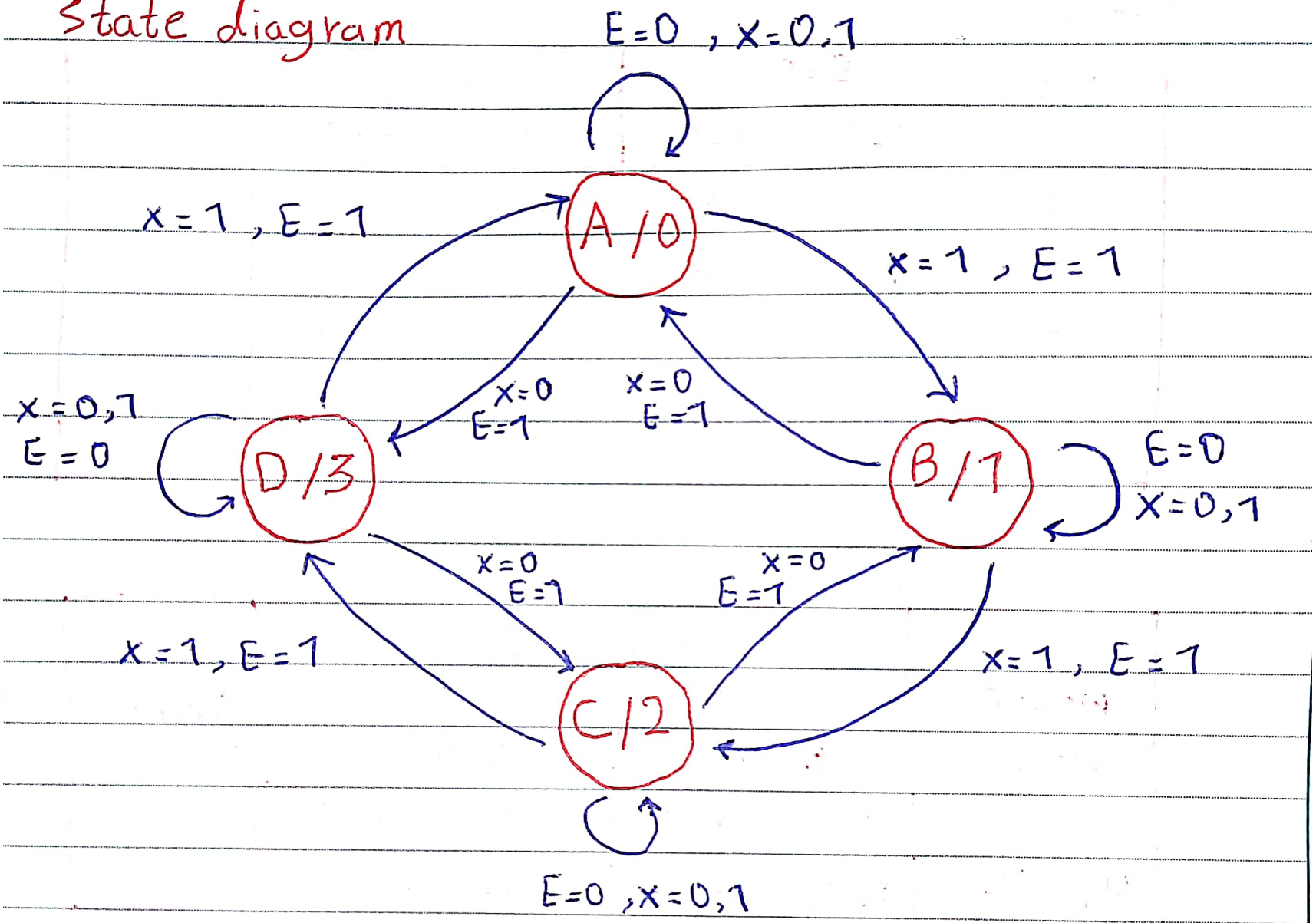
Up_Down Counter with Enable

State diagram

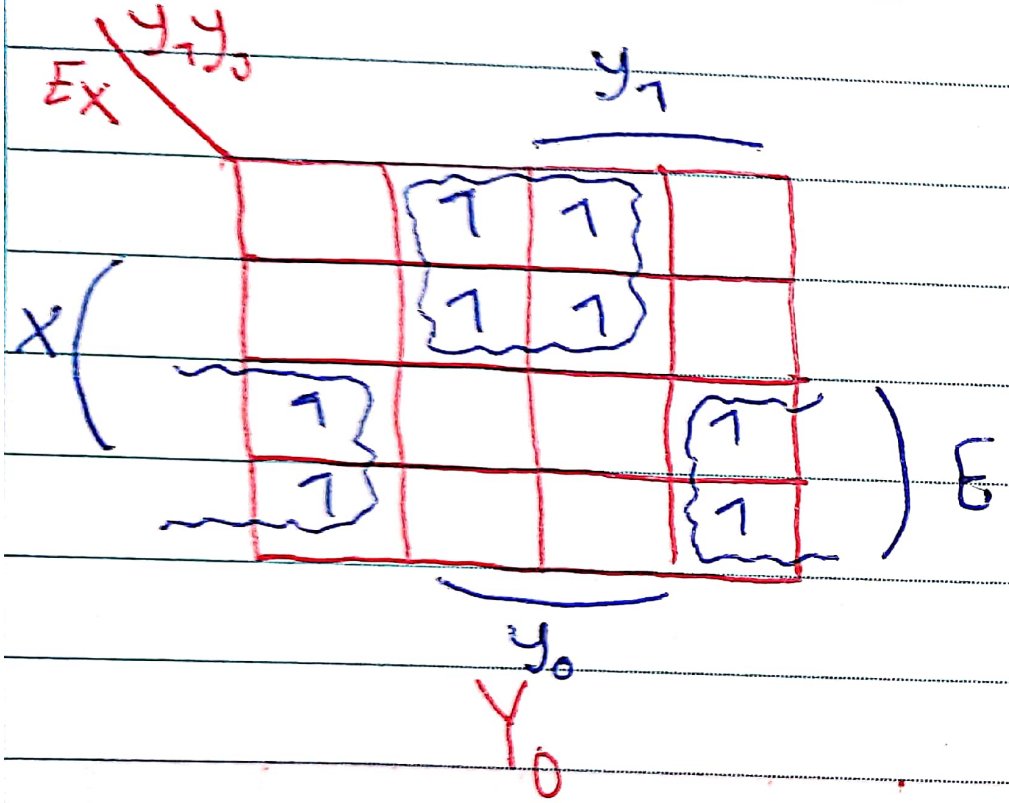


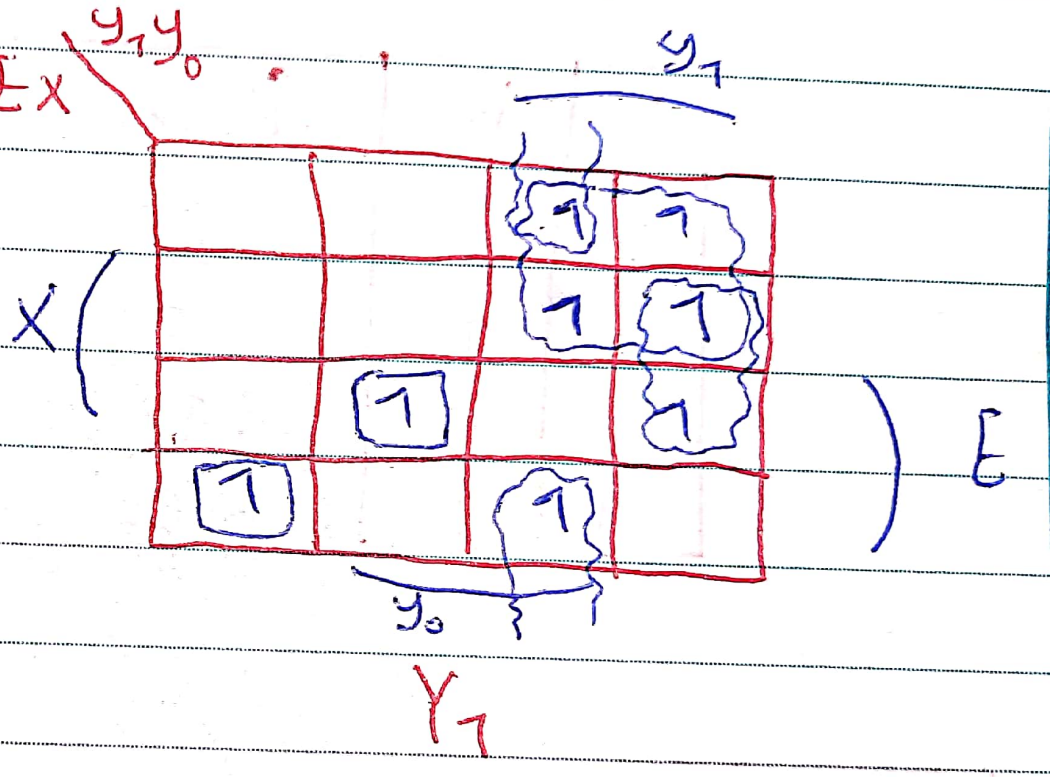
state table (Implementation Using D-Flip Flop)

present state	next state				output
	E = 0		E = 1		
	X = 0	X = 1	X = 0	X = 1	
A	A	A	D	B	0
B	B	B	A	C	1
C	C	C	B	D	2
D	D	D	C	A	3

present state		Next stat				Output	
		E = 0		E = 1			
		X = 0	X = 1	X = 0	X = 1		
y_1	y_0	Y_1 Y_0	Y_1 Y_0	Y_1 Y_0	Y_1 Y_0	z_1	z_0
0	0	0 0	0 0	1 1	0 1	0	0
0	1	0 1	0 1	0 0	1 0	0	1
1	0	1 0	1 0	0 1	1 1	1	0
1	1	1 1	1 1	1 0	0 0	1	1

Karnaugh table (using D-flipflop)





$$Y_0 = E\bar{y}_0 + \bar{E}y_0$$

$$\boxed{Y_0 = E \oplus y_0}$$

$$Y_1 = \bar{E}y_1 + y_1\bar{y}_0X + y_1y_0\bar{X} + \bar{y}_1y_0EX + \bar{y}_1\bar{y}_0E\bar{X}$$

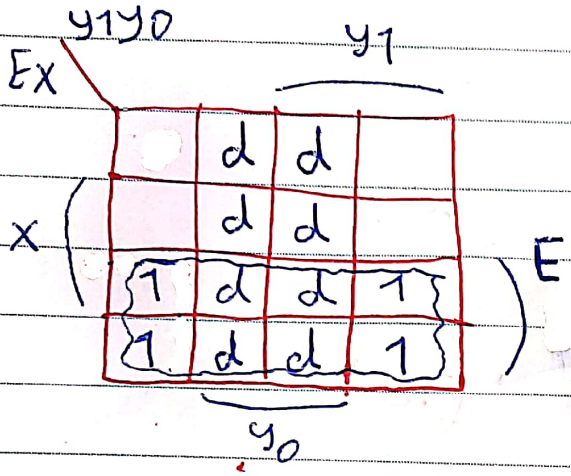
$$\boxed{Y_1 = \bar{E}y_1 + (y_1 + E)(y_0 \oplus X)}$$

state table (Implementation using JK-flipflop)

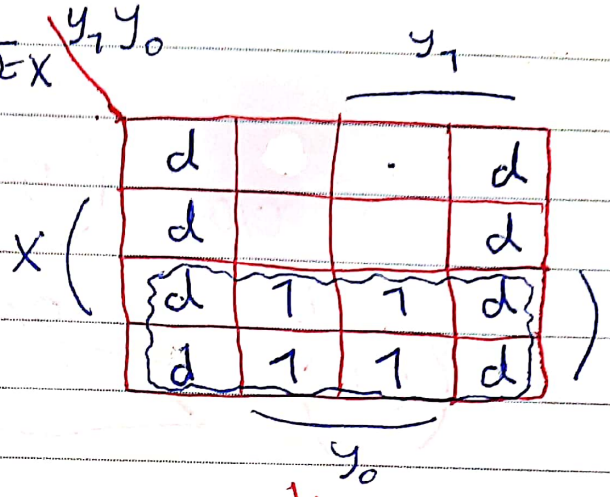
J	K	Q_{next}
0	0	Q
0	1	0
1	0	1
1	1	~Q

Current State	Next State												Output
	E = 0						E = 1						
	X = 0			X = 1			X = 0			X = 1			
y1 y0	Y1 Y0	J1 K1	J0 K0	Y1 Y0	J1 K1	J0 K0	Y1 Y0	J1 K1	J0 K0	Y1 Y0	J1 K1	J0 K0	z1 z0
0 0	0 0	0 d	0 d	0 0	0 d	0 d	1 1	1 d	1 d	0 1	0 d	1 d	0 0
0 1	0 1	0 d	d 0	0 1	0 d	d 0	0 0	0 d	d 1	1 0	1 d	d 1	0 1
1 0	1 0	d 0	0 d	1 0	d 0	0 d	0 1	d 1	1 d	1 1	d 0	1 d	1 0
1 1	1 1	d 0	d 0	1 1	d 0	d 0	1 0	d 0	d 1	0 0	d 1	d 1	1 1

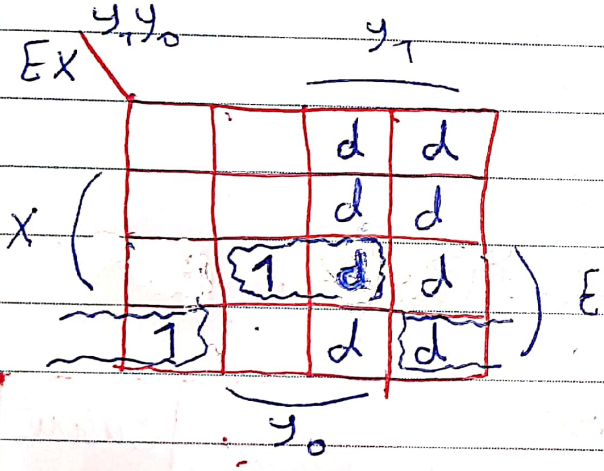
Karnaugh map (using jk-flipflop) ✓



$J_0 = E$

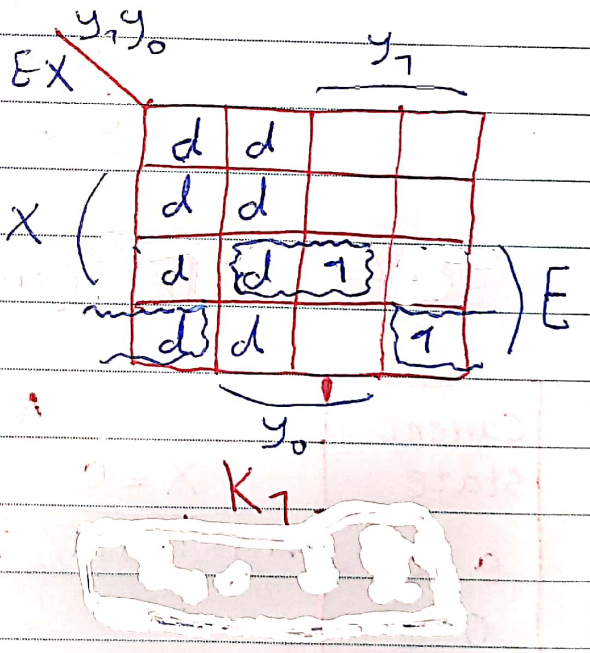


$K_0 = E$



$J_1 = E\bar{y}_0\bar{x} + Ey_0x$

$J_1 = E(y_0 \odot x)$



$K_1 = J_1$

$K_1 = E(y_0 \odot x)$

implementation by JK-flipflop is more simple than the D-flipflop.