Asynchronous Counter :

1. Count up , down :

→ For count up :

M = 8 ⇒ 8 states, count 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7

$2^n \geq M \rightarrow 2^n \geq 8 \Rightarrow n = 3$

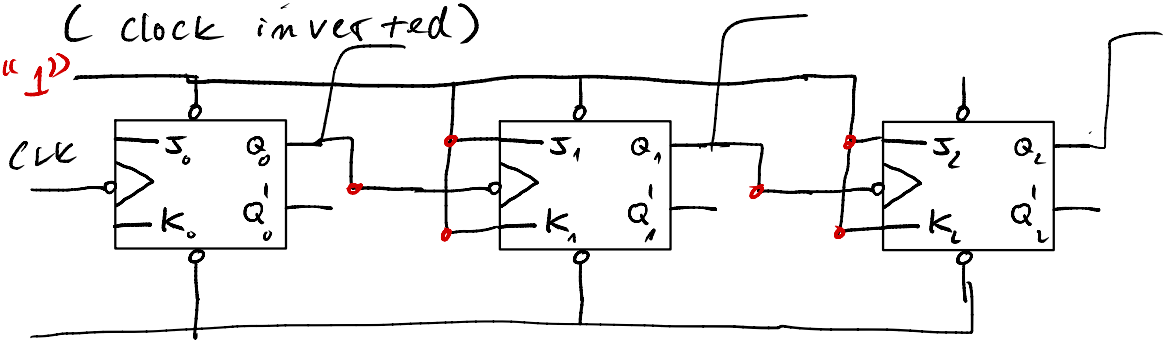
So, we need at least 3 - FFs for these given values

↳ Build state sequence for a 3-bit binary counter:

Clock Pulse	Q_2	Q_1	Q_0
Initially	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8 (recycles)	0	0	0 (Neutral State)

* Trong trường hợp này, TTTG - TTĐ

⇒ Q được nối vào CLK để đếm lên (clock inverted)



Có nghĩa là, nếu hỏi đếm xuống, thì Q' được nối vào CLK

Ex: Count up, M = 5, J-K FF

M = 5 → 5 states count, count 0 - 1 - 2 - 3 - 4

$2^n \geq 5 \Rightarrow n = 3$

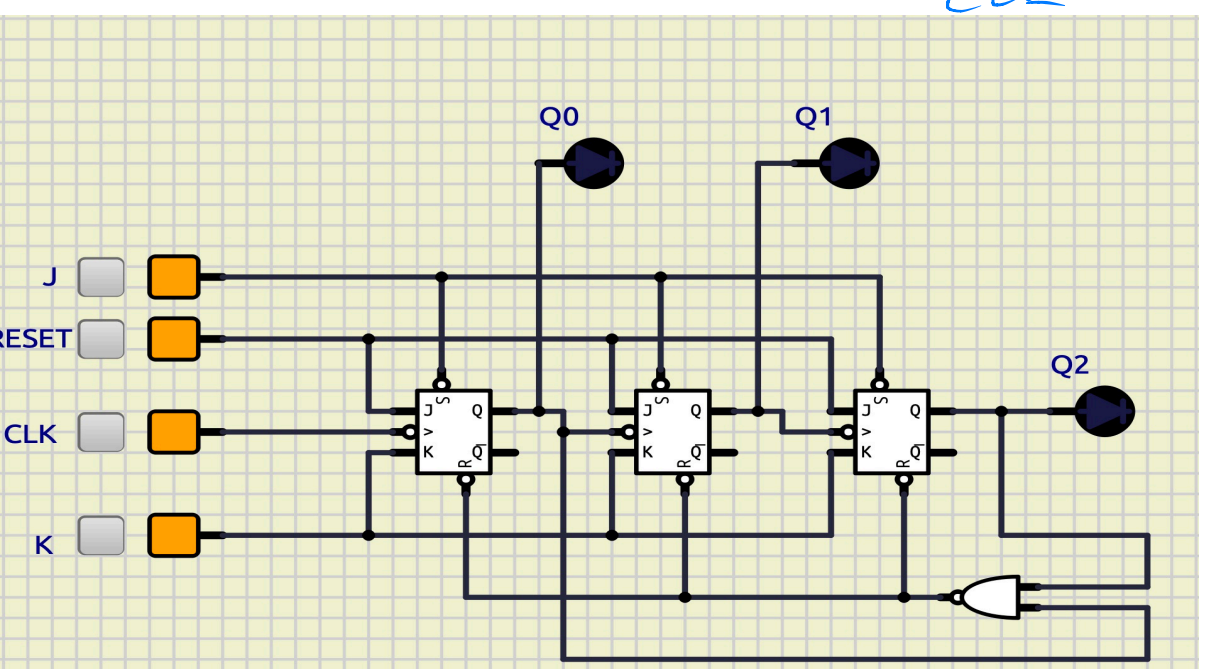
So, we need at least 3 - FFs for these given values

↳ Build state sequence for a 3-bit binary counter:

Clock Pulse	Q_2	Q_1	Q_0	
Initially	0	0	0	
1	0	0	1	
2	0	1	0	
3	0	1	1	
4	1	0	0	
5 (recycles)	1	0	1	(Neutral State)
	↓	↓	↓	
	0	0	0	(set to 0)

- Trong case nay, TTTG > TT Đếm => Lấy bit 1

$Y = \overline{Q_2} + \overline{Q_0} = \overline{Q_2 Q_0}$, (Count up → Q nối vào CLK



Ex: Count down, $N = 6$, J-K FFs

$M = 5 \rightarrow$ 5 states count, count $7-6-5-4-3-2$

$2^n \geq 6 \Rightarrow n = 3$

So, we need at least 3 - FFs for these given values

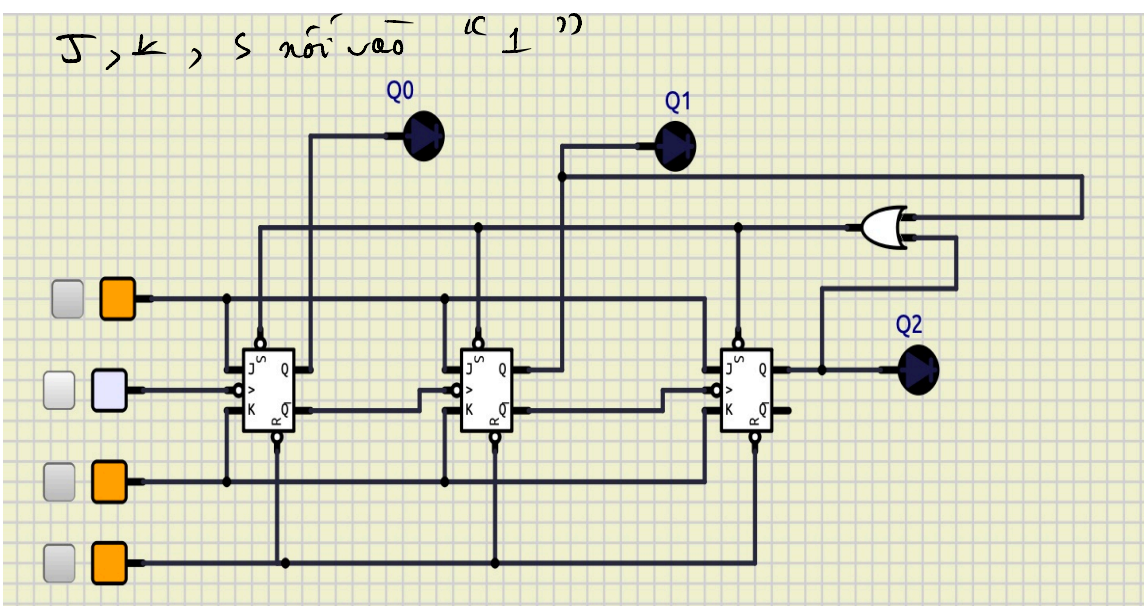
↳ Build state sequence for a 3-bit binary counter:

Clock Pulse	Q_2	Q_1	Q_0
Initially	1	1	1
1	1	1	0
2	1	0	1
3	1	0	0
4	0	1	1
5	0	1	0
6 (recycles)	0 ↓ 1	0 ↓ 1	1 ↓ 1

(Neutral State)

- Trong case này, TTTG < TT Đếm => Lấy bit 0

$Y = Q_2 + Q_1$, Count down → Q' nối vào CLK



Synchronous Counter :