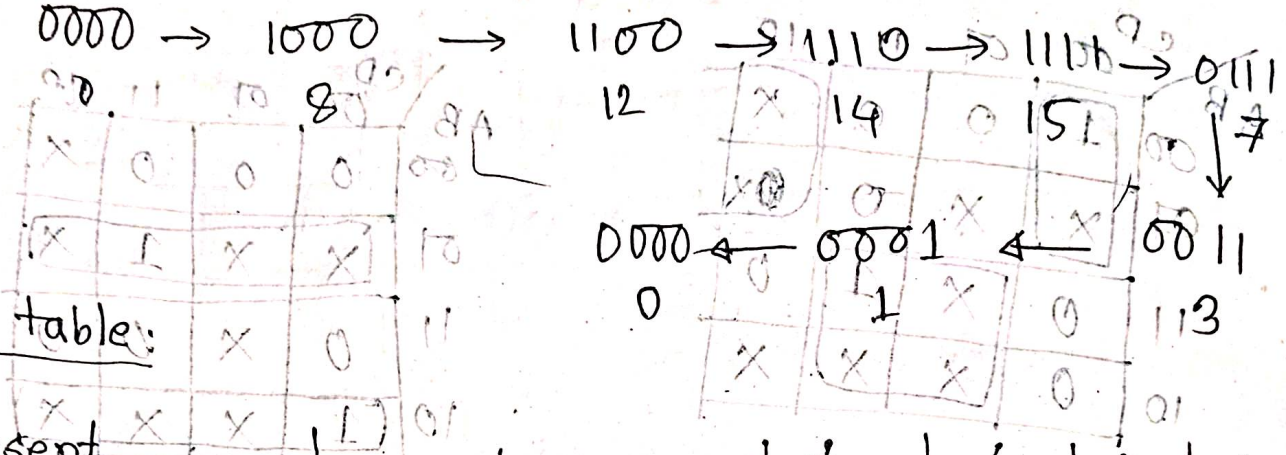
Lab Practice :

0000 → 1000 → 1100 → 1110 → 1111 → 0111



Truth table:

Present				Next				t_A	t_B	t_C	t_D
A	B	C	D	W	X	Y	Z				
0	0	0	0	1	0	0	0	1	0	0	0
0	0	0	1	0	0	0	0	0	0	0	1
0	0	1	0	X	X	X	X	X	X	X	X
0	0	1	1	0	0	0	1	0	0	1	0
0	1	0	0	X	X	X	X	X	X	X	X
0	1	0	1	X	X	X	X	X	X	X	X
0	1	1	0	X	X	X	X	X	X	X	X
0	1	1	1	0	0	1	1	0	1	0	0
1	0	0	0	1	1	0	0	0	1	0	0
1	0	0	1	X	X	X	X	X	X	X	X
1	0	1	0	X	X	X	X	X	X	X	X
1	0	1	1	X	X	X	X	X	X	X	X
1	1	0	0	1	1	1	0	0	0	1	0
1	1	0	1	X	X	X	X	X	X	X	X
1	1	1	0	1	1	1	1	0	0	0	1
1	1	1	1	0	1	1	1	1	0	0	0

t_A

ABCD
$Q_3 Q_2 Q_1 Q_0$

AB \ CD	00	01	11	10
00	1	0	0	X
01	X	X	0	X
11	0	X	1	0
10	0	X	X	X

$t_A = \bar{A}\bar{C}\bar{D} + AD$

$= \bar{Q_3} Q_1 \bar{Q_0} + Q_3 Q_0$

t_B

AB \ CD	00	01	11	10
00	0	0	0	X
01	X	X	1	X
11	0	X	0	0
10	1	X	X	X

$t_B = A\bar{B} + \bar{A}B$

$= A \oplus B$

$Q_2 \oplus Q_3$

t_C

AB \ CD	00	01	11	10
00	0	0	1	X
01	X	X	0	X
11	1	X	0	0
10	0	X	X	X

$t_C = B\bar{C} + \bar{A}\bar{B}C$

t_D

AB \ CD	00	01	11	10
00	0	1	0	X
01	X	X	0	X
11	0	X	0	1
10	0	X	X	X

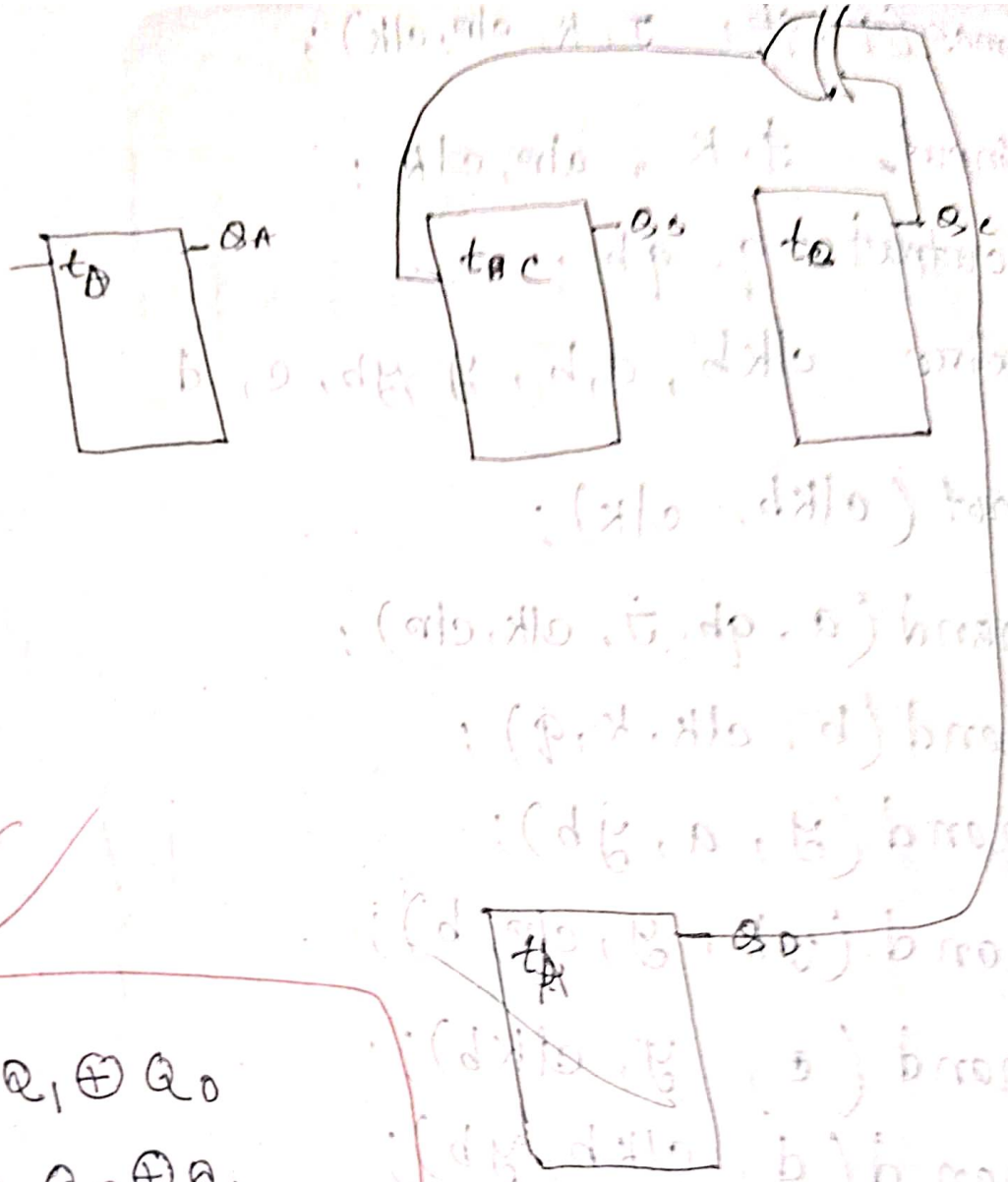
$t_A = \bar{A}D + A\bar{D}$

$= \bar{Q_3}Q_0 + Q_3\bar{Q_0}$

$t_D = C \oplus D = Q_3 \oplus Q_0$

$t_C = \bar{B}C + B\bar{C}$

$= B \oplus C$



$t_0 = Q_1 \oplus Q_0$

$t_1 = Q_2 \oplus Q_1$

$t_2 = Q_3 \oplus Q_2$

$t_3 = \overline{Q_3 \oplus Q_0}$

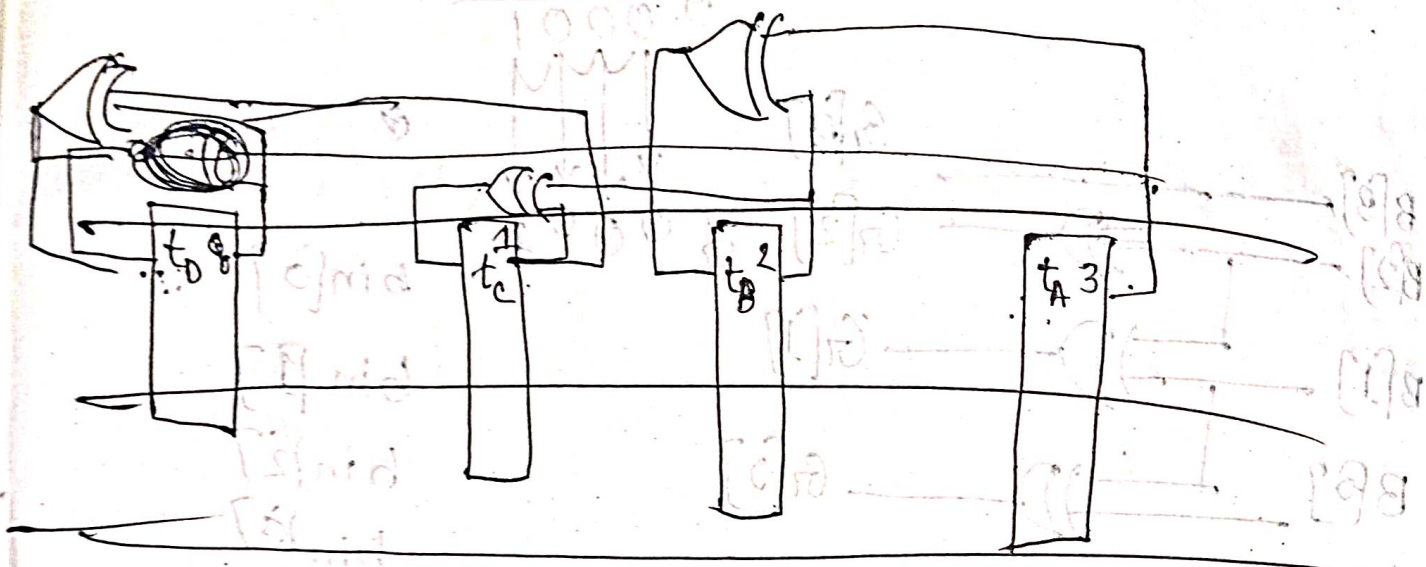
$AD + \overline{AD}\,B \qquad \overline{A}\,\overline{D}$

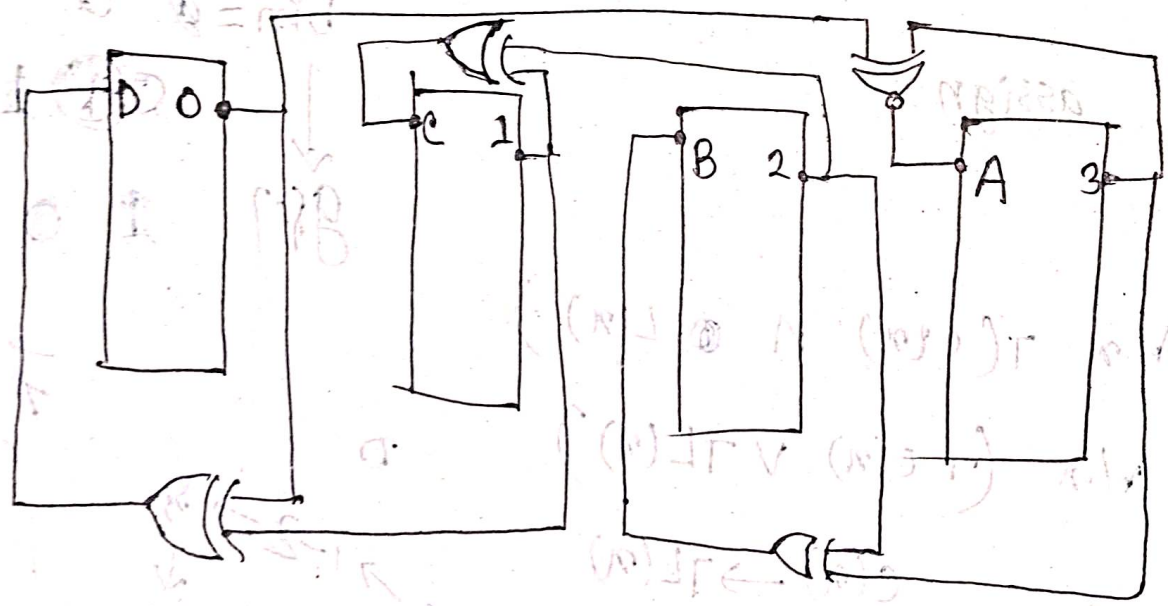
```
module
JK_mas (q, qb, J, K, clr, clk);

    input  J, K, clr, clk;
    output q, qb;
    wire   clkb, a, b, y, yb, c, d

    not (clkb, clk);
    nand (a, qb, J, clk, clr);
    nand (b, clk, K, q);
    nand (y, a, yb);
    nand (yb, y, clr, b);
    nand (c, y, clkb);
    nand (d, clkb, yb);
    nand (q, c, qb);
    nand (qb, q, clr, d);

endmodule
```


t_D 0
t_C 1
t_B 2
t_A 3


D 0
C 1
B 2
A 3