a)

Cnt	Q_1	Q_0	Q_1^+	Q_0^+	y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	1	1	0
1	0	0	0	1	0
1	0	1	1	0	0
1	1	0	1	1	0
1	1	1	0	0	1
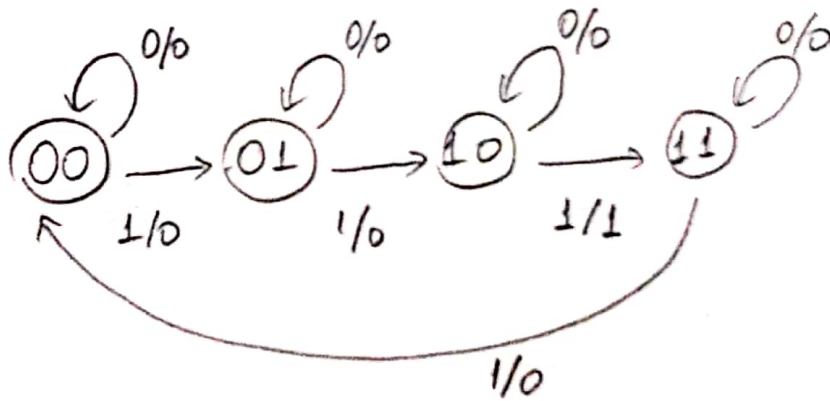
b) Mealy-type

c)

Cnt	Q_1	Q_0	Q_1^+	Q_0^+	S_1	R_1	S_0	R_0
0	0	0	0	0	0	X	0	X
0	0	1	0	1	0	X	X	0
0	1	0	1	0	X	0	0	X
0	1	1	1	1	X	0	X	0
1	0	0	0	1	0	X	1	0
1	0	1	1	0	1	0	0	1
1	1	0	1	1	X	0	1	0
1	1	1	0	0	0	1	0	1

S_1

$Q_1 Q_0$ / CNT	00	01	11	10
0	0	0	X	X
1	0	①	0	X

$$S_1 = CNT \cdot \overline{Q_1} \cdot Q_0$$

R_1

$Q_1 Q_0$ / CNT	00	01	11	10
0	X	X	0	0
1	X	0	①	0

$$R_1 = CNT \cdot Q_1 \cdot Q_0$$

S_0

$Q_1 Q_0$ / CNT	00	01	11	10
0	0	X	X	0
1	①	0	0	①

$$S_0 = CNT \cdot \overline{Q_0}$$

②

R_0

$Q_1 Q_0$ / CNT	00	01	11	10
0	X	0	0	X
1	0	①	①	0

$$R_0 = CNT \cdot Q_0$$

CNT

CIk

②

Q_3	Q_2	Q_1	Q_0	Q_3^+	Q_2^+	Q_1^+	Q_0^+	T_3	T_2	T_1	T_0
0	0	0	0	0	0	0	1	0	0	0	1
0	0	0	1	0	0	1	0	0	0	1	1
0	0	1	0	0	0	1	1	0	0	0	1
0	0	1	1	0	1	0	0	0	1	1	1
0	1	0	0	0	1	0	1	0	0	0	1
0	1	0	1	0	1	1	0	0	0	1	1
0	1	1	0	0	1	1	1	0	0	0	1
0	1	1	1	1	0	0	0	1	1	1	1
1	0	0	0	1	0	0	1	0	0	0	1
1	0	0	1	1	0	1	0	0	0	1	1
1	0	1	0	1	0	1	1	0	0	0	1
1	0	1	1	1	1	0	0	0	1	1	1
1	1	0	0	1	1	0	1	0	0	0	1
1	1	0	1	1	1	1	0	0	0	1	1
1	1	1	0	1	1	1	1	0	0	0	1
1	1	1	1	0	0	0	0	1	1	1	1

→ the Circuit counts from 0 to 15. After 15, it starts 0 again. ③

T3

Q_2Q_1 \ Q_1Q_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	0	0	1	0
10	0	0	0	0

$$T_3 = Q_2 Q_1 Q_0$$

T2

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

$$t_2 = Q_1 Q_0$$

$$t_0 = 1$$

T1

Q_2Q_2 \ Q_1Q_0	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

$$T_1 = Q_0$$

Clk
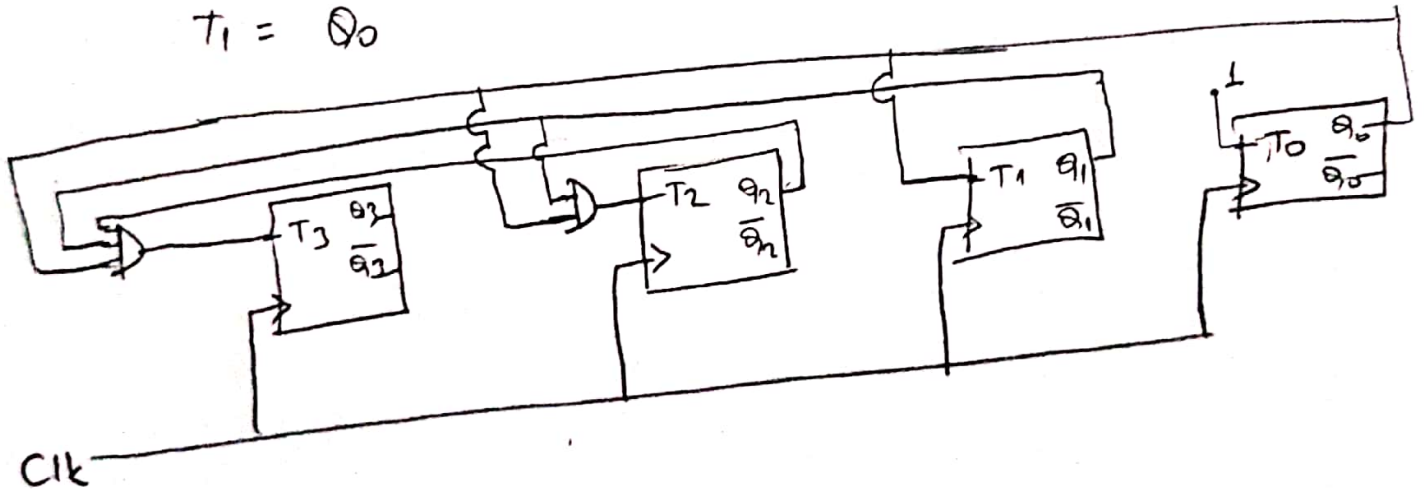
(3-)

a)
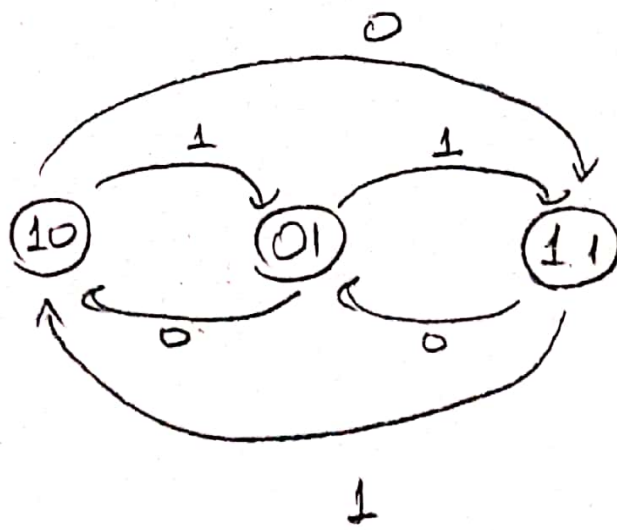
X	Q_1	Q_0	Q_1^+	Q_0^+	D_1	D_0
0	0	0	X	X	X	X
0	0	1	1	0	1	0
0	1	0	1	1	1	1
0	1	1	0	1	0	1
1	0	0	X	X	X	X
1	0	1	1	1	1	1
1	1	0	0	1	0	1
1	1	1	1	0	1	0

b) D_1

$Q_1 Q_0$ \ X	0	1
00	X	X
01	1	1
11	0	1
10	1	0

$$D_1 = \overline{Q_1} + X Q_0 + \overline{X}\,\overline{Q_0}$$

$$D_1 = \overline{Q_1} + X \odot Q_0$$

(5)

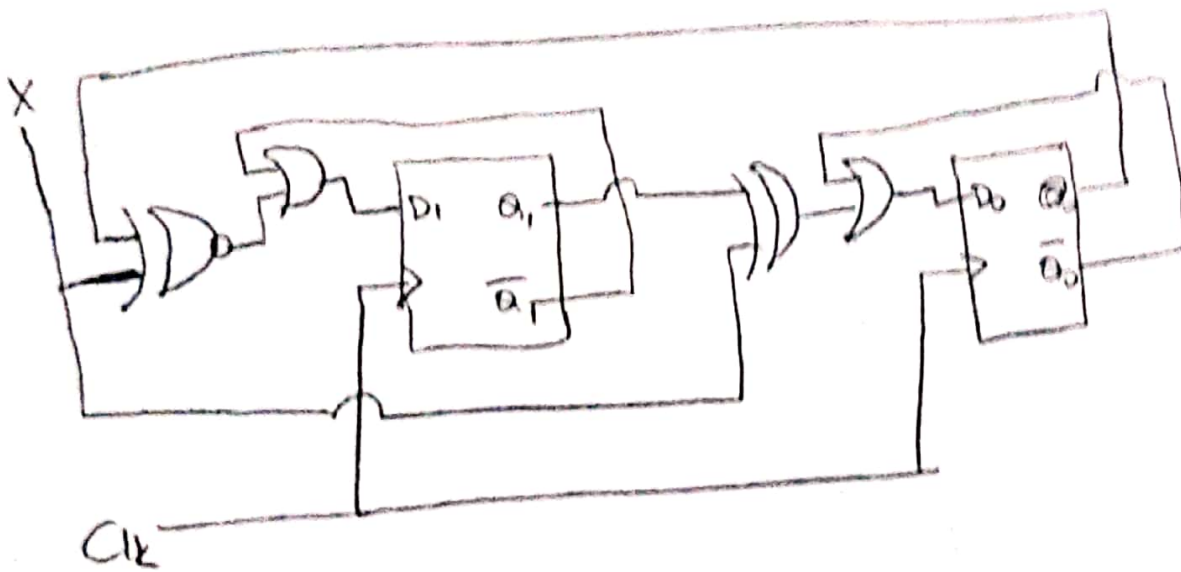D_0

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

$$D_0 = \overline{Q_0} + Q_1\overline{X} + X\overline{Q_1}$$

$$D_0 = \overline{Q_0} + Q_1 \oplus X$$

X

D_1 Q_1

$\overline{Q_1}$

D_0 Q_0

$\overline{Q_0}$

Clk

(6)