Zarema Balgabekova HW 4

1.

	1s complement	2s complement
10011100	01100011	01100100
10011101	01100010	01100011
10101000	01010111	01011000
00000000	11111111	00000000
10000000	01111111	10000000

2.

a) 11010 − 10001

$$\begin{array}{r} {\scriptstyle 1\,1\,1\,1} \\ 11010 \\ +\,01111 \\ \hline 101001 \end{array}$$

(discard end carry)

$\Rightarrow$ 11010 − 1001 = 01001

b) 11110 − 1110 = 11110 − 01110

$$\begin{array}{r} {\scriptstyle 1\,1\,1\,1} \\ 11110 \\ +\,10010 \\ \hline 110000 \end{array}$$

(discard end carry)

$\Rightarrow$ 11110 − 1110 = 10000

c) 1111110 − 1111110

$$\begin{array}{r} {\scriptstyle 1\,1\,1\,1\,1\,1} \\ 1111110 \\ +\,0000010 \\ \hline 10000000 \end{array}$$

(discard end carry)

$\Rightarrow$ 1111110 − 1111110 = 0000000

d) 101001 − 101 = 101001 − 000101

$$\begin{array}{r} {}^{1\,1\,1\;\;1\,1} \\ 101001 \\ +\,111011 \\ \hline 1100100 \end{array}$$ (discard end carry)

$\Rightarrow$ 101001 − 101 = 100100

3.

$$D_A = (B\bar{C} + \bar{B}C)x + (BC + \bar{B}\bar{C})\bar{x}$$

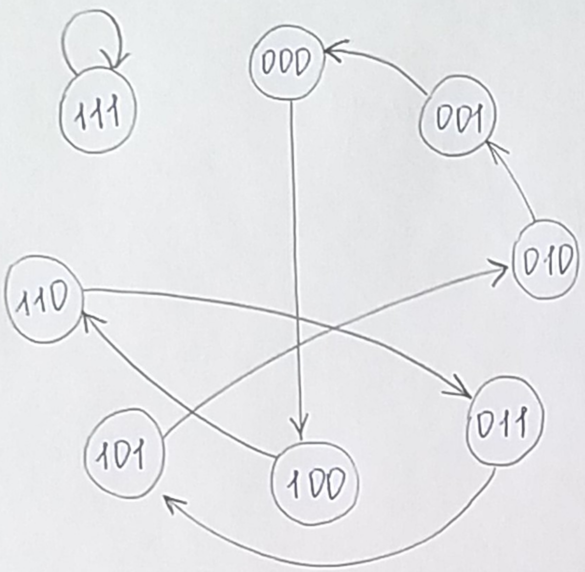
$$D_B = A$$

$$D_C = B$$

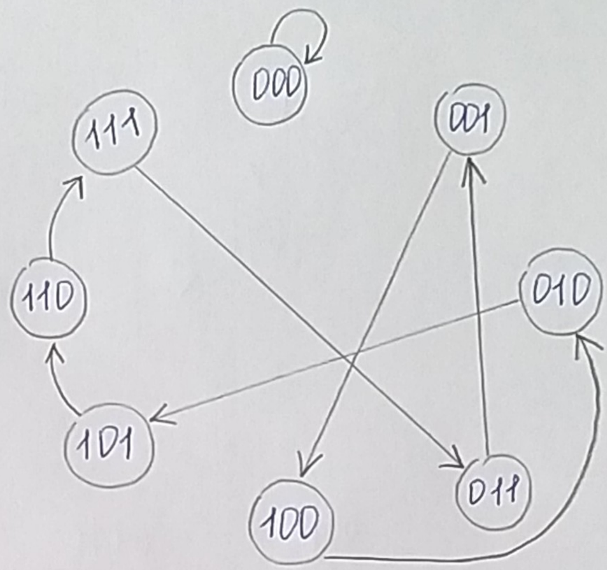
a)

Current state			Input	Next state		
A(t)	B(t)	C(t)	x	A(t+1)	B(t+1)	C(t+1)
0	0	0	0	1	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	1	0	1
0	1	1	0	1	0	1
0	1	1	1	0	0	1
1	0	0	0	1	1	0
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	1	1	0
1	1	0	0	0	1	1
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	0	1	1

b) $x = 0$



$x = 1$

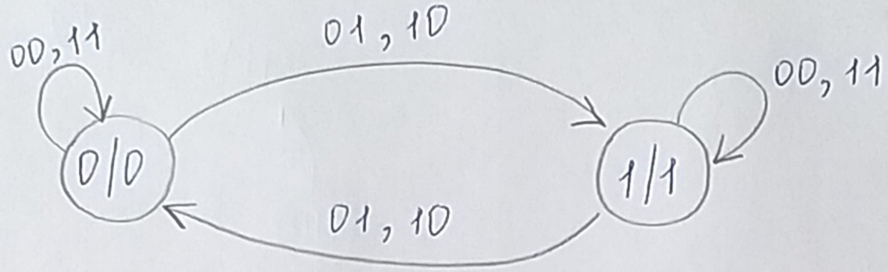


4. $D = x \oplus y \oplus S$

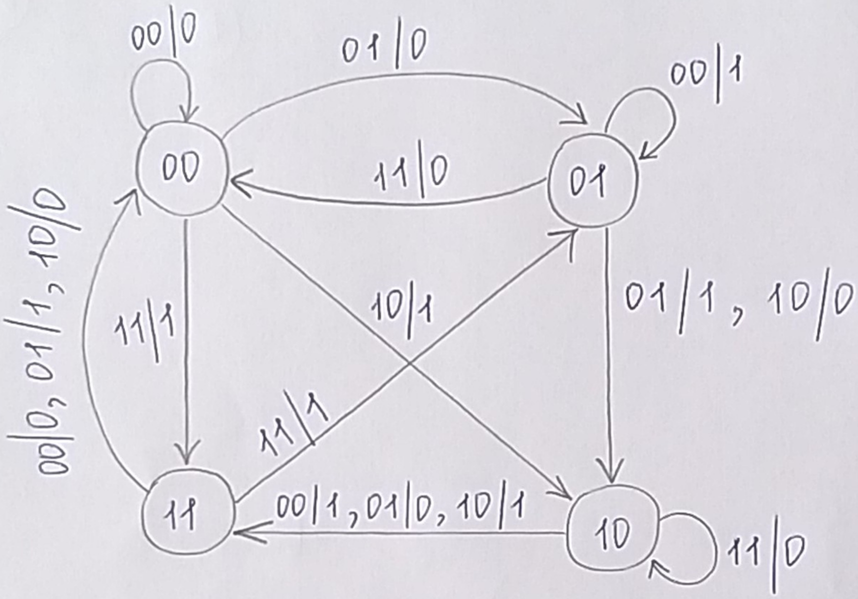
State table:

Current state $Q(t)$	Input x	Input y	Next state $Q(t+1)$	Output S
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	0
1	0	0	1	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

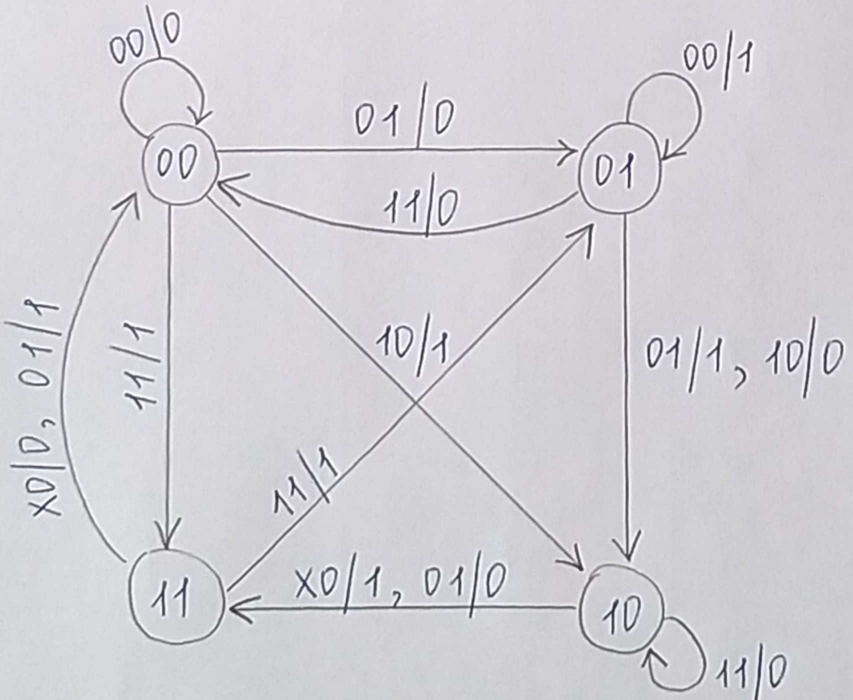
State diagram:



5.



State diagram can be simplified if X = unspecified:

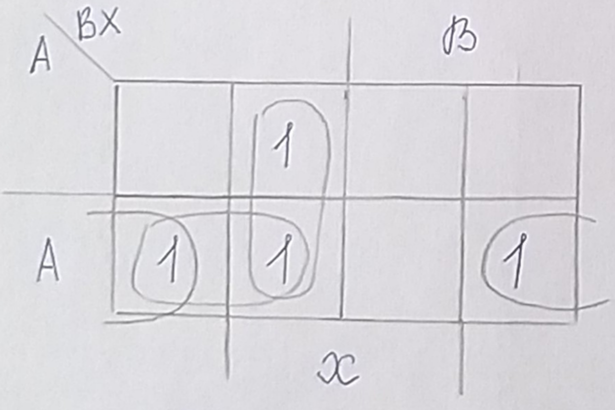


6. State table:

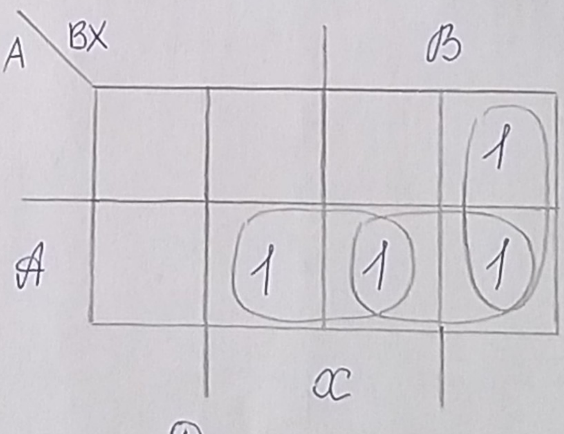
Current state $A(t)$	$B(t)$	Input x	Next state $A(t+1)$	$B(t+1)$
0	0	0	0	0
0	0	1	1	0
0	1	0	0	1
0	1	1	0	0
1	0	0	1	0
1	0	1	1	1
1	1	0	1	1
1	1	1	0	1

$$A(t+1) = D_A(A, B, x) = \sum m(1, 4, 5, 6)$$

$$B(t+1) = D_B(A, B, x) = \sum m(2, 5, 6, 7)$$



D_A



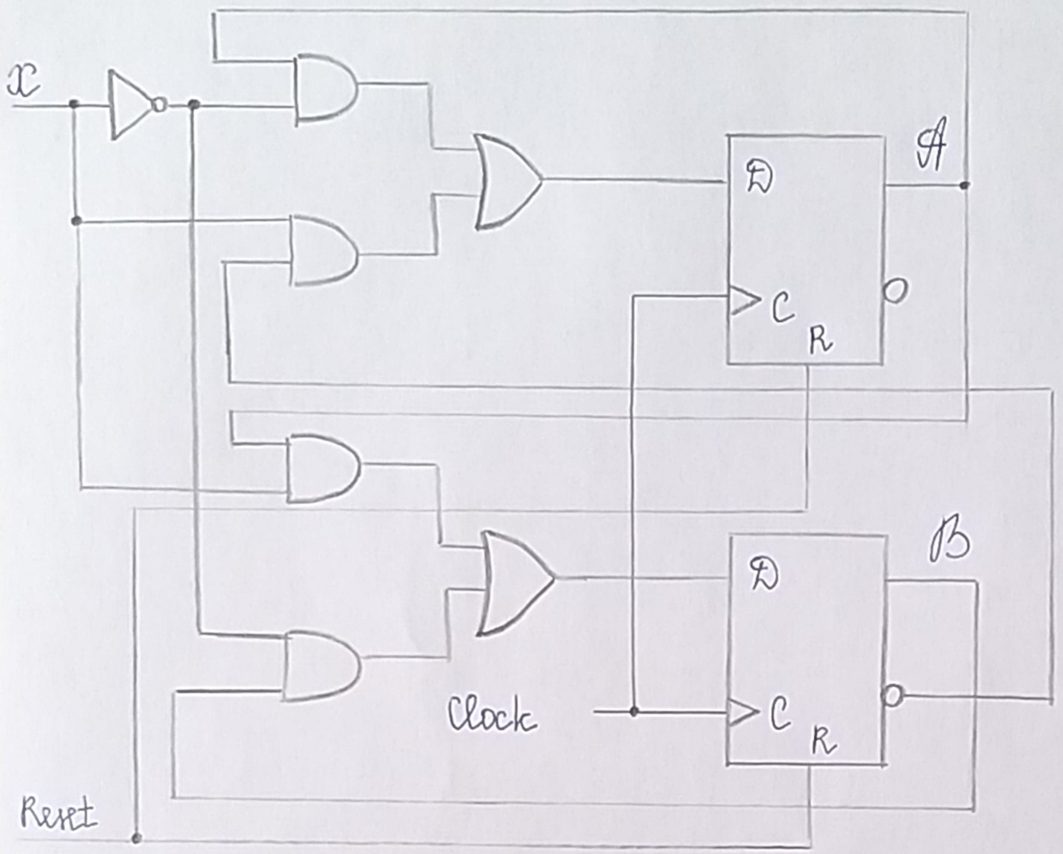
D_B

Flip-flop input equations:

$$D_A = A\bar{x} + \bar{B}x$$

$$D_B = Ax + B\bar{x}$$

Logic diagram:



7. a) State table:

Current state	Input x	Next state	Output Z
A	0	B	0
A	1	D	0
B	0	D	0
B	1	C	0
C	0	A	0
C	1	F	0
D	0	F	1
D	1	C	1
E	0	C	1
E	1	E	1
F	0	E	1
F	1	F	1

B) State assignment:

Gray Code Assignment is used, and the least significant Bit is equal to output:

A = 000, B = 010, C = 110, D = 001, E = 011, F = 111

100, 101 – don't care conditions

Current state A	B	C	Next state $x=0$	$x=1$	Output Z
0	0	0	010	001	0
0	0	1	111	110	1
0	1	1	110	011	1
0	1	0	001	110	0
1	1	0	000	111	0
1	1	1	011	111	1
1	0	1	XXX	XXX	X
1	0	0	XXX	XXX	X

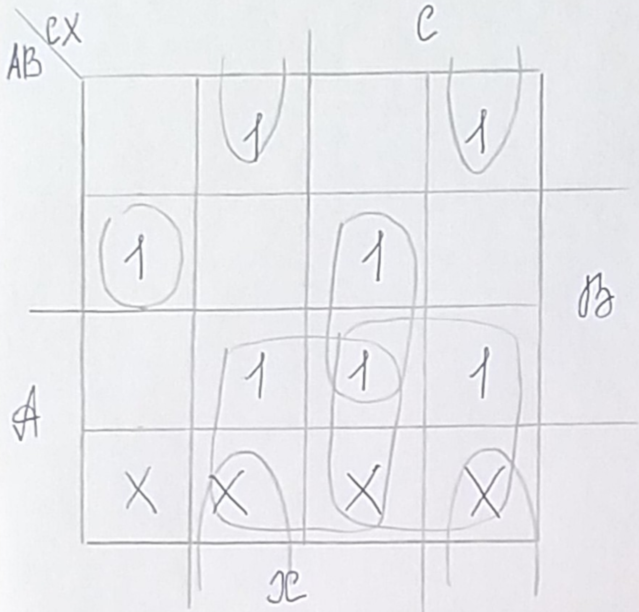
c)

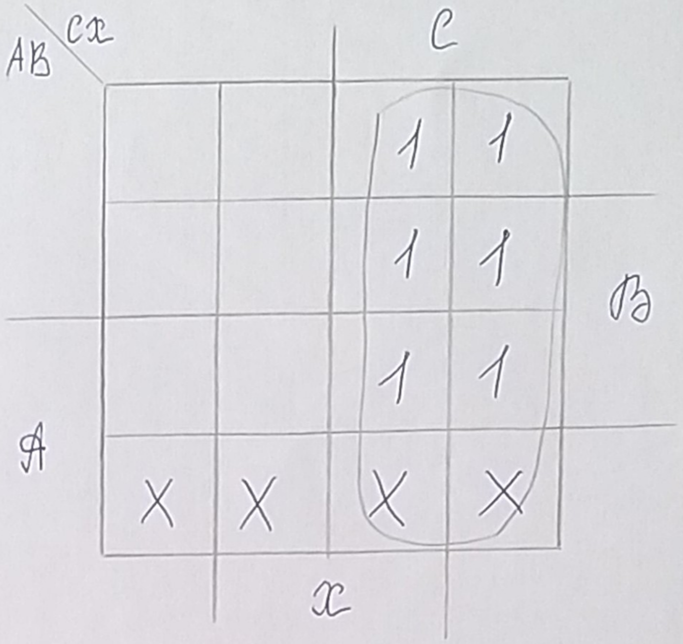
AB \ CX	00	01	11	10
00			1	1
01		1		1
11		1	1	
10	X	X	X	X

$D_A = AX + \bar{B}C + B\bar{C}X + \bar{A}C\bar{X}$

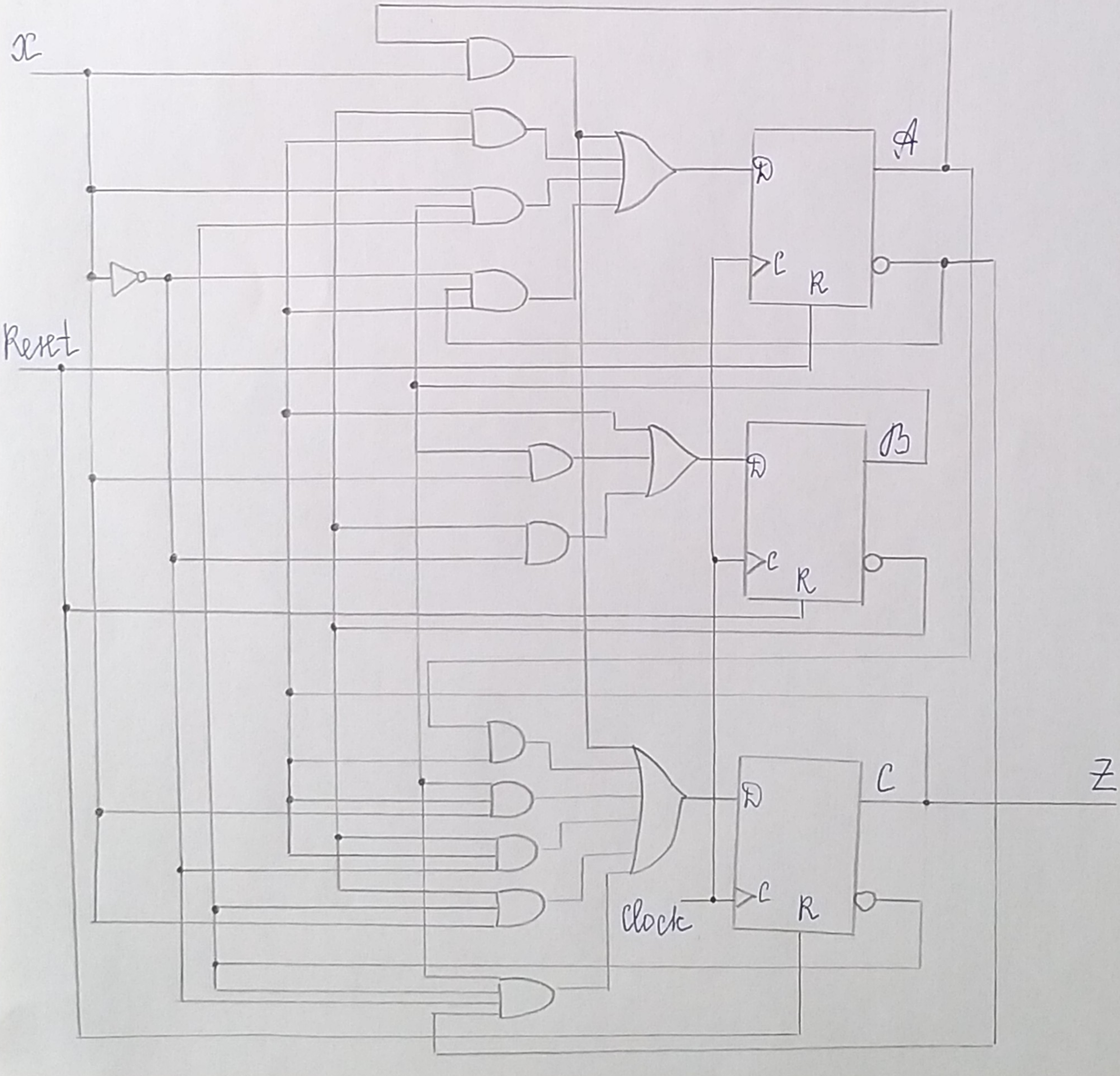
AB \ CX	00	01	11	10
00	1		1	1
01		1	1	1
11		1	1	1
10	X	X	X	X

$D_B = C + BX + \bar{B}\bar{X}$

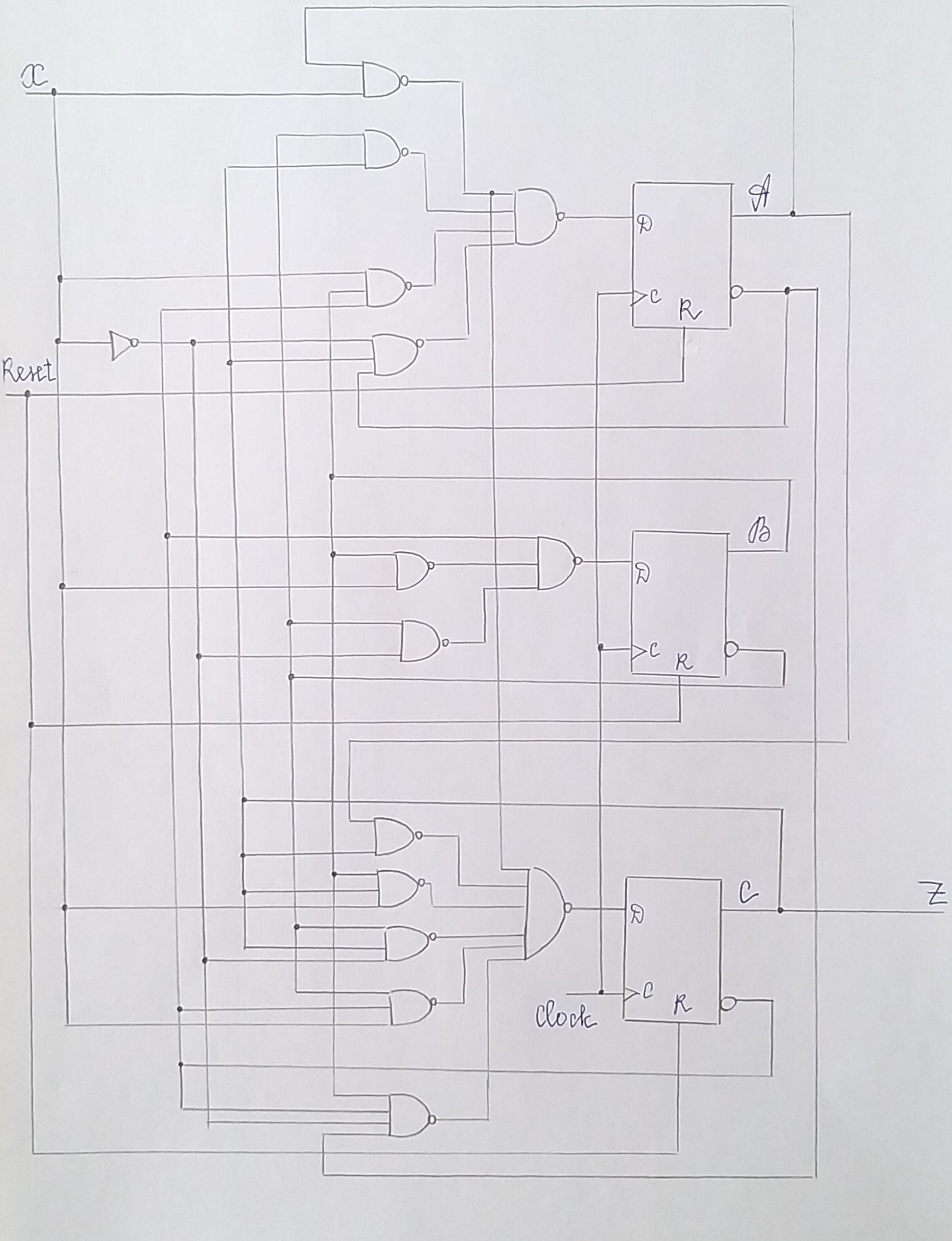




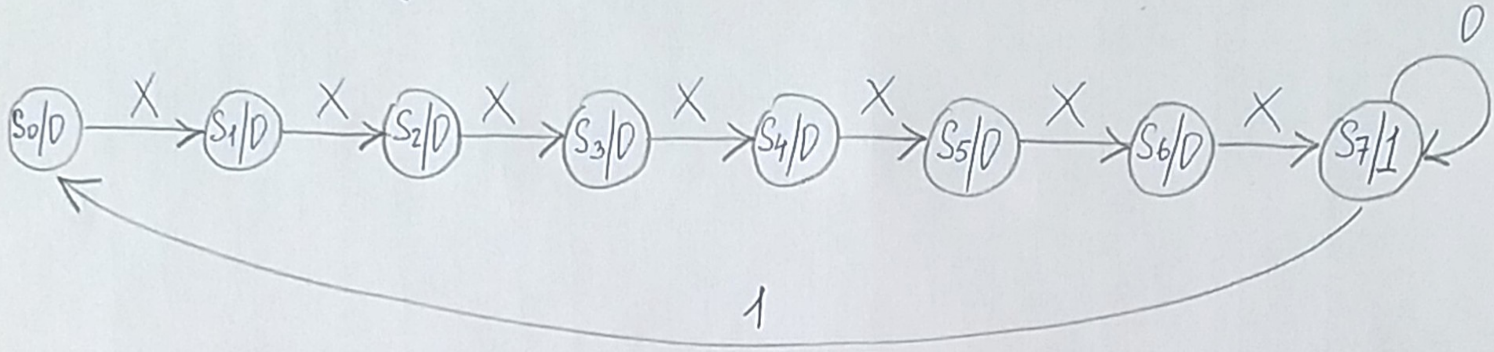
$D_C = Ax + AC + BCx + \bar{B}C\bar{x} + \bar{B}\bar{C}x + \bar{A}B\bar{C}\bar{x}$ $Z = C$



Technology mapping



8. a) State diagram:



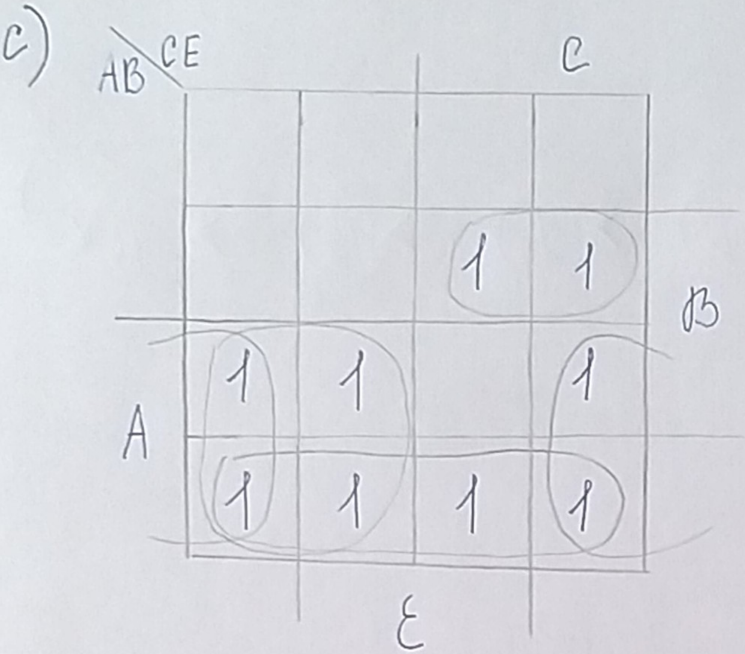
b) State table:

Current state	Next state E = 0	Next state E = 1	Output Z
S_0	S_1	S_1	0
S_1	S_2	S_2	0
S_2	S_3	S_3	0
S_3	S_4	S_4	0
S_4	S_5	S_5	0
S_5	S_6	S_6	0
S_6	S_7	S_7	0
S_7	S_7	S_0	1

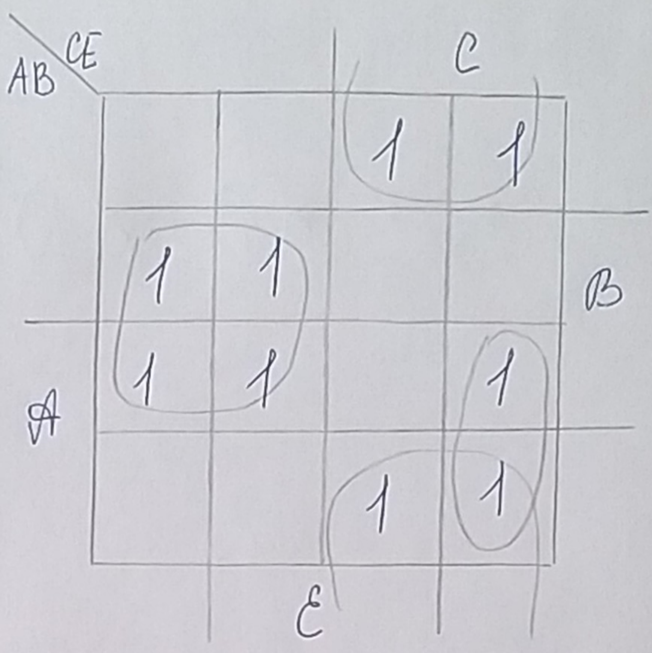
State assignment

Current state A	B	C	Next state E = 0	E = 1	Output Z
0	0	0	001	001	0
0	0	1	010	010	0
0	1	0	011	011	0
0	1	1	100	100	0
1	0	0	101	101	0
1	0	1	110	110	0
1	1	0	111	111	0
1	1	1	111	000	1

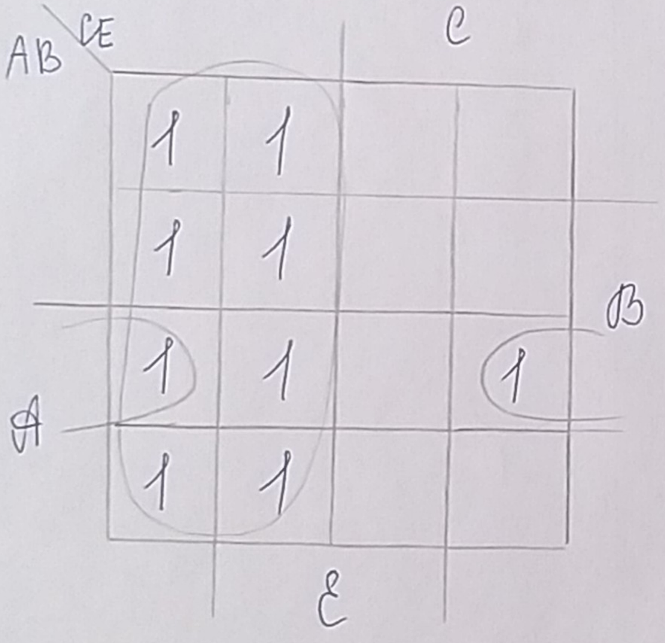
c)



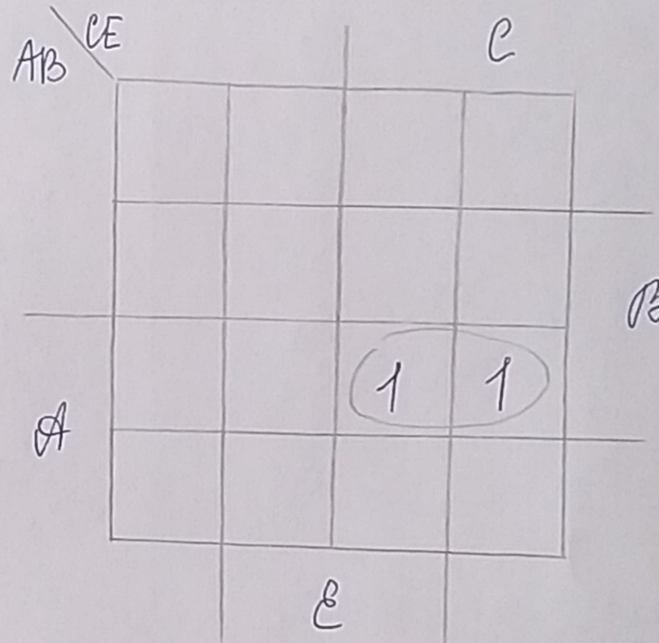
$D_A = A\bar{C} + A\bar{B} + A\bar{E} + \bar{A}BC$



$D_B = B\bar{C} + \bar{B}C + AC\bar{E}$



$D_C = \bar{C} + AB\bar{E}$



$Z = ABC$

Flip-flop input equations:

$D_A = A(\bar{C} + \bar{B} + \bar{E}) + \bar{A}BC$

$D_B = B \oplus C + AC\bar{E}$

$D_C = \bar{C} + AB\bar{E}$

Output equation:

$Z = ABC$

Logic diagram: