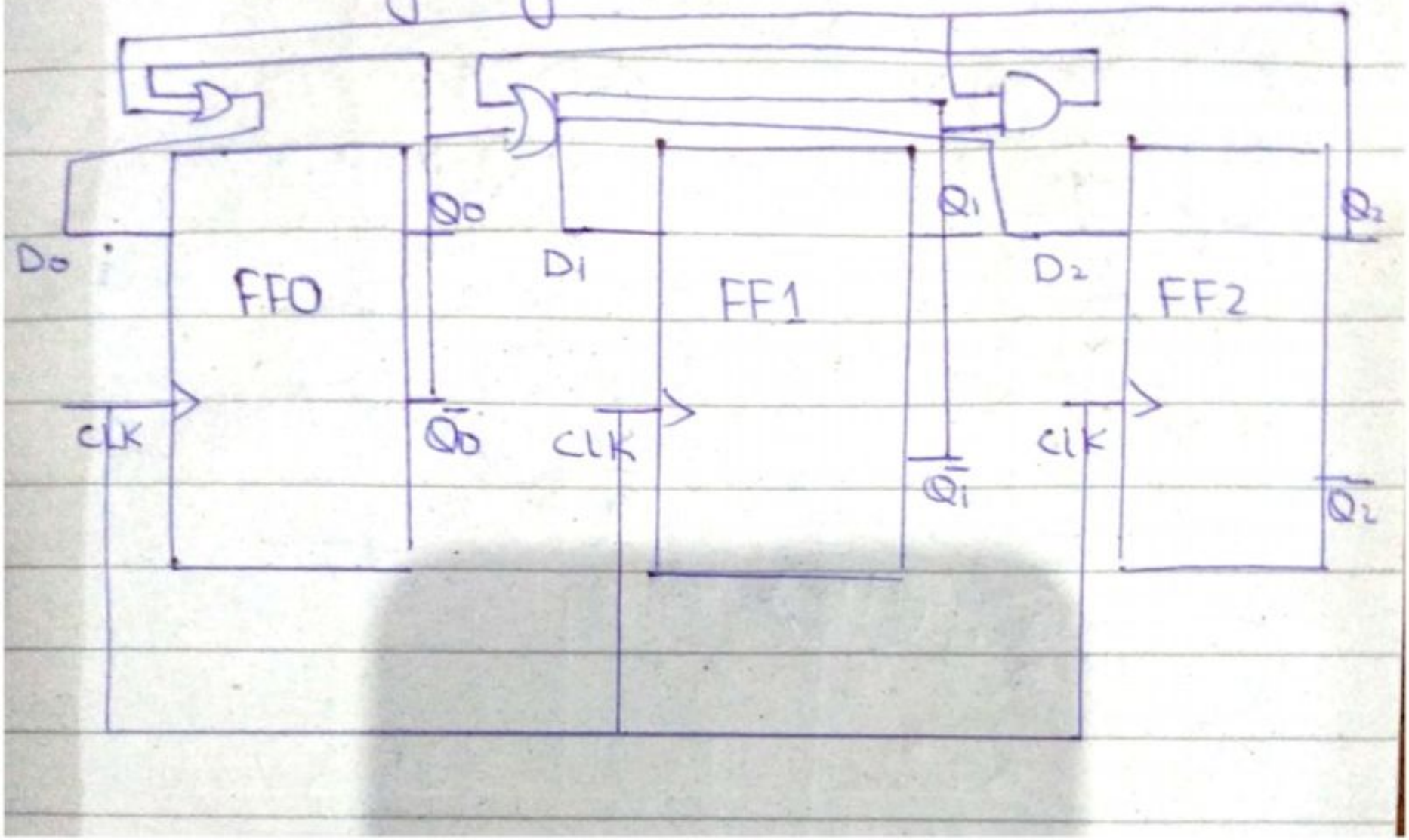


Q_2Q_1 \ Q_0	0	1
00	X	0
01	1	X
11	X	1
10	X	1

$D_0 = \bar{Q}_0 + Q_2$

Scanned with CamScanner

=> Designing counter

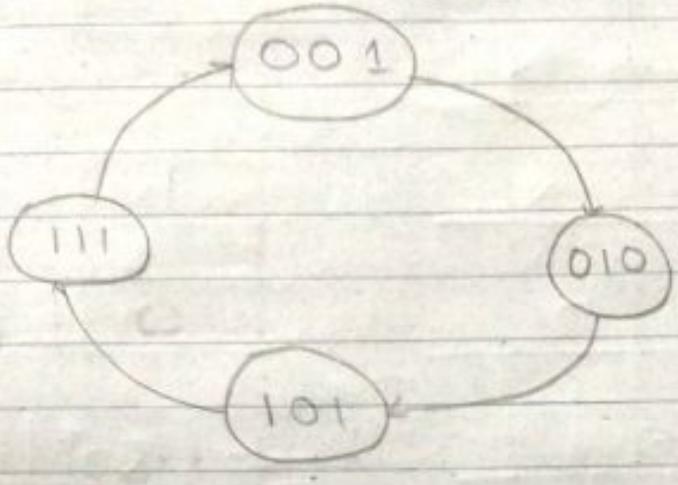


Scanned with CamScanner

Q.1

1 - 2 - 5 - 7

State diagram



Next state table

Q_2	Q_1	Q_0	Q_2^*	Q_1^*	Q_0^*
0	0	1	0	1	0
0	1	0	1	0	1
1	0	1	1	1	1
1	1	1	0	0	1

Scanned with CamScanner

Transition table

Q_2	Q_2^*	J_2	K_2
0	0	0	X
0	1	1	X
1	1	X	0
1	0	X	1

Q_1	Q_1^*	J_1	K_1
0	1	1	X
1	0	X	1
0	1	1	X
1	0	X	1

Q_0	Q_0^*	J_0	K_0
1	0	X	1
0	1	1	X
1	1	X	0
1	1	X	0

Scanned with CamScanner

Truth table

Q_2Q_1 \ Q_0	0	1
00	X	0
01	1	X
11	X	X
10	X	X

J_2

$\rightarrow Q_1 = J_2$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	X	X
11	X	1
10	X	0

$K_2 = \rightarrow Q_1$

Q_2Q_1 \ Q_0	0	1
00	X	1
01	X	X
11	X	X
10	X	1

J_1

$J_1 = 1$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	1	X
11	X	1
10	X	X

K_1

$K_1 = 1$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	1	X
11	X	X
10	X	X

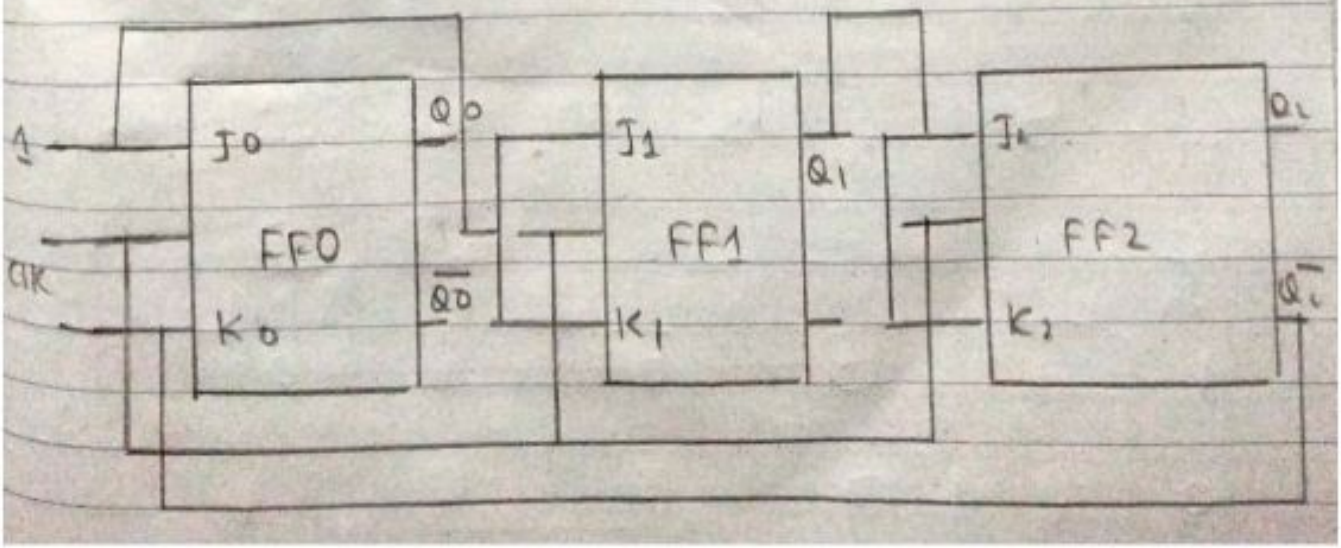
J_0

$J_0 = 1$

Q_2Q_1 \ Q_0	0	1
00	X	1
01	X	X
11	X	0
10	X	0

K_0

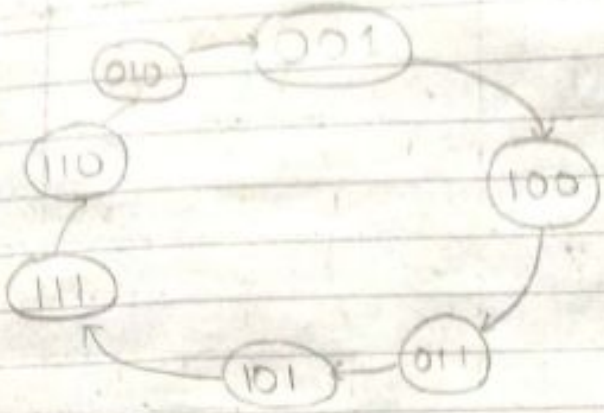
$K_0 = \overline{Q_2}$



Scanned with CamScanner

Q.21

State diagram



Next state table

Q_2	Q_1	Q_0	Q_2^*	Q_1^*	Q_0^*
0	0	1	1	0	0
1	0	0	0	1	1
0	1	1	1	0	1
1	0	1	1	1	1
1	1	1	1	1	0
1	1	0	0	1	0
0	1	0	0	0	1

Scanned with CamScanner

Transition table

Q_2	Q_2^*	J_2	K_2	Q_1	Q_1^*	J_1	K_1
0	1	1	X	0	0	0	X
1	0	X	1	0	1	1	X
0	1	1	X	1	0	X	1
1	1	X	0	0	1	1	X
1	1	X	0	1	1	X	0
1	0	X	1	1	1	X	0
0	0	0	X	1	0	X	1

Q_0	Q_0^*	J_0	K_0
1	0	X	1
0	1	1	X
1	1	X	0
1	1	X	0
1	0	X	1
0	0	0	X
0	1	1	X

Scanned with CamScanner

Q_2Q_1 \ Q_0	0	1
00	X	1
01	0	1
11	X	X
10	X	X

$T_2 = Q_0$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	X	X
11	1	0
10	1	0

$K_2 = \overline{Q_0}$

Q_2Q_1 \ Q_0	0	1
00	X	0
01	X	X
11	X	X
10	1	1

$J_1 = Q_2$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	1	1
11	0	0
10	X	X

$K_1 = \overline{Q_2}$

Q_2Q_1 \ Q_0	0	1
00	X	X
01	1	X
11	0	X
10	1	X

$J_0 = \overline{Q_2} + Q_2\overline{Q_1}$

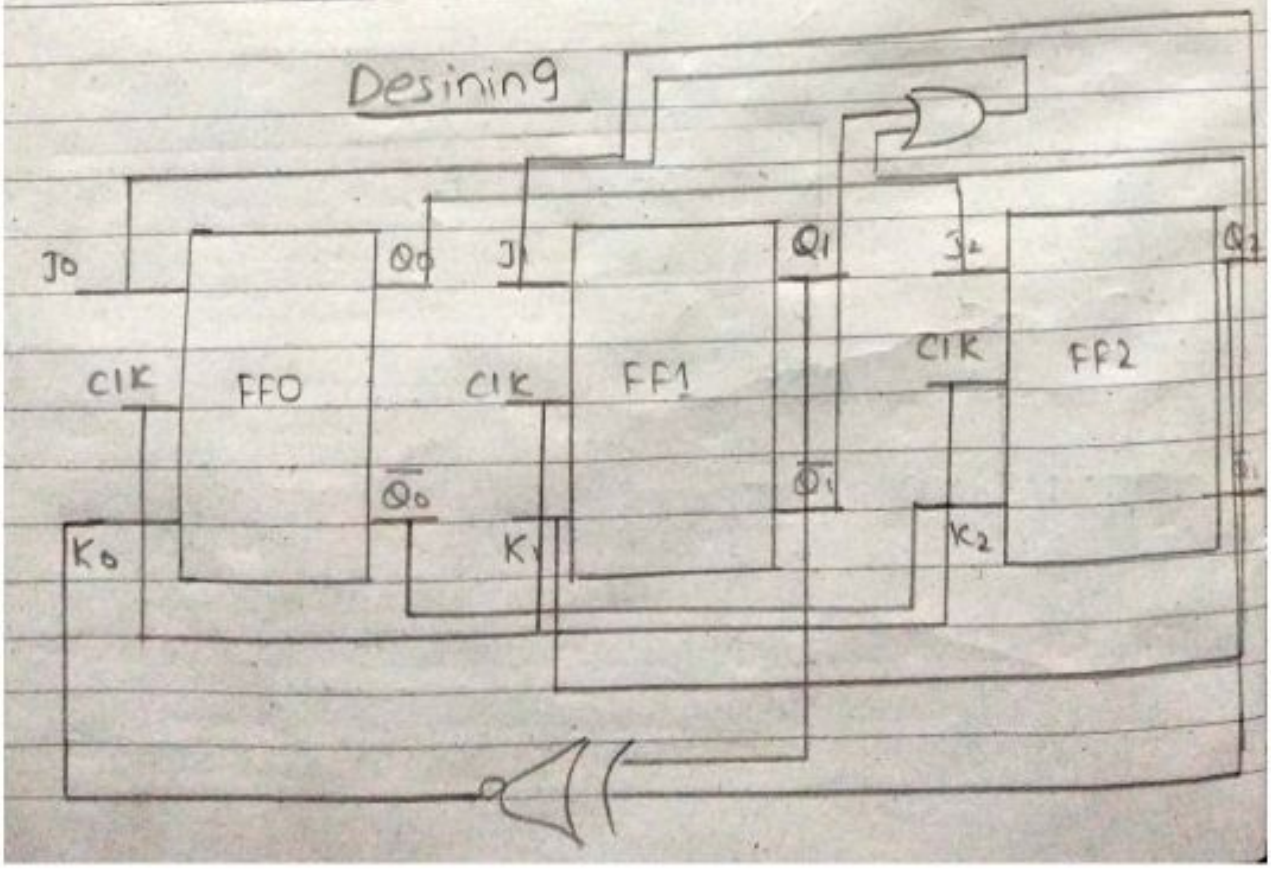
$= \overline{Q_2} + \overline{Q_1}$

Q_2Q_1 \ Q_0	0	1
00	X	1
01	X	0
11	X	1
10	X	0

$K_0 = \overline{Q_1}\,\overline{Q_2} + Q_1Q_2$

$= \overline{Q_1 \oplus Q_2}$

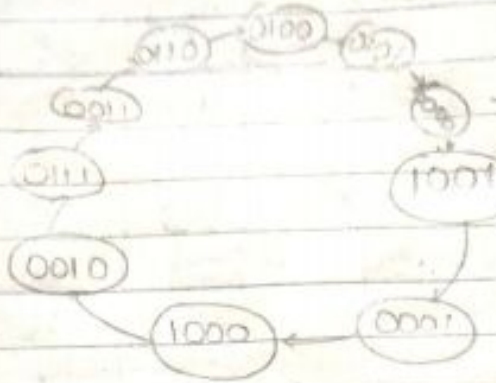
Desining



Scanned with CamScanner

Q.20

state diagram



=> Next state table

Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+
0	0	0	0	1	0	0	1
1	0	0	1	0	0	0	1
0	0	0	1	1	0	0	0
1	0	0	0	0	0	1	0
0	0	1	0	0	1	1	1
0	1	1	1	0	0	1	1
0	0	1	1	0	1	1	0
0	1	1	0	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	0	0	0

Scanned with CamScanner

0 - 0 : 0 X

=> Transition table

Q_3	Q_3^*	J_3	K_3
0	1	1	X
1	0	X	1
0	1	1	X
1	0	X	1
0	0	0	X
0	0	0	X
0	0	0	X
0	0	0	X
0	0	0	X
0	0	0	X

Q_1	Q_1^*	J_1	K_1
0	0	0	X
0	0	0	X
0	0	0	X
0	1	1	X
1	1	X	0
1	1	X	0
1	1	X	0
1	0	X	1
0	0	0	X
0	0	0	X

Q_2	Q_2^*	J_2	K_2
0	0	0	X
0	0	0	X
0	0	0	X
0	0	0	X
0	1	1	X
1	0	X	1
0	1	1	X
1	1	X	0
1	1	X	0
1	0	X	1

Q_0	Q_0^*	J_0	K_0
0	1	1	X
1	1	X	0
1	0	X	1
0	0	0	X
0	1	1	X
1	1	X	0
1	0	X	1
0	0	0	X
0	1	1	X
1	0	X	1

Scanned with CamScanner

$J_0 = \bar{Q}_3 \bar{Q}_1 + \bar{Q}_3 \bar{Q}_2$

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	1	X	X	1
01	1	X	X	0
11	X	X	X	X
10	0	X	X	X

$J_1 = \bar{Q}_0 \bar{Q}_1 Q_3 + Q_1 \bar{Q}_0 Q_3$

$= \bar{Q}_0 Q_3 (Q_1 + \bar{Q}_1)$

$\boxed{J_1 = \bar{Q}_0 Q_3}$

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	0	0	X	X
01	0	0	X	X
11	X	X	X	X
10	1	0	X	X

$\boxed{J_2 = Q_1}$

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	0	0	1	1
01	X	X	X	X
11	X	X	X	X
10	0	0	X	X

$K_0 = \bar{Q}_1 \bar{Q}_3 + \bar{Q}_3 \bar{Q}_2 Q_1 + Q_3 \bar{Q}_2 Q_1$

$\boxed{K_0 = \bar{Q}_1 \bar{Q}_3 + Q_1 \bar{Q}_2}$

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	X	1	1	X
01	X	1	0	X
11	X	X	X	X
10	X	0	X	X

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	X	X	0	0
01	X	X	0	1
11	X	X	X	X
10	X	X	X	X

$K_1 = Q_1 \bar{Q}_0 Q_2 + \bar{Q}_1 \bar{Q}_0 Q_2$

$\boxed{K_1 = \bar{Q}_0 Q_2}$

Scanned with CamScanner

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	X	X	X	X
01	0	1	1	0
11	X	X	X	X
10	X	X	X	X

$$K_2 = Q_0$$

Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	1	X	X	X
01	X	X	X	X
11	X	X	X	X
10	X	1	X	X

$$K_3 = 1$$

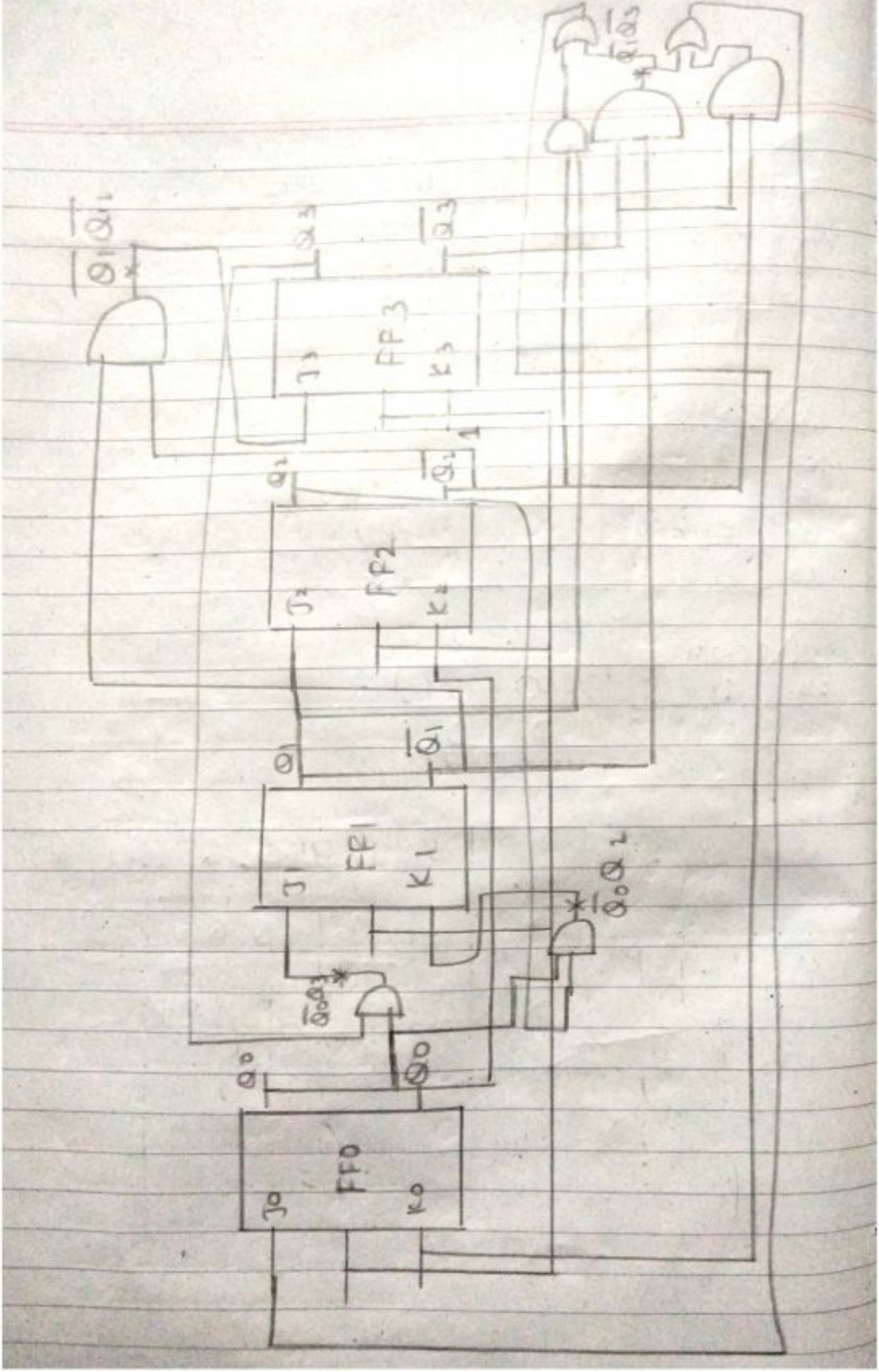
Q_3Q_2 \ Q_1Q_0	00	01	11	10
00	1	1	0	0
01	0	0	0	0
11	X	X	X	X
10	X	X	X	X

$$J_3 = \bar{Q}_3 Q_2 \bar{Q}_1 + Q_3 \bar{Q}_2 \bar{Q}_1$$

$$= \bar{Q}_2 \bar{Q}_1 (Q_3 + \bar{Q}_3)$$

$$J_3 = \bar{Q}_2 \bar{Q}_1$$

Scanned with CamScanner

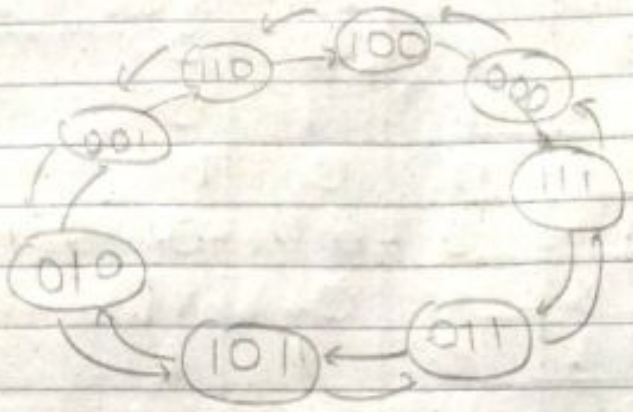


Scanned with CamScanner

UP/DOWN SYNCHRONOUS

D-7-3-5-2-1-6-4

State diagram



(next state table)

Up counter Y=1

Q_2	Q_1	Q_0	Y	Q_2^*	Q_1^*	Q_0^*
0	0	0	1	1	1	1
1	1	1	1	0	1	1
0	1	1	1	1	0	1
1	0	1	1	0	1	0
0	1	0	1	0	0	1
0	0	1	1	1	1	0
1	1	0	1	1	0	0
1	0	0	1	0	0	0

Scanned with CamScanner

next state table

for down counter Y=0

Q_2	Q_1	Q_0	Y	Q_2^*	Q_1^*	Q_0^*
0	0	0	0	1	0	0
1	0	0	0	1	1	0
1	1	0	0	0	0	1
0	0	1	0	0	1	0
0	1	0	0	1	0	1
1	0	1	0	0	1	1
0	1	1	0	1	1	1
1	1	1	0	0	0	0

Transition table

UP				down			
Q_2	Q_2^*	J_2	K_2	Q_2	Q_2^*	J_2	K_2
0	1	1	X	0	1	1	X
1	0	X	1	1	1	X	0
0	1	1	X	1	0	X	1
1	0	X	1	0	0	0	X
0	0	0	X	0	1	1	X
0	1	1	X	1	0	X	1
1	1	X	0	0	1	1	X
1	0	X	1	1	0	X	1

Scanned with CamScanner

up

Q_1	Q_1^*	J_1	K_1
0	1	1	X
1	1	X	0
1	0	X	1
0	1	1	X
1	0	X	1
0	1	1	X
1	0	X	1
0	0	0	X

down

Q_1	Q_1^*	J_1	K_1
0	0	0	X
0	1	1	X
1	0	X	1
0	1	1	X
1	0	X	1
0	1	1	X
1	1	X	0
1	0	X	1

up

Q_0	Q_0^*	J_0	K_0
0	1	1	X
1	1	X	0
1	1	X	0
1	0	X	1
0	1	1	X
1	0	X	1
0	0	0	X
0	0	0	X

down

Q_0	Q_0^*	J_0	K_0
0	0	0	X
0	0	0	X
0	1	1	X
1	0	X	1
0	1	1	X
1	1	X	0
1	1	X	0
1	0	X	1

Scanned with CamScanner

$J_2 = Q_1Q_0 + \bar{Q}_0\bar{Y} + Y\bar{Q}_1\bar{Q}_0$

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

$J_1 = Q_2\bar{Y} + \bar{Y}\bar{Q}_2 + Q_2\bar{Y}$

$K_1 = \bar{Q}_2Y + Q_2\bar{Y} + \bar{Q}_0$

$J_0 = \bar{Q}_2\bar{Y} + \bar{Y}Q_2$

$K_0 = Q_2 + Q_1 \oplus Y$

$J_1 = Q_2\bar{Y} + \bar{Y}Q_0$

$K_1 = \bar{Q}_0 + (Q_2 \oplus Y) \cdot K_1$

Scanned with CamScanner