Take home Assignment - 3

① 4 Bit Binary Synchronous up counter

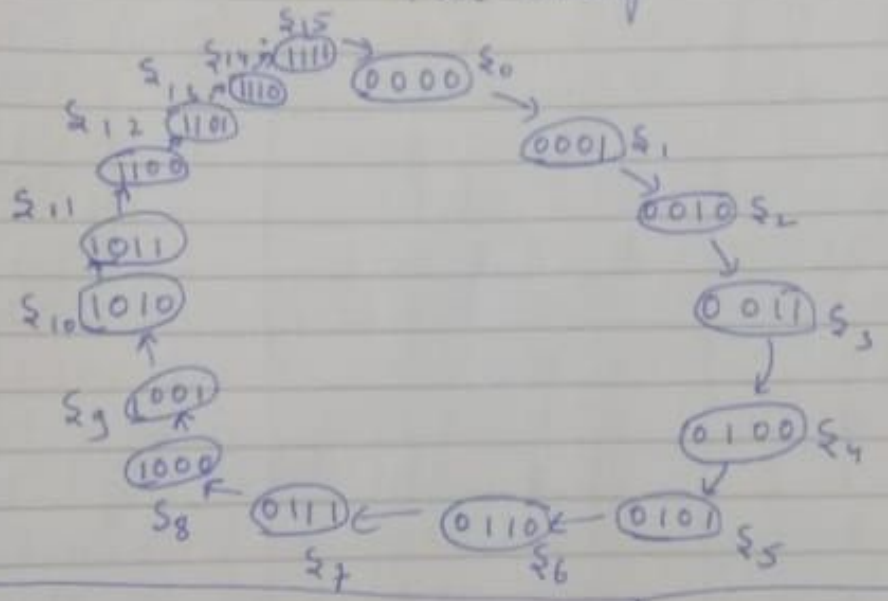
State diag

No of state = $2^n = 2^4 = 16$; Max value = $2^n - 1 = 2^4 - 1 = 15$

(n → no of flip flop)

MSB ← $A_3 A_2 A_1 A_0$ → LSB

4 Bit Binary



Excitation table

Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

K-Map for obtaining T_3, T_2, T_1, T_0

For T_1

A_3A_2 \ A_1A_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

$T_1 = A_0$

For T_2

A_3A_2 \ A_1A_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

$T_2 = A_1 A_0$

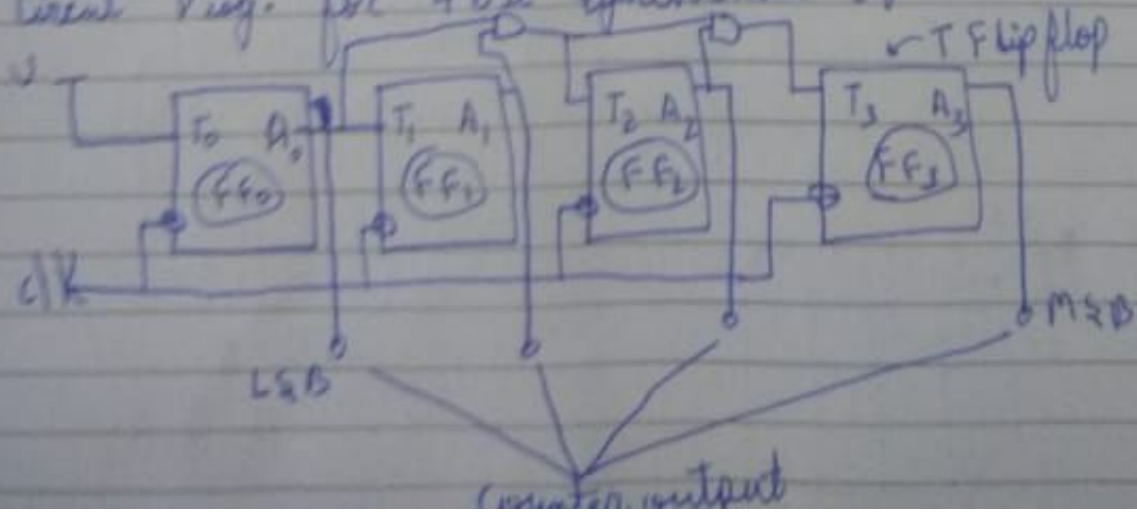
Hence, $T_3 = A_2 A_1 A_0$

$T_0 = 1$

Excitation table

Present state $A_3\ A_2\ A_1\ A_0$	Next states $A_3^*\ A_2^*\ A_1^*\ A_0^*$	$T_3\ T_2\ T_1\ T_0$
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

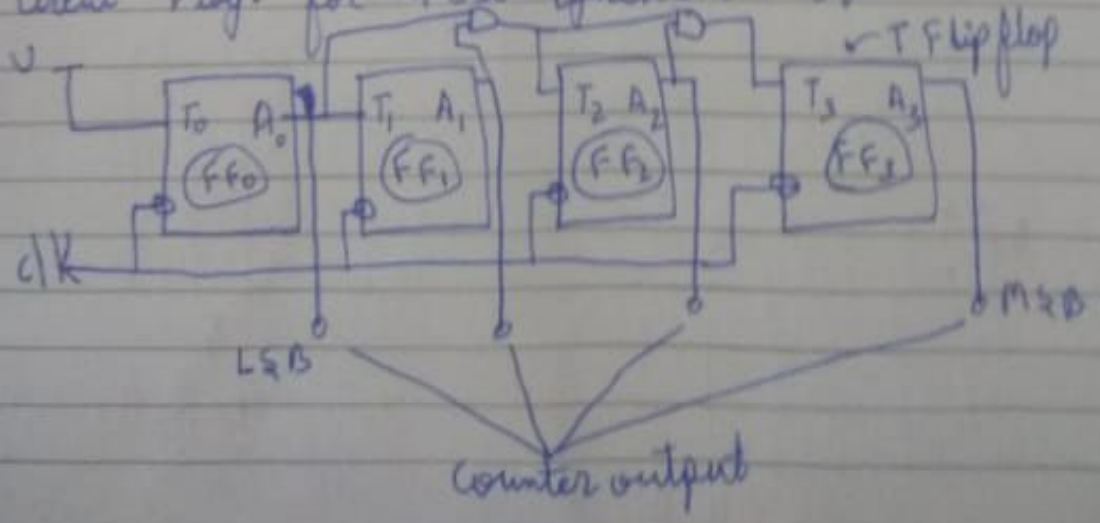
Circuit Diag. for 4 Bit Synchronous UP



Excitation table

Present state				Next state							
A_3	A_2	A_1	A_0	A_3^+	A_2^+	A_1^+	A_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

Circuit Diag. for 4 Bit Synchronous UP

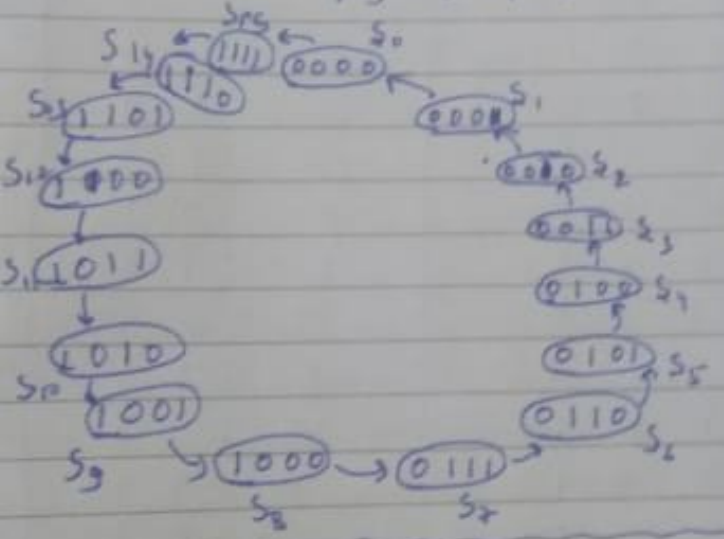


② 4 Bit Binary Synchronous Down-Counter

state diag.

No of state = $2^n = 2^4 = 16$; Max. value = $2^n - 1 = 2^4 - 1 = 15$

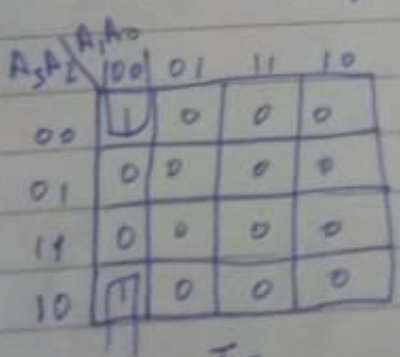
MSB ← $A_3\ A_2\ A_1\ A_0$ → LSB



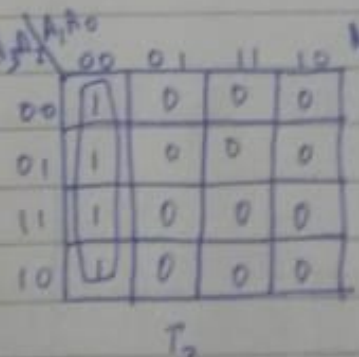
Excitation table

Q_n	Q_{n+1}	T
0	0	0
0	1	1
1	0	1
1	1	0

K-Maps for T_3, T_2, T_1, T_0

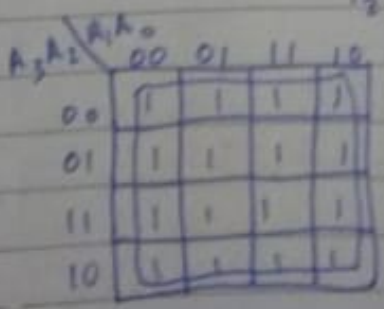


T_3



T_2

T_1



$T_3 = \bar{A}_2\ \bar{A}_1\ \bar{A}_0$

$T_2 = \bar{A}_1\ \bar{A}_0$

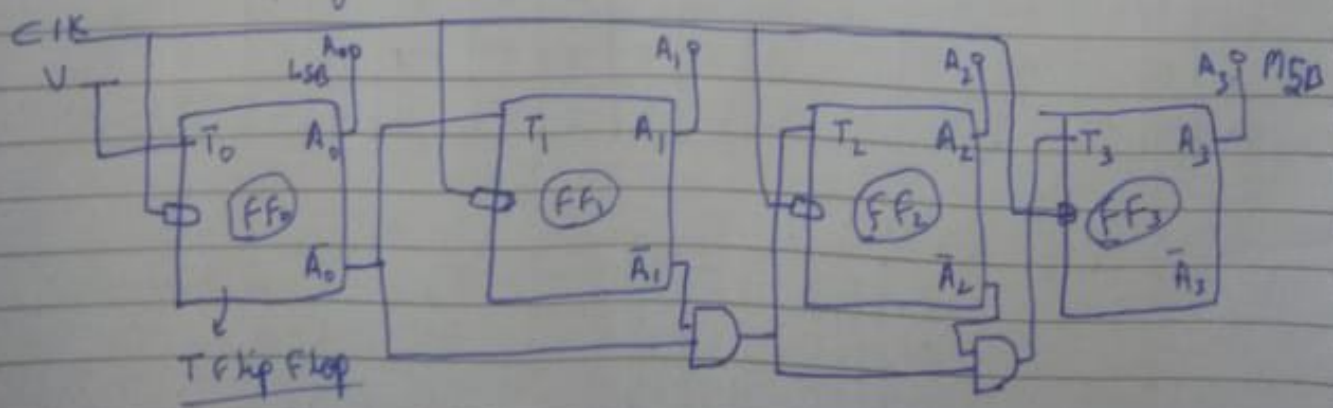
$T_1 = \bar{A}_0$

$T_0 = 1$

Exitation table

Previous State $A_3\ A_2\ A_1\ A_0$	Next State $A_3^*\ A_2^*\ A_1^*\ A_0^*$	$T_3\ T_2\ T_1\ T_0$
0 0 0 0	1 1 1 1	1 1 1 1
0 0 0 1	0 0 0 0	0 0 0 1
0 0 1 0	0 0 0 1	0 0 1 1
0 0 1 1	0 0 1 0	0 0 0 1
0 1 0 0	0 0 1 1	0 1 1 1
0 1 0 1	0 1 0 0	0 0 0 1
0 1 1 0	0 1 0 1	0 0 1 1
0 1 1 1	0 1 1 0	0 0 0 1
1 0 0 0	0 1 1 1	1 1 1 1
1 0 0 1	1 0 0 0	0 0 0 1
1 0 1 0	1 0 0 1	0 0 1 1
1 0 1 1	1 0 1 0	0 0 0 1
1 1 0 0	1 0 1 1	0 1 1 1
1 1 0 1	1 1 0 0	0 0 0 1
1 1 1 0	1 1 0 1	0 0 1 1
1 1 1 1	1 1 1 0	0 0 0 1

Circuit diag for 4 Bit Synchronous Down



③ 4-Bit Binary Asynchronous UP

in 4 bit Asynchronous counter No of flip flops = 4
& output of previous flip flop is fed as clock pulse to next flip flop.

MSB ← → LSB

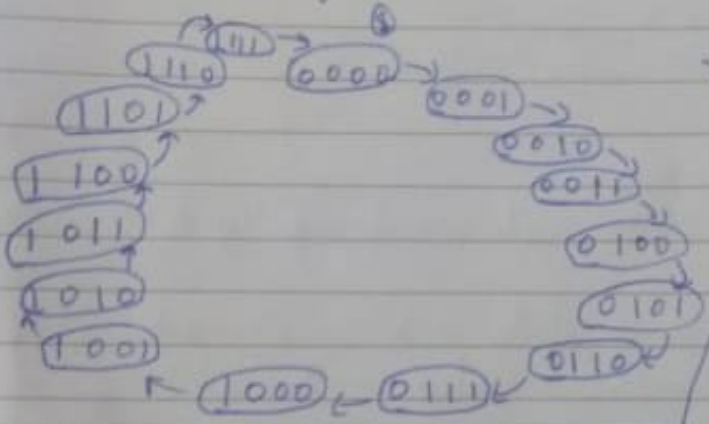
$A_3\ A_2\ A_1\ A_0$

no of flip flop = 4

No of state $= 2^n = 2^4 = 16$

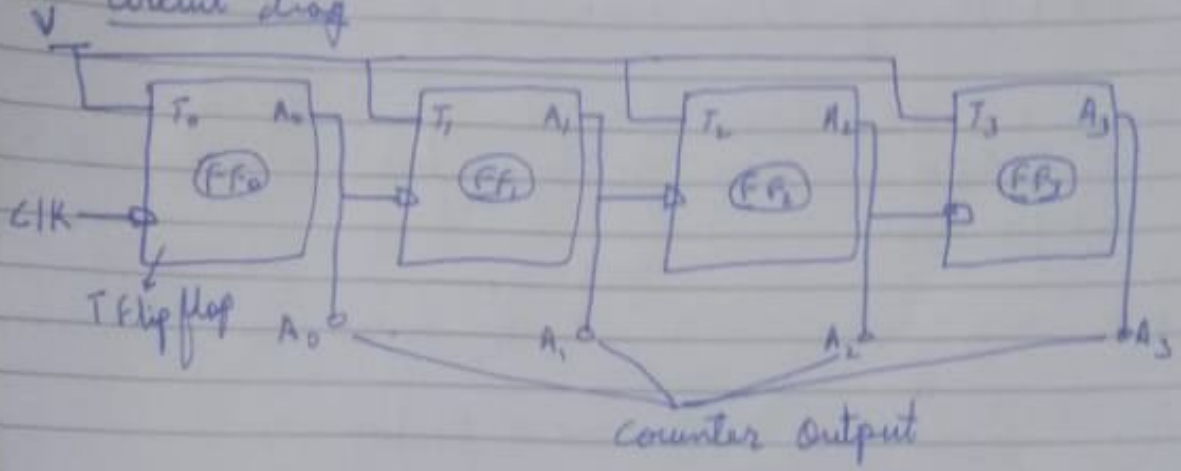
Mod. value $= 2^n - 1 = 2^4 - 1 = 15$

State diag



Clock	A_3	A_2	A_1	A_0	Decimal Eq^v
Initially	0	0	0	0	0
1st	0	0	0	1	1
2nd	0	0	1	0	2
3rd	0	0	1	1	3
4th	0	1	0	0	4
5	0	1	0	1	5
6	0	1	1	0	6
7	0	1	1	1	7
8	1	0	0	0	8
9	1	0	0	1	9
10	1	0	1	0	10
11	1	0	1	1	11
12	1	1	0	0	12
13	1	1	0	1	13
14	1	1	1	0	14
15	1	1	1	1	15
16	0	0	0	0	(again start from top)

Circuit diag



④ 4-bit Asynchronous Down

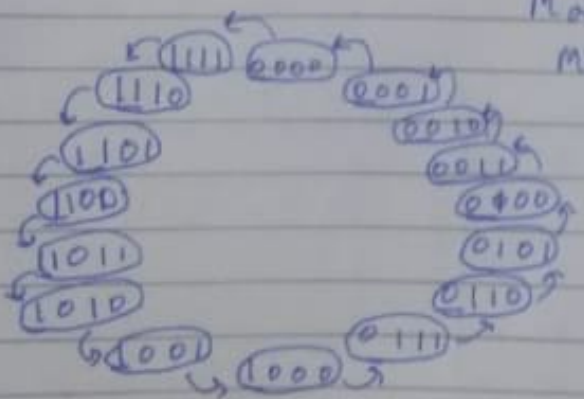
first flip flop is clock driver rest are driven by $\bar{A}$

State diag

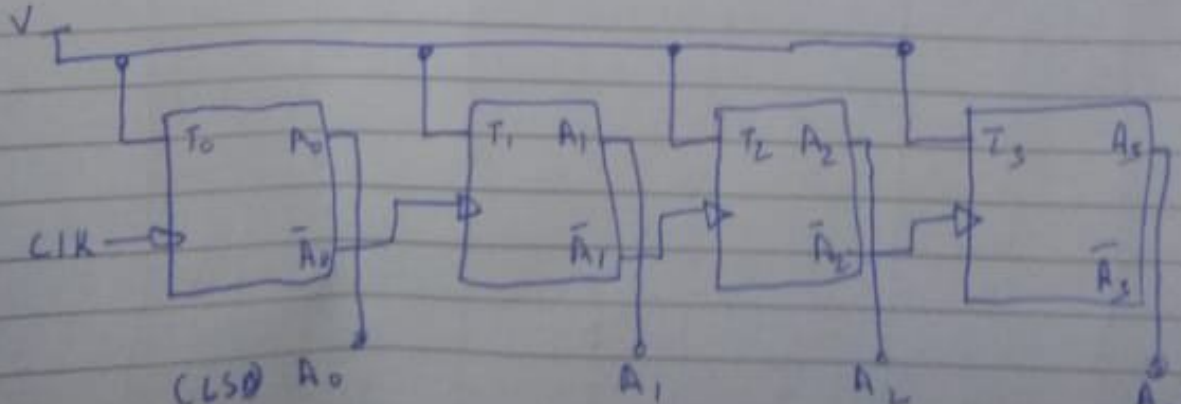
No of state $= 2^n = 2^4 = 16$

Maximum value $= 2^4 - 1 = 15$

MSB ← $A_3\ A_2\ A_1\ A_0$ → LSB



Circuit diag:



State table

Clock	A_3	A_2	A_1	A_0	Decimal Eqv
Initially	0	0	0	0	0
After 1st	1	1	1	1	15
2nd	1	1	1	0	14
3rd	1	1	0	1	13
4th	1	1	0	0	12
5	1	0	1	1	11
6	1	0	1	0	10
7	1	0	0	1	9
8	1	0	0	0	8
9	0	1	1	1	7
10	0	1	1	0	6
11	0	1	0	1	5
12	0	1	0	0	4
13	0	0	1	1	3
14	0	0	1	0	2
15	0	0	0	1	1
16	0	0	0	0	0 (start from top)