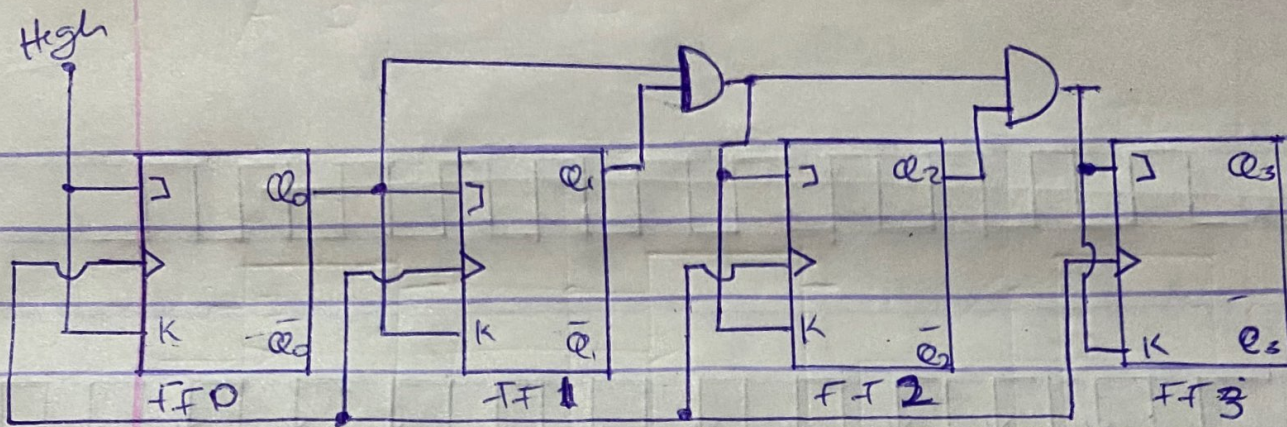
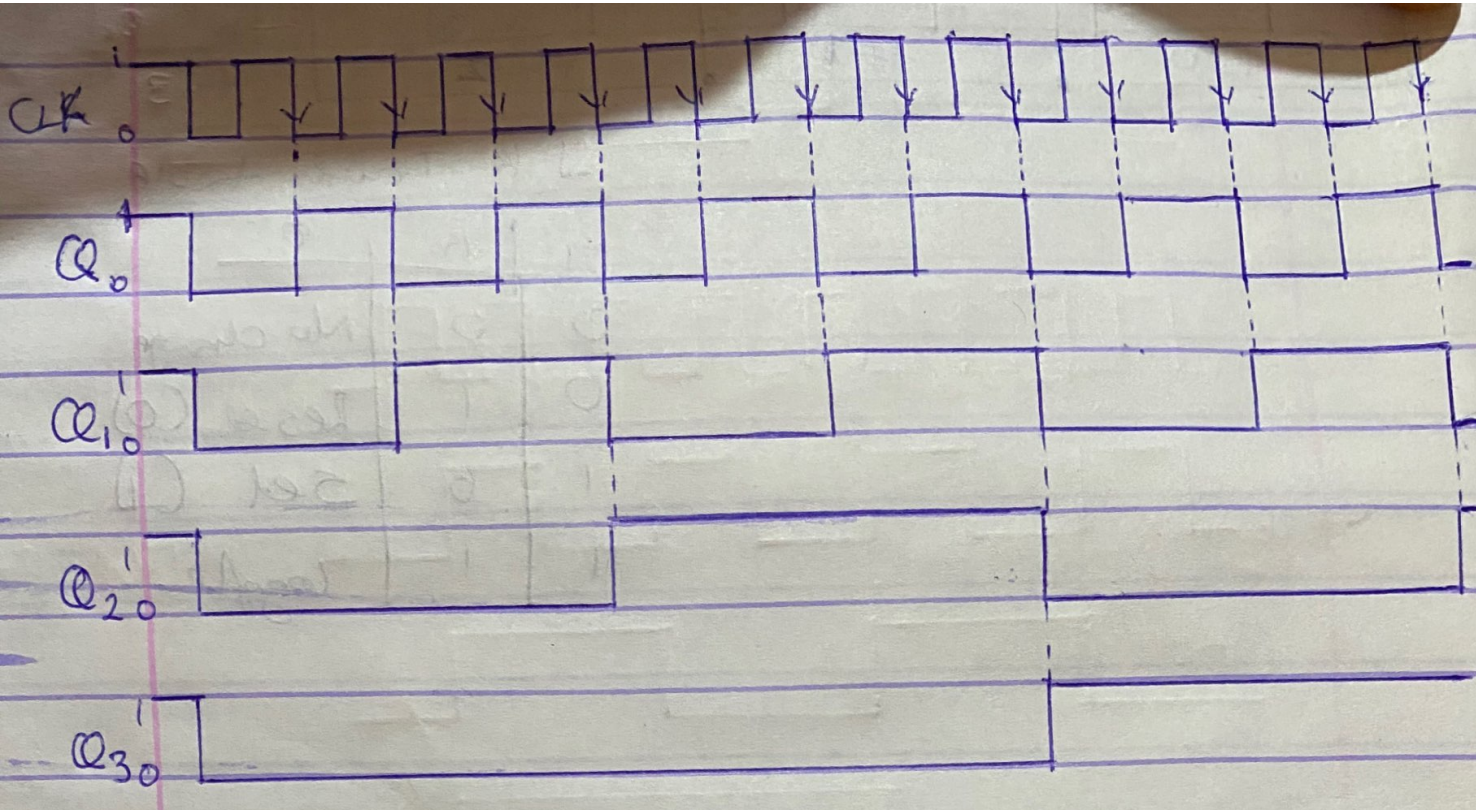


# A 4-BIT BINARY COUNTER



J-K Truth table

| J | K | Q         |
|---|---|-----------|
| 0 | 0 | No change |
| 0 | 1 | Reset (0) |
| 1 | 0 | Set (1)   |
| 1 | 1 | Toggle    |



Timing diagram showing frequency division

# BINARY COUNTING SYSTEM

| $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|-------|-------|-------|-------|
| $Q_3$ | $Q_2$ | $Q_1$ | $Q_0$ |
| 0     | 0     | 0     | 0     |
| 0     | 0     | 0     | 1     |
| 0     | 0     | 1     | 0     |
| 0     | 0     | 1     | 1     |
| 0     | 1     | 0     | 0     |
| 0     | 1     | 0     | 1     |
| 0     | 1     | 1     | 0     |
| 0     | 1     | 1     | 1     |
| 1     | 0     | 0     | 0     |
| 1     | 0     | 0     | 1     |
| 1     | 0     | 1     | 0     |
| 1     | 0     | 1     | 1     |
| 1     | 1     | 0     | 0     |
| 1     | 1     | 0     | 1     |
| 1     | 1     | 1     | 0     |
| 1     | 1     | 1     | 1     |
| 0     | 0     | 0     | 0     |
| 0     | 0     | 0     | 1     |
| 0     | 0     | 1     | 0     |
| 0     | 0     | 1     | 1     |

Before applying clock pulse

After pulse 1

After pulse 2

After pulse 3

After pulse 4

After pulse 5

After pulse 6

After pulse 7

After pulse 8

After pulse 9

After pulse 10

After pulse 11

After pulse 12

After pulse 13

After pulse 14

After pulse 15

After pulse 16 (returns to 0000)

After pulse 17

After pulse 18

After pulse 19

2) MOD number =  $2^6 = 64$

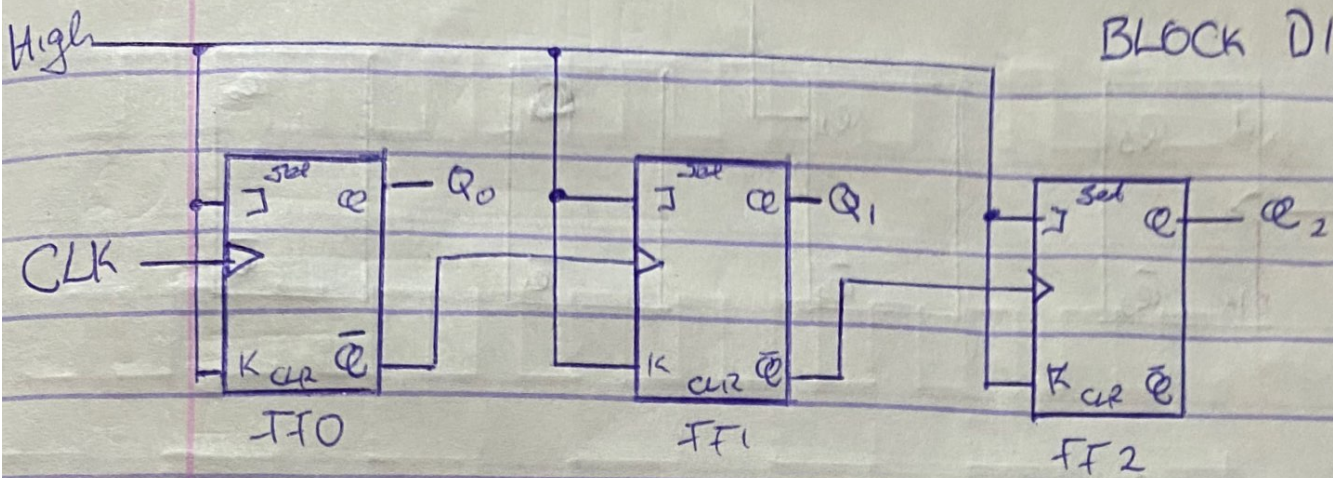
ii) Frequency at the last flip flop will equal the input clock frequency divided by MOD number  
 $\Rightarrow$  frequency at  $Q_5 = \frac{1}{64} \text{ MHz} = 15.625 \text{ kHz}$

iii) The Counter will count from 000000 to 111111  
(total of 64 states)

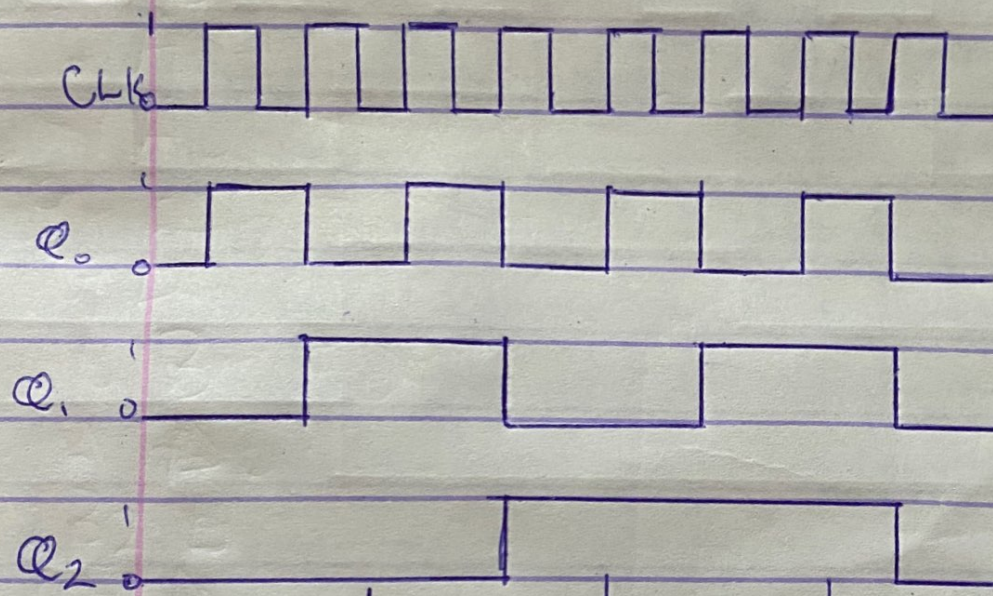
iv) Since <sup>it is a</sup> ~~the~~ MOD-64 Counter, every 64 pulses will bring the counter back to its initial state. Therefore, after 128 pulses, the counter is back to 000000 and after the 129th pulse, it brings the counter to 000001 state.

# A 3-BIT ASYNCHRONOUS COUNTER

BLOCK DIAGRAM



TIMING DIAGRAM



| State | Q <sub>2</sub> | Q <sub>1</sub> | Q <sub>0</sub> |
|-------|----------------|----------------|----------------|
| 0     | 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              |

TRUTH TABLE