



## **Logic Design Final Assignment - Solutions (TA)**

**Dr. Shahram Etemadi**

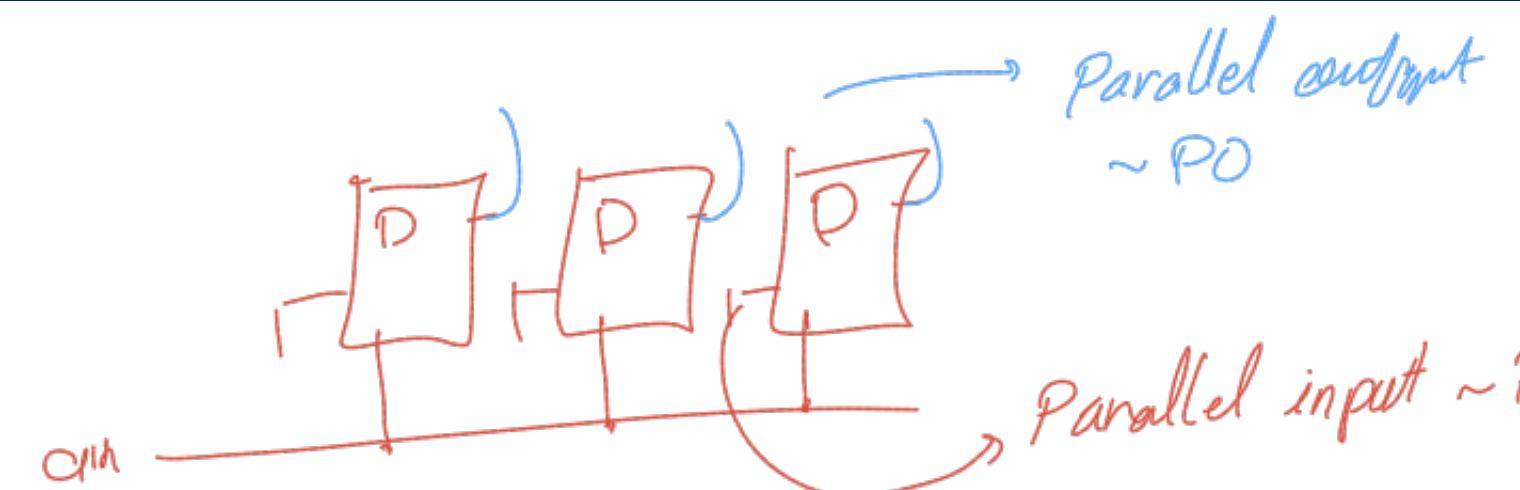
Led by **Abolfazl Ranjbar**

**Computer Engineering Department**

**University of Isfahan**

Fall Semester 2024

# Question - 1



Universal shift register

$S_1, S_0$	operation
00	no change
01	Right shift
10	left shift
11	Parallel load

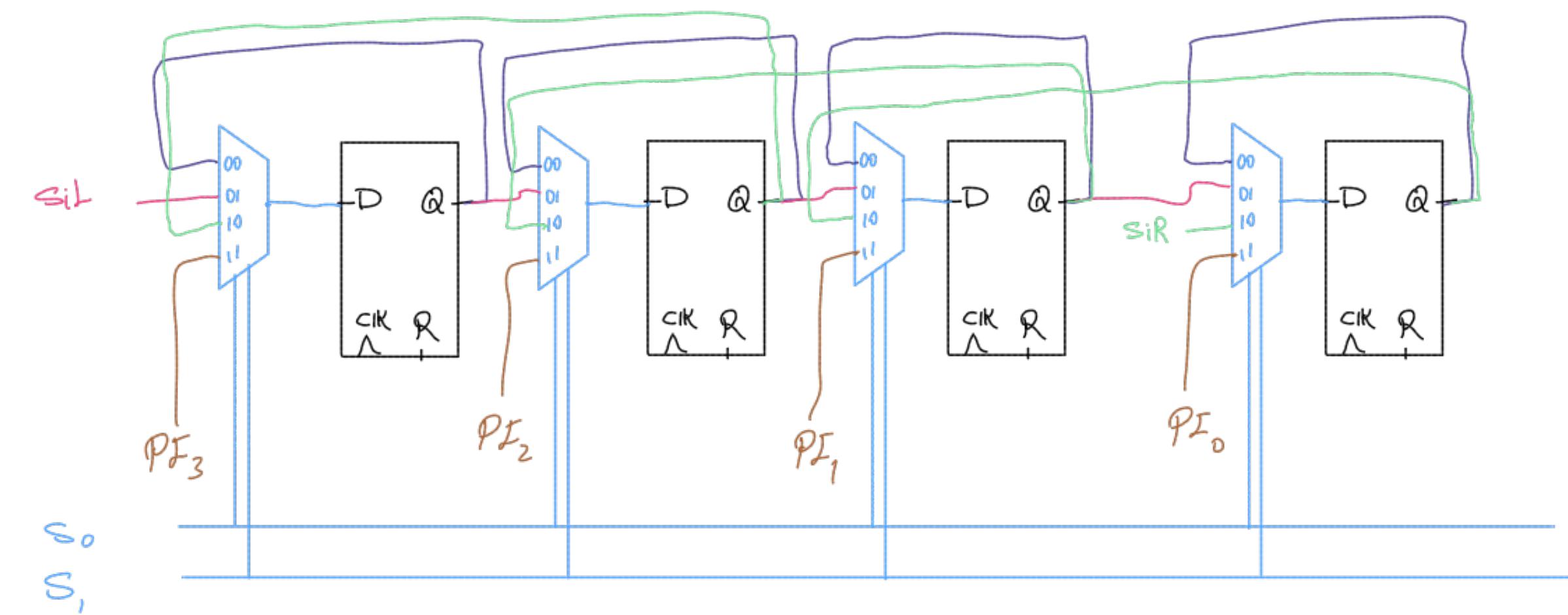
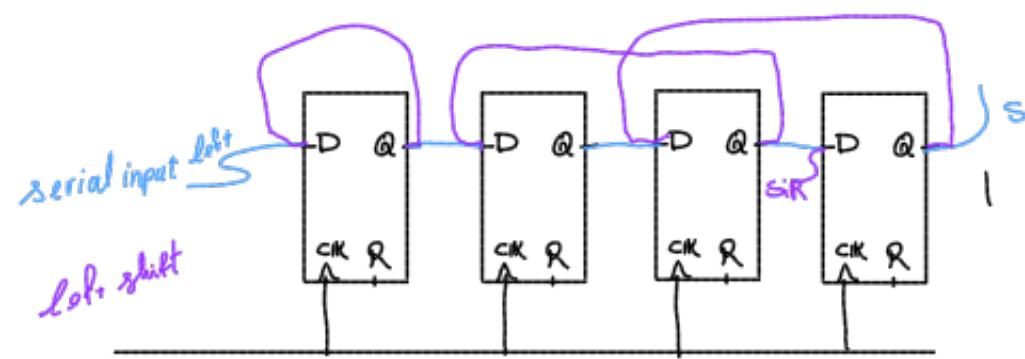
1- نمودار شیفت رجیستر عام ۴ بیتی طراحی کنید که قابلیت‌های زیر را داشته باشد:

الف) بدون تغییر (نگهداری وضعیت فعلی)

ب) شیفت به راست

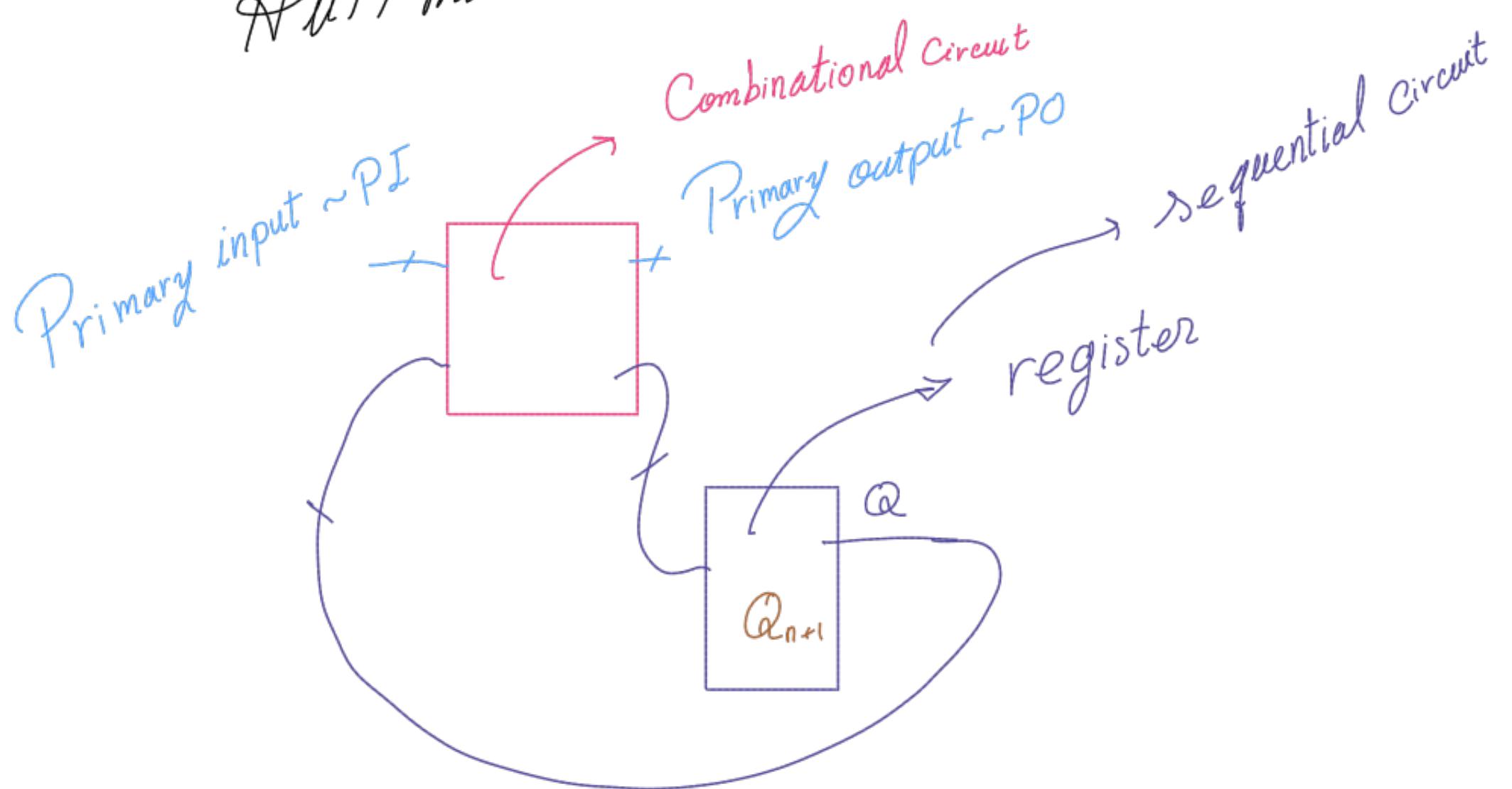
ج) شیفت به چپ

د) بارگزاری موازی

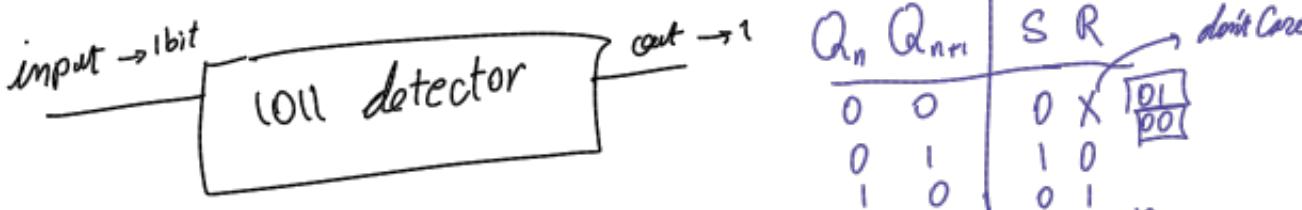


State Diagram  $\rightarrow$  State table + State Assignment  
 $\quad\quad\quad$  $\curvearrowright$  transition table + Flip Flop  $\rightarrow$  excitation table

Huffman Model



## Question - 2

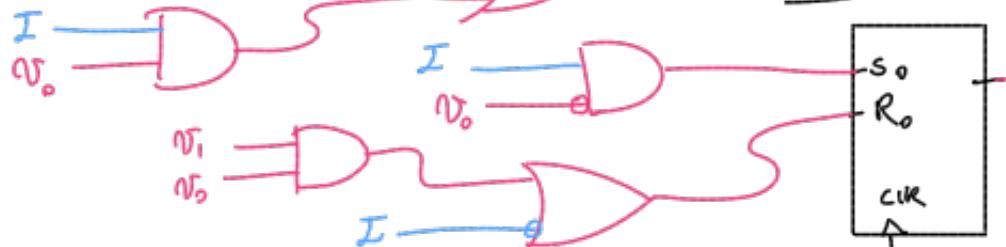
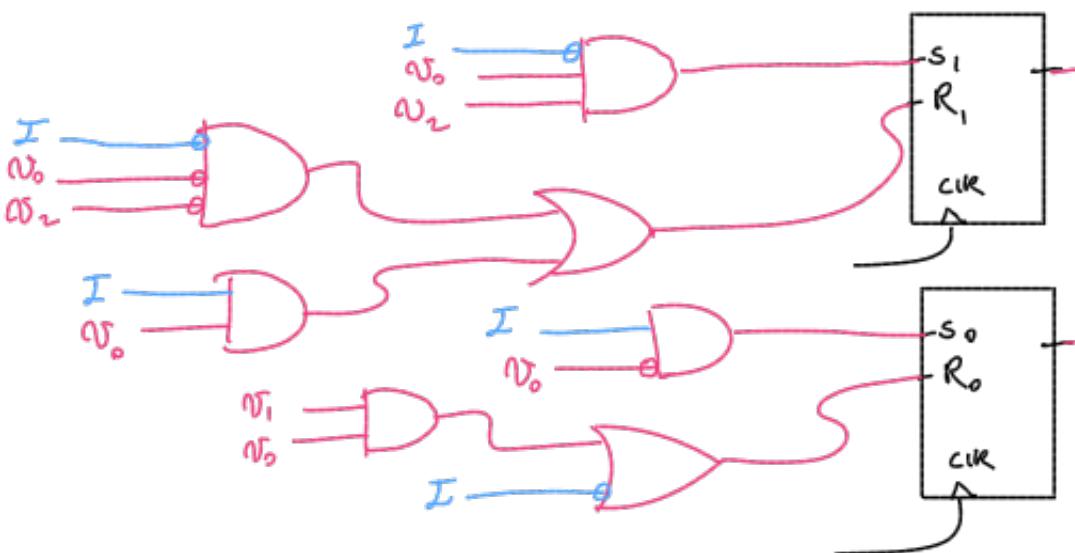
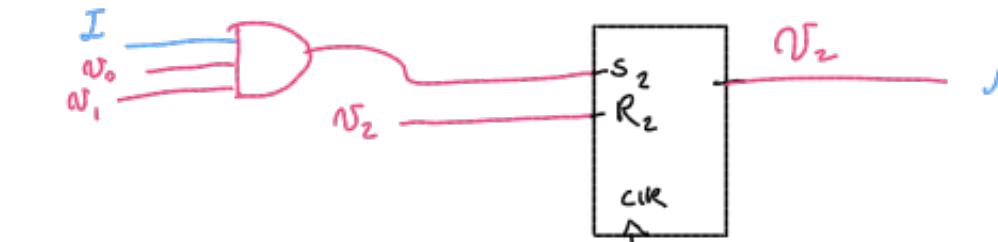


$Q_n$	$Q_{n+1}$	S R	detetor
0 0	0 X	0 X	1011
0 1	1 0	1 0	1011
1 0	0 1	0 1	1011
1 1	X 0	X 0	00

۲- یک مدار طراحی کنید که رشته باینری «۱۱۰۱» را در یک جریان ورودی تشخیص دهد. در صورتی که این دنباله شناسایی شود مقدار «۱» و در غیر این صورت مقدار «۰» را تولید کند. ( تنها با استفاده از فلیپ فلاب (sr)

*excitation table*

$Q_n$	I	$Q_{n+1}$	$S_2 R_2$	$S_1 R_1$	$S_0 R_0$	M
000	0	000	0X	0X	0X	0
000	1	001	0X	0X	10	0
001	0	010	0X	10	01	0
001	1	001	0X	0X	X0	0
010	0	000	0X	01	0X	0
010	1	011	0X	X0	10	0
011	0	010	0X	X0	01	0
011	1	100	10	01	01	0
100	0	010	01	10	0X	1
100	1	001	01	0X	10	1
N <sub>2</sub> N <sub>1</sub> N <sub>0</sub>		N <sub>2</sub> N <sub>1</sub> N <sub>0</sub>				M = N <sub>2</sub>



$N_0 I$	$S_2 = \bar{N}_0 \bar{I}$
00 01 11 10	
00 00 00 00	0 0 0 0
01 00 00 00	1 0 0 0
11 X X X X	X X X X
10 0 0 X X	0 0 X X

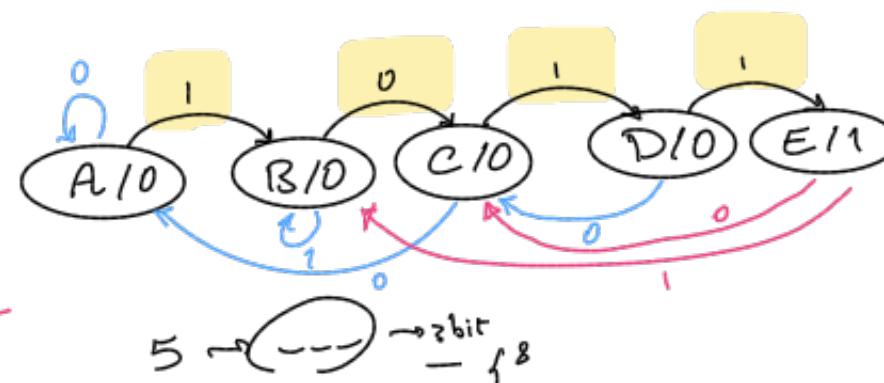
  

$N_0 I$	$S_1 = N_0 \bar{I} + \bar{N}_1 \bar{I}$
00 01 11 10	
00 00 00 00	0 0 0 0
01 00 00 00	1 0 0 0
11 X X X X	X X X X
10 1 0 X X	0 1 X X

$N_0 I$	$S_0 = \bar{N}_0 \bar{I}$
00 01 11 10	
00 00 00 00	0 0 0 0
01 00 00 00	1 0 0 0
11 X X X X	X X X X
10 0 X X X	0 X X X

$$\begin{aligned} A &\rightarrow 0^0 \\ B &\rightarrow 1^1 \\ C &\rightarrow 10^0 \\ D &\rightarrow 101^0 \\ E &\rightarrow 1011^1 \end{aligned}$$



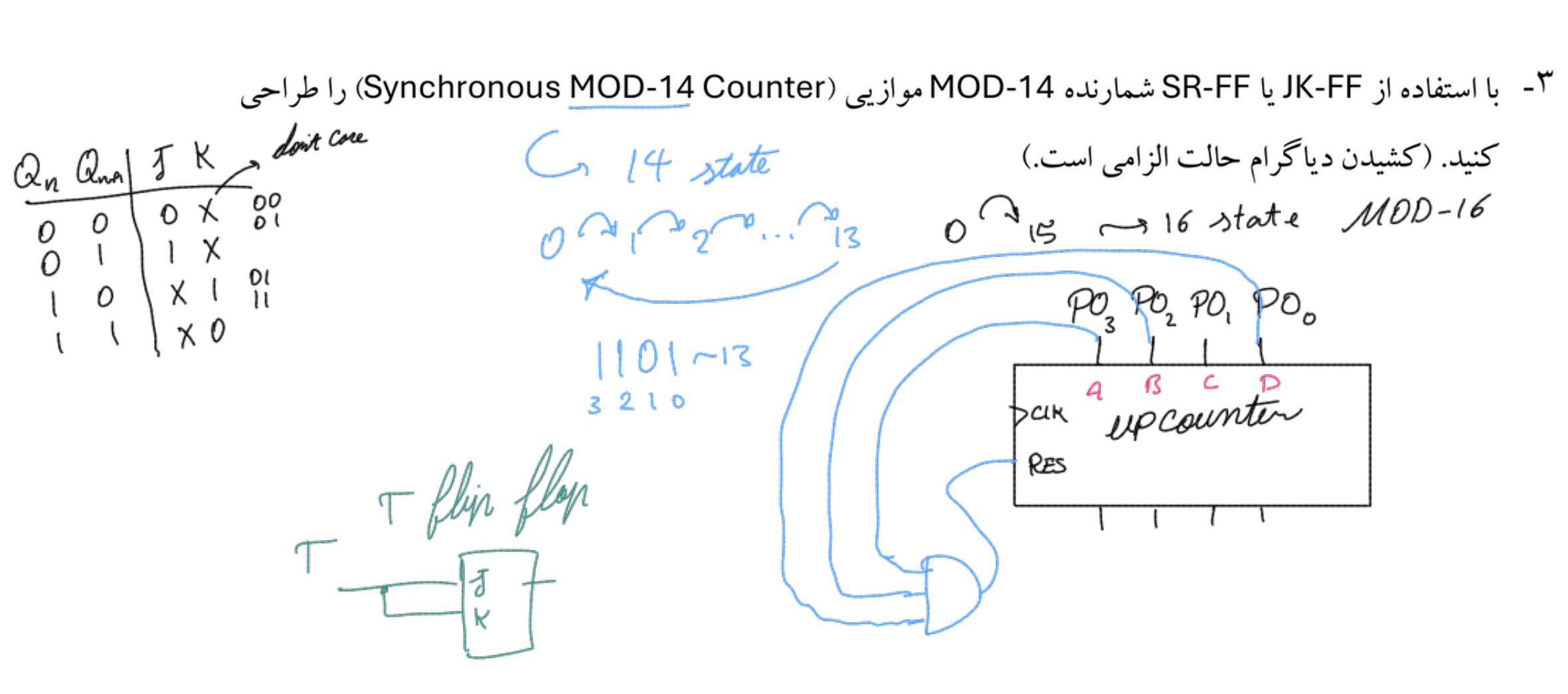
$Q_n$	$Q_{n+1}$	i=0	i=1	M
000	A	A	B	0
001	B	C	B	0
010	C	A	D	0
011	D	C	E	0
100	E	C	B	1

*state assignment*      *state table*

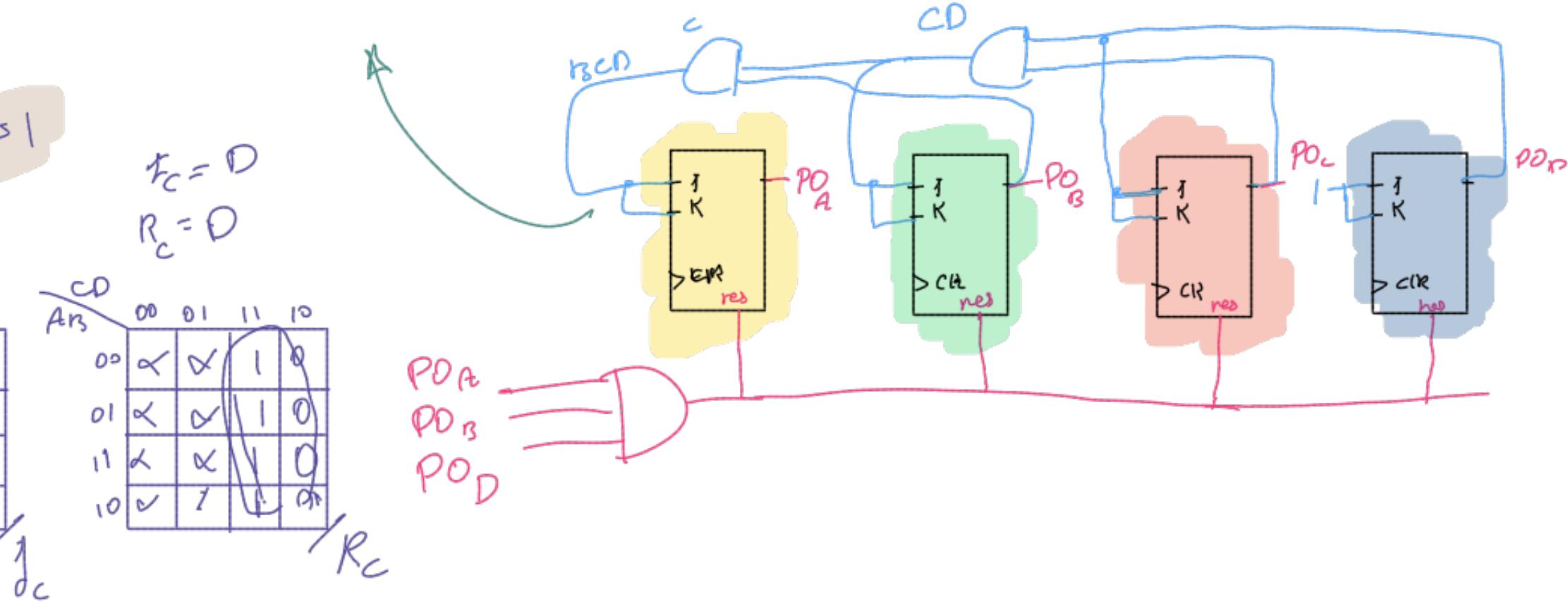
$Q_n$	$Q_{n+1}$	i=0	i=1	M
000	001	001	001	0
001	010	001	001	0
010	000	011	011	0
011	010	010	100	0
100	010	010	001	1

*transition table*

Present				next			
A	B	C	D	$A'$	$B'$	$C'$	$D'$
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	1	0	1
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
1	0	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	1	0	1	0
1	0	1	0	1	1	0	1
1	1	0	0	1	1	0	0
1	1	0	1	1	1	1	0
1	1	1	0	0	0	0	0
15	1	1	1	1	1	1	1

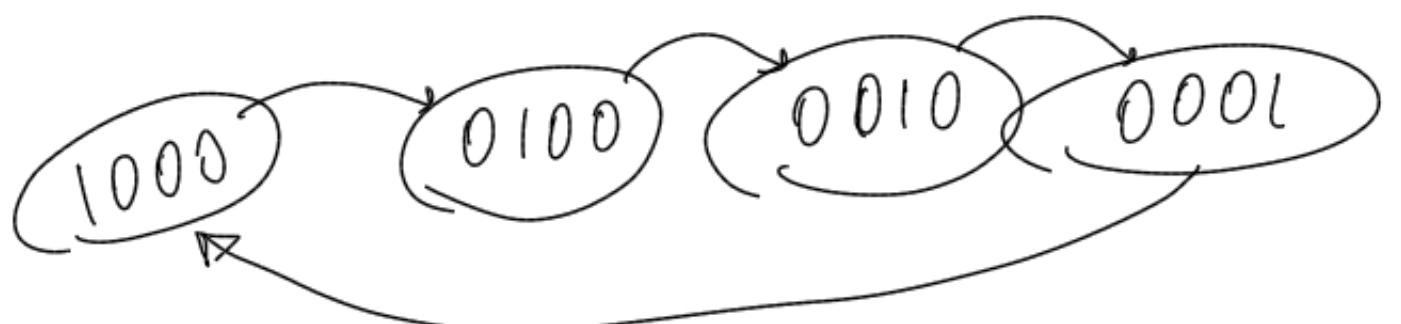


CD		A <sub>3</sub>																	
00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10	00	01	11	10
00	0	0	1	0	X	X	X	0	0	1	0	0	0	1	0	0	0	1	0
01	X	X	X	X	0	0	1	0	0	0	1	0	X	X	X	0	0	1	0
11	X	X	X	X	0	0	1	0	0	0	1	0	X	X	X	0	0	1	0
10	0	0	1	0	X	X	X	0	0	1	0	0	0	1	0	0	0	1	0



### Question - 4

۴- با استفاده از یک مدار D-FF 4-bit Ring Counter طراحی کنید.



$Q_{n+1}$

$Q_n$

$\downarrow$

$A \ B \ C \ D$

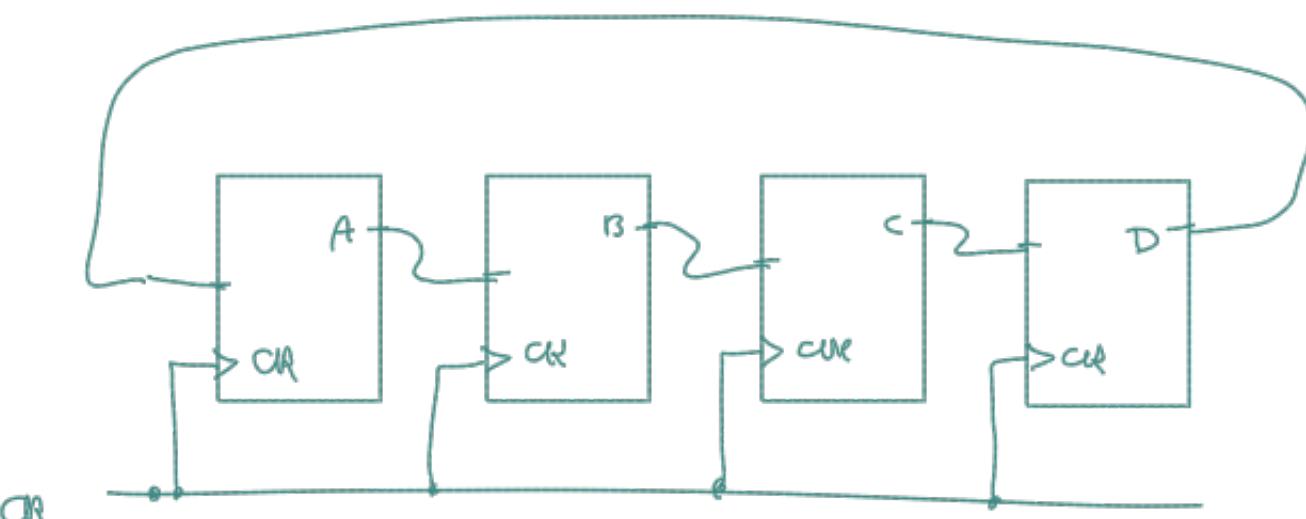
1000  
0100  
0010  
0001  
1000  
 $A \ B \ C \ D$

		AB				$D_A \leftarrow Q_n$	
		00	01	11	10		
		00	1	X	0		
		01	0	X	X	X	
		11	X	X	X		
		10	0	X	X		

		AB				$D_B \leftarrow Q_n$	
		00	01	11	10		
		00	0	0	0		
		01	0	X	X	X	
		11	X	X	X		
		10	1	X	X		

		AB				$D_C \leftarrow Q_n$	
		00	01	11	10		
		00	0	X	0		
		01	X	X	X	X	
		11	X	X	X		
		10	0	X	X		

		AB				$D_D \leftarrow Q_n$	
		00	01	11	10		
		00	1	X	0		
		01	0	X	X	X	
		11	X	X	X		
		10	0	X	X		



## Question - 5



$J$	$K$	$Q$
0	0	$Q$
0	1	0
1	0	1
1	1	$\bar{Q}$

$JK$  - flipflops

- ۵- با استفاده JK-FF یک مدار 3-bit Ring Counter طراحی کنید.

Present	new	$J_2 K_2$	$J_1 K_1$	$J_0 K_0$
100	010	X 1	1 X	0 X
010	001	0 X	X 1	1 X
001	100	1 X	0 X	X 1

$$Q_2 Q_1 Q_0$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	1	X	X	0	0
1	X	X	X	X	X	X

$$J_2 = S_2$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	X	X	X	X	X
1	X	X	X	X	X	X

$$K_2 = 1$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	0	X	X	X	X
1	X	X	X	X	X	X

$$J_1 = S_2$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	X	X	X	X	1
1	X	X	X	X	X	X

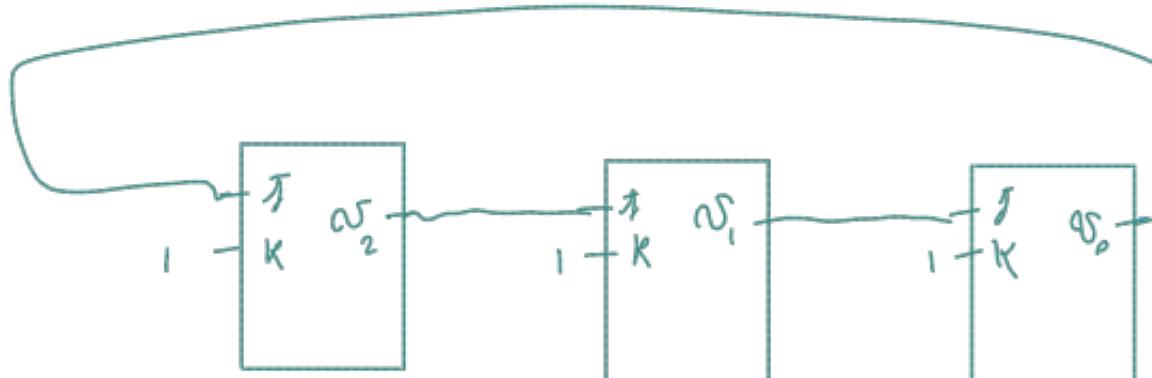
$$K_1 = 1$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	X	X	X	1	X
1	X	X	X	X	X	X

$$J_0 = S_2$$

$S_2$	$S_1$	$S_0$	00	01	U	10
0	X	1	X	X	X	X
1	X	X	X	X	X	X

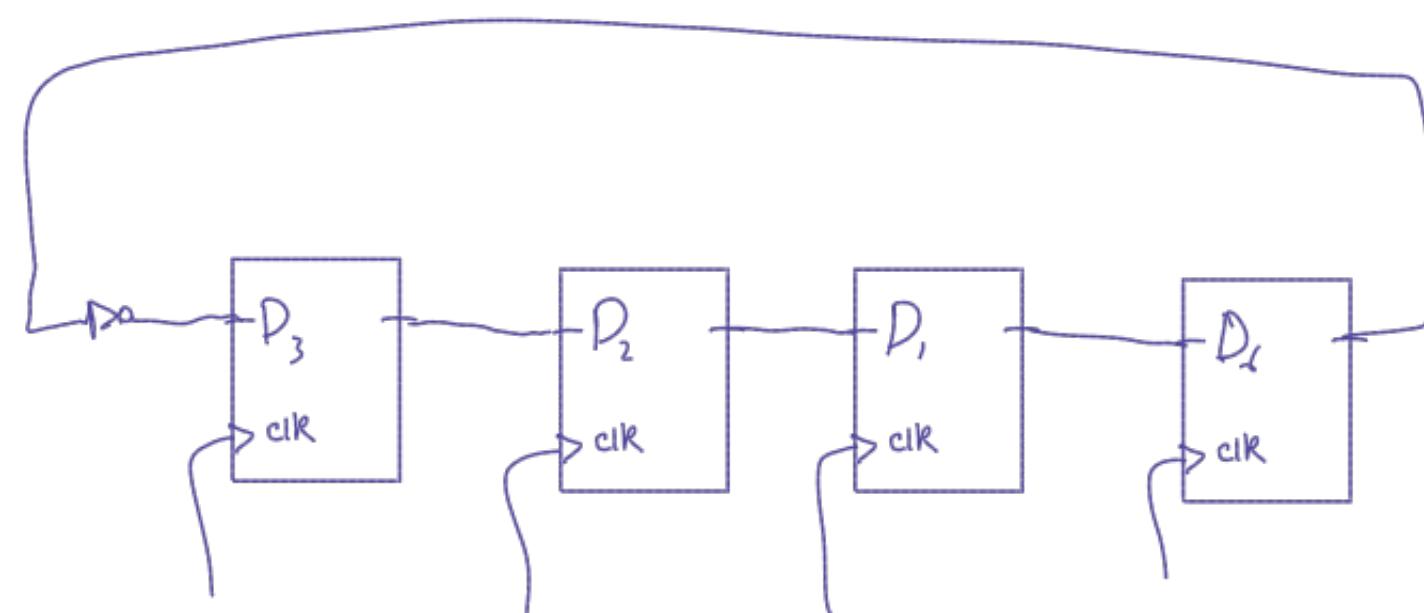
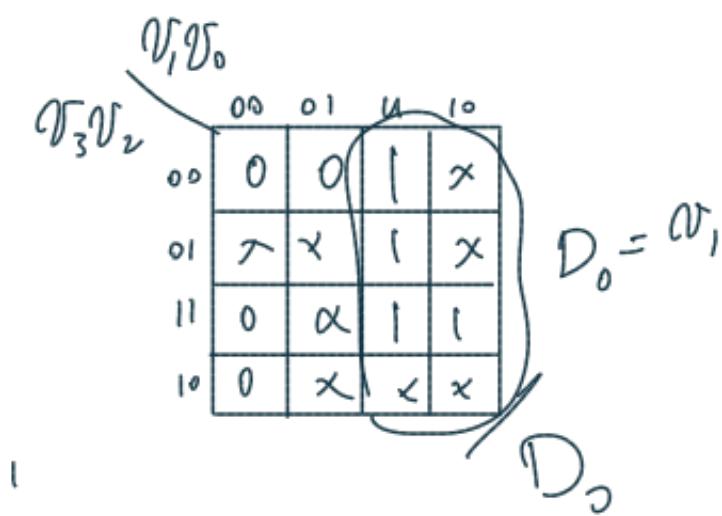
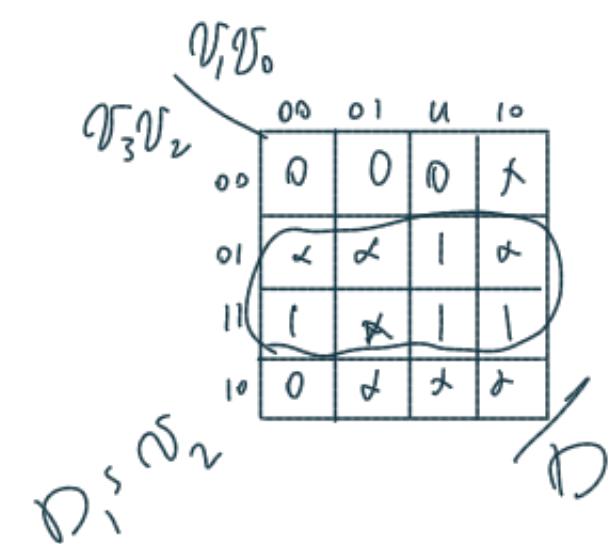
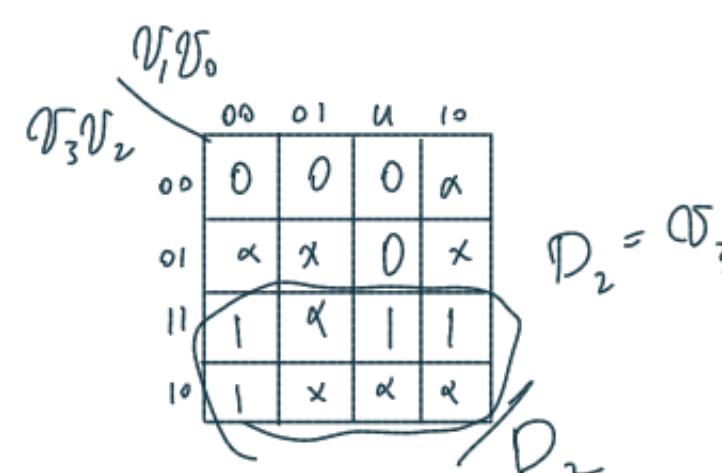
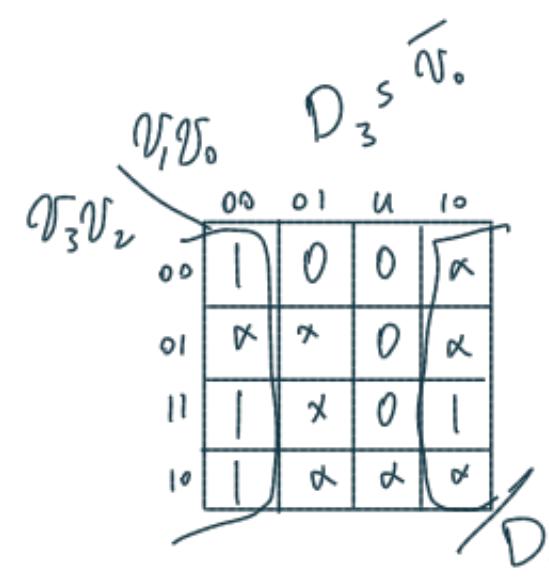
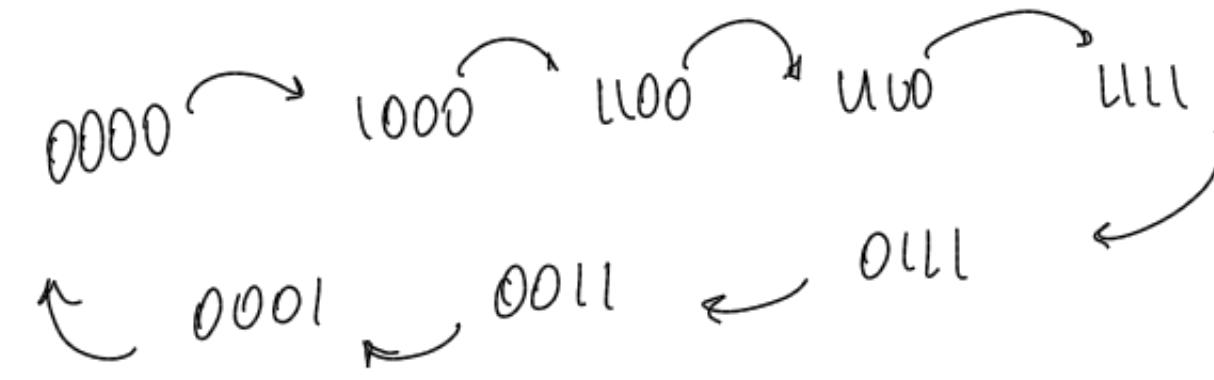
$$K_0 = 1$$

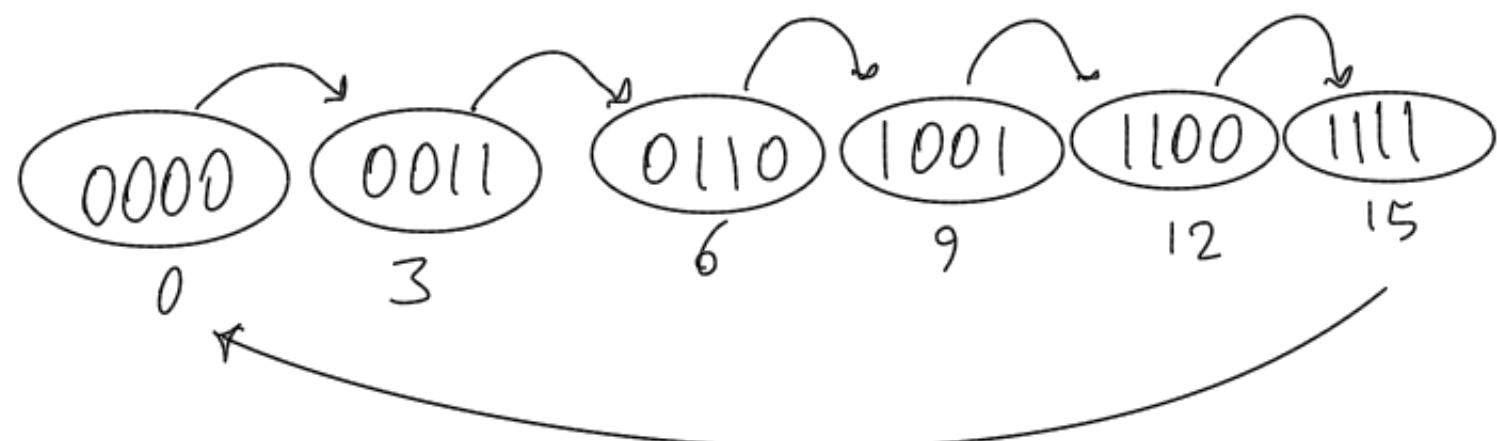


## Question - 6

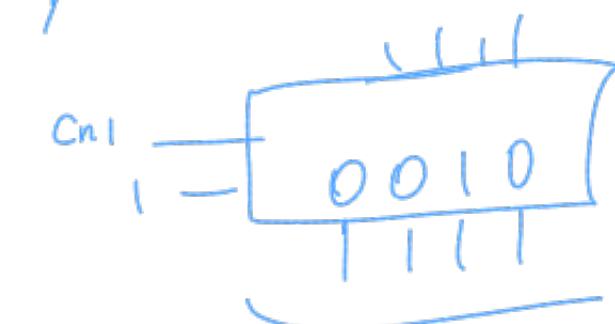
- ۶- با استفاده از D-FF یک مدار 4-bit Johnson Counter طراحی کنید.

Present	next	$D_3 D_2 D_1 D_0$
0000	1000	1000
1000	1100	1100
1100	1110	1110
1110	1111	1111
1111	0111	0111
0111	0011	0011
0011	0001	0001
0001	0000	0000
	$\bar{V}_3 \bar{V}_2 \bar{V}_1 \bar{V}_0$	$\bar{V}_3 \bar{V}_2 \bar{V}_1 \bar{V}_0$





parallel load

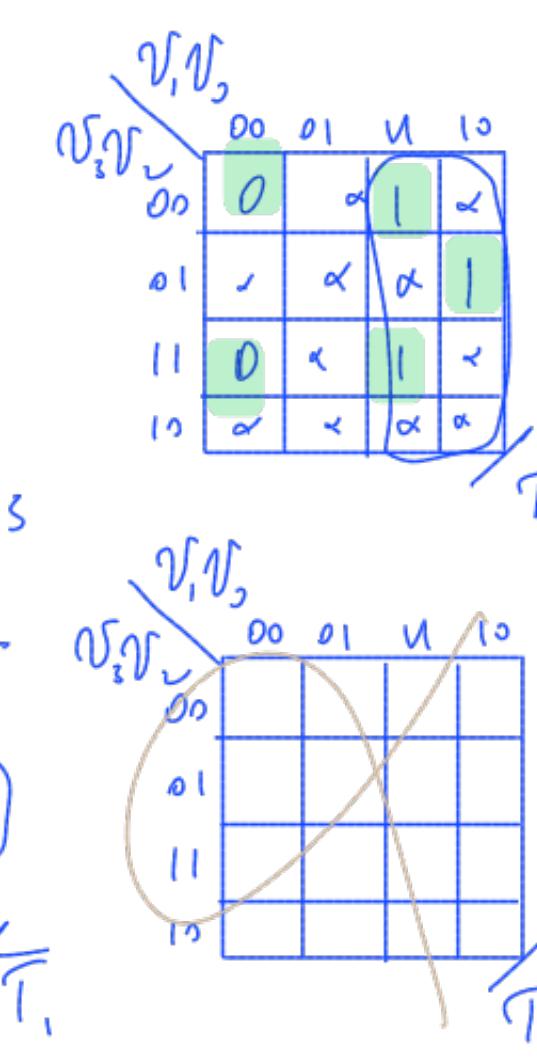
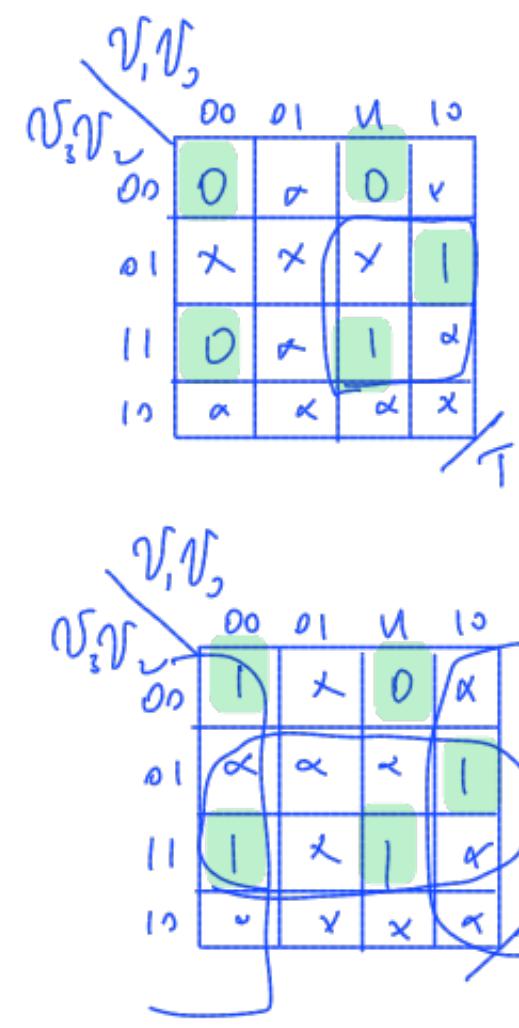


- ۷ با استفاده از  $\text{FF-T}$  یک مدار شمارنده ۴ بیتی طراحی کنید که ۳ تا ۳ تا بشمارد.

4-bit up counter  
3 to 3+

$T - \text{FF}$

Present	New	$T_3$	$T_2$	$T_1$	$T_0$
0000	0011	0	0	1	1
0011	0110	0	1	0	1
0110	1001	1	1	1	1
1100	1111	0	0	1	1
1111	0000	1	1	1	1
		$\bar{V}_3 V_2 V_1 V_0$	$V_3 \bar{V}_2 V_1 V_0$	$V_3 V_2 \bar{V}_1 V_0$	$V_3 V_2 V_1 \bar{V}_0$

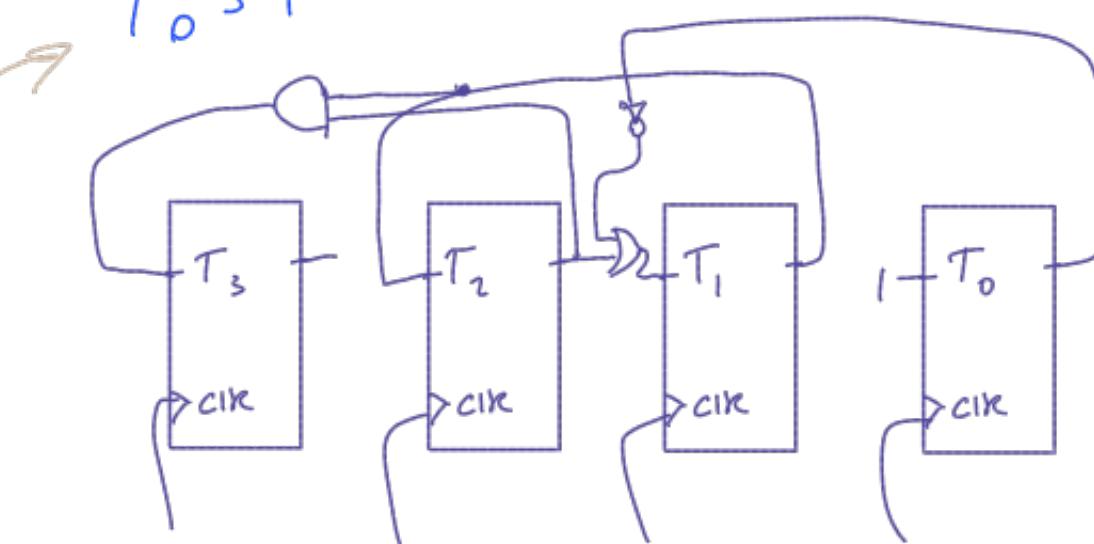


$$T_3 = V_2 V_1$$

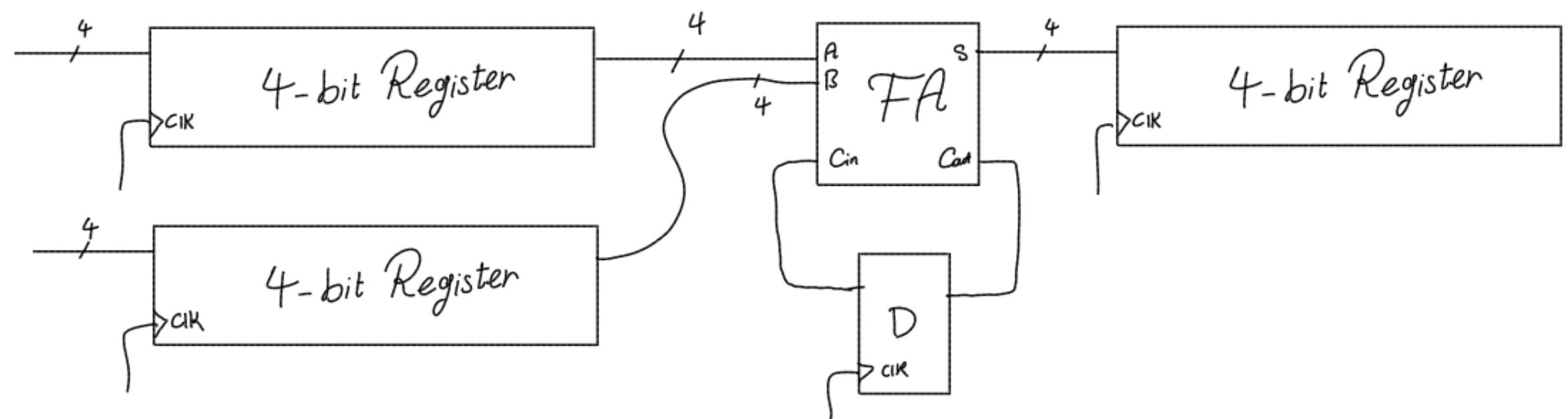
$$T_2 = V_1$$

$$T_1 = \bar{V}_0 + V_2$$

$$T_0 = 1$$



-۸- مدار یک جمع کننده ترتیبی را رسم کنید، به طوری که ورودی های A و B هر کدام در یک رجیستر مقداردهی شده باشند و خروجی را در یک رجیستر دیگر ذخیره کند. (طراحی ابتکاری)



### Question - 9

$\pi$	$A$	$B$	$C$	$A^*BC^*$	$T_A$	$T_B$	$T_C$
0	0	0	0	100	1	0	0
1	0	0	1	001	0	0	1
0	0	1	0	000	0	0	1
1	0	1	1	011	0	1	0
0	1	0	0	001	0	1	0
1	0	1	0	010	0	0	1
0	0	1	0	011	0	0	1
1	0	1	1	110	1	0	0
0	1	1	0	010	1	0	0
1	0	1	1	111	0	0	1
0	1	1	1	101	0	1	0
1	0	1	1	110	0	0	1
0	1	1	0	101	0	1	0
1	0	1	0	111	0	0	1
0	1	0	1	100	0	0	1
1	0	1	0	000	1	0	0

$\pi$	$A$	$B$	$T_B$	$C$
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
1	1	0	0	0
1	1	1	1	1

$$T_A = \bar{C} (\pi \oplus A \oplus B)$$

$$T_B = C (\pi \oplus A \oplus B) \rightarrow$$

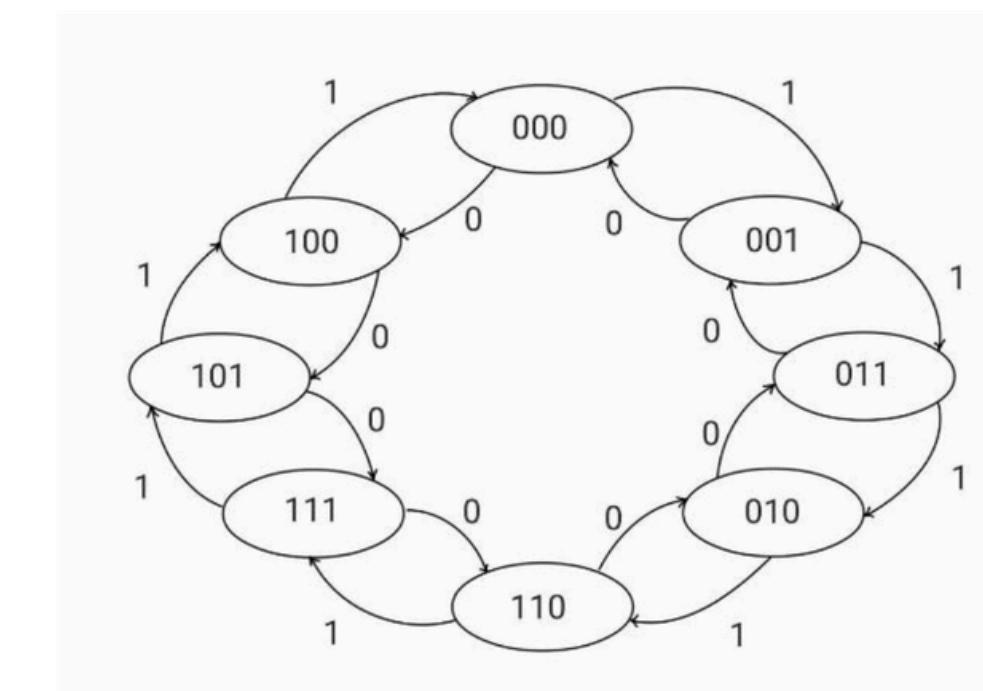
$$T_C = \pi \oplus A \oplus B \oplus C$$

$\pi$	$A$	$B$	$C$	$T_A$
00	1			0
01	0			0
11	1			1
10				1

$\pi$	$A$	$B$	$C$	$T_B$
00				0
01				0
11				0
10	1			1

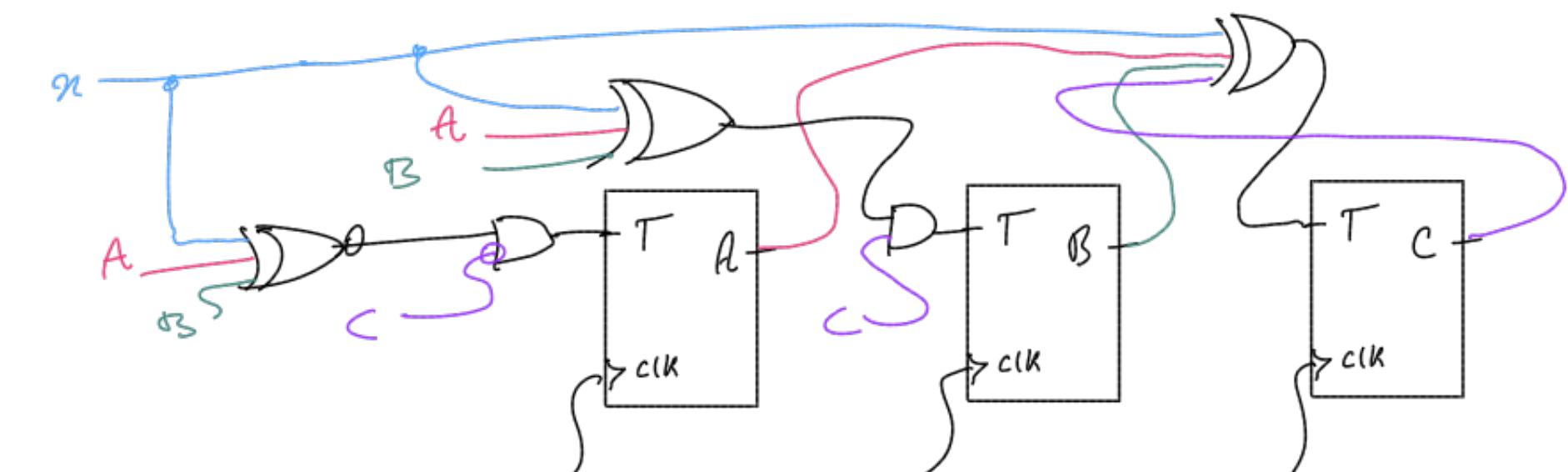
$\pi$	$A$	$B$	$T_A$	$C$
00			0	0
01			0	1
11	1		1	1
10			1	0

nOR nnoR  
نوار مسیر خروجی



000 0	$\rightarrow$ 1
001 0	$\rightarrow$ 0
010 0	$\rightarrow$ 0
011 0	$\rightarrow$ 1
0	0
0	0

nOR



9- مدار مربوط به دیاگرام زیر را رسم کنید.

## TA Team and Contributions:

- **Abolfazl Ranjbar**
- **Ehsan Saberi**
- **Pourya Ardestani**

*with special thanks to **Alireza Banizaman** (from Chemical Engineering Department) for additional support*

