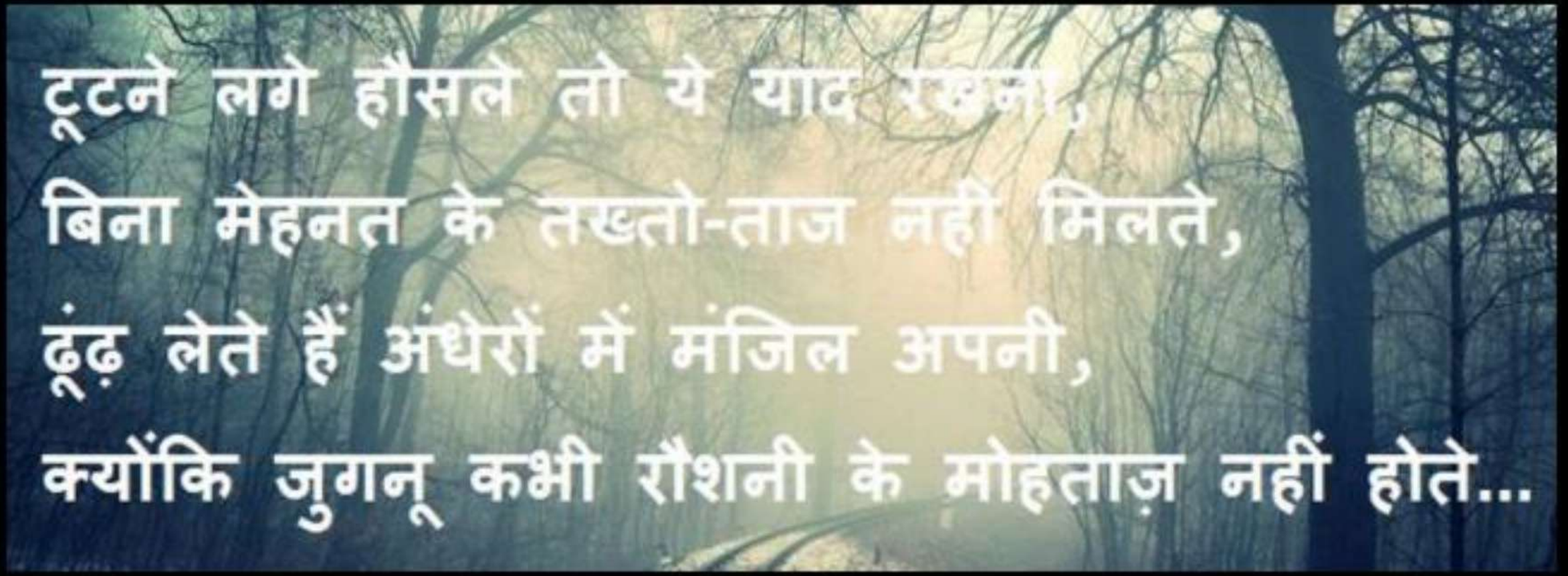
EC/EE/CS & IT/IN

Digital Electronics

NUMBER SYSTEM

LECTURE NO. 11

Chandan Jha Sir (CJ Sir)


टूटने लगे हौसले तो ये याद रखना,
बिना मेहनत के तख्तो-ताज नहीं मिलते,
ढूंढ़ लेते हैं अंधेरों में मंजिल अपनी,
क्योंकि जुगनू कभी रौशनी के मोहताज़ नहीं होते...

ABOUT ME

- Cleared Gate Multiple times with double Digit Rank (AIR 23, AIR 26)
- Qualified ISRO Exam
- Mentored More then 1 Lakhs+ Students (Offline & Online)
- More then 250+ Motivational Seminar in various Engineering College including NITs & Some of IITs

Chandan Jha

SYNCHRONOUS COUNTER

STEP 1. Write the Present and next state.

STEP 2. Write the Excitation Table of FF.

STEP 3. Write the Logical Expression.

STEP 4. Minimize the Logical expression.

STEP 5. Hardware Implementation.

Q Design a Synchronous Counter by using "T" Flip Flop which count the sequence

$0 \rightarrow 2 \rightarrow 3 \rightarrow 0$ $\{00 \rightarrow 10 \rightarrow 11 \rightarrow 00 \rightarrow \ldots\}$

Method (1)

Step 1

Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	1	0	1	0
1	0	1	1	0	1
1	1	0	0	1	1

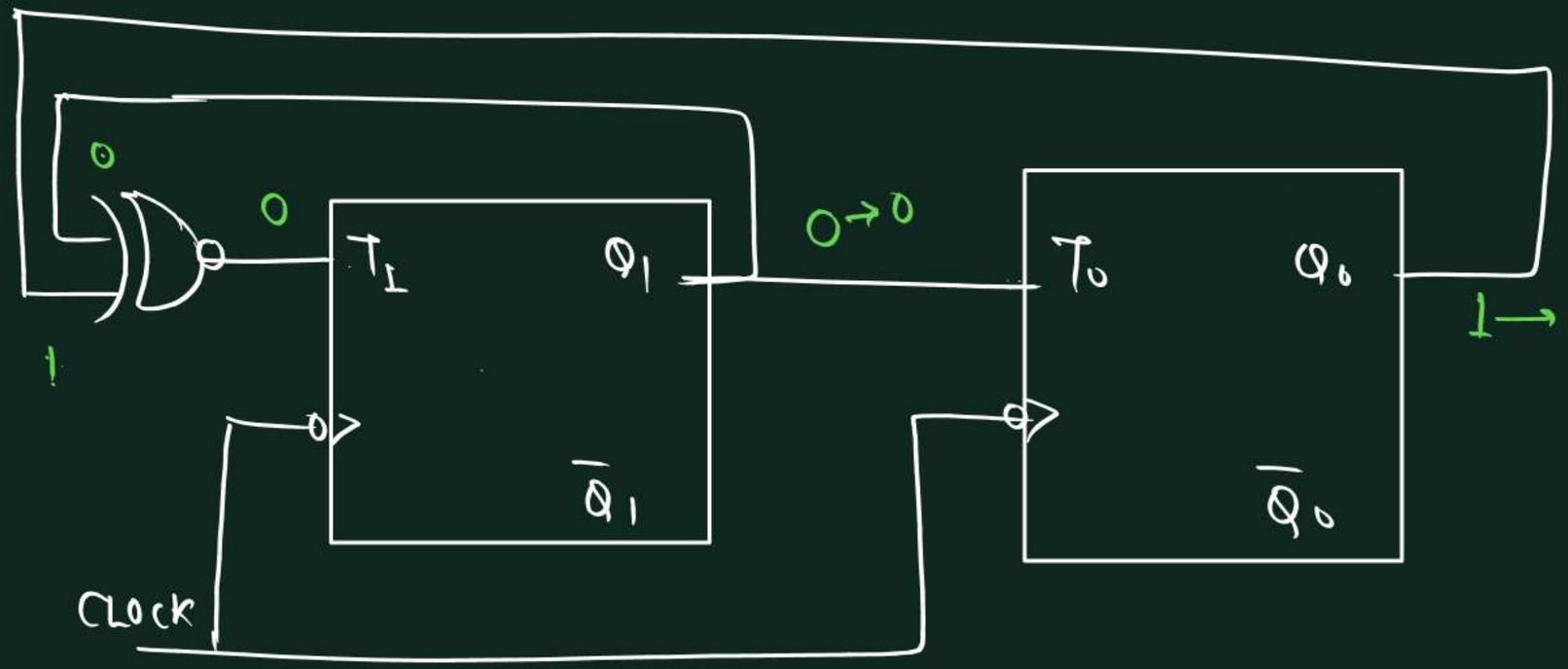
Step 3.

Step 4. $T_1 = \bar{Q}_1 \bar{Q}_0 + Q_1 Q_0$

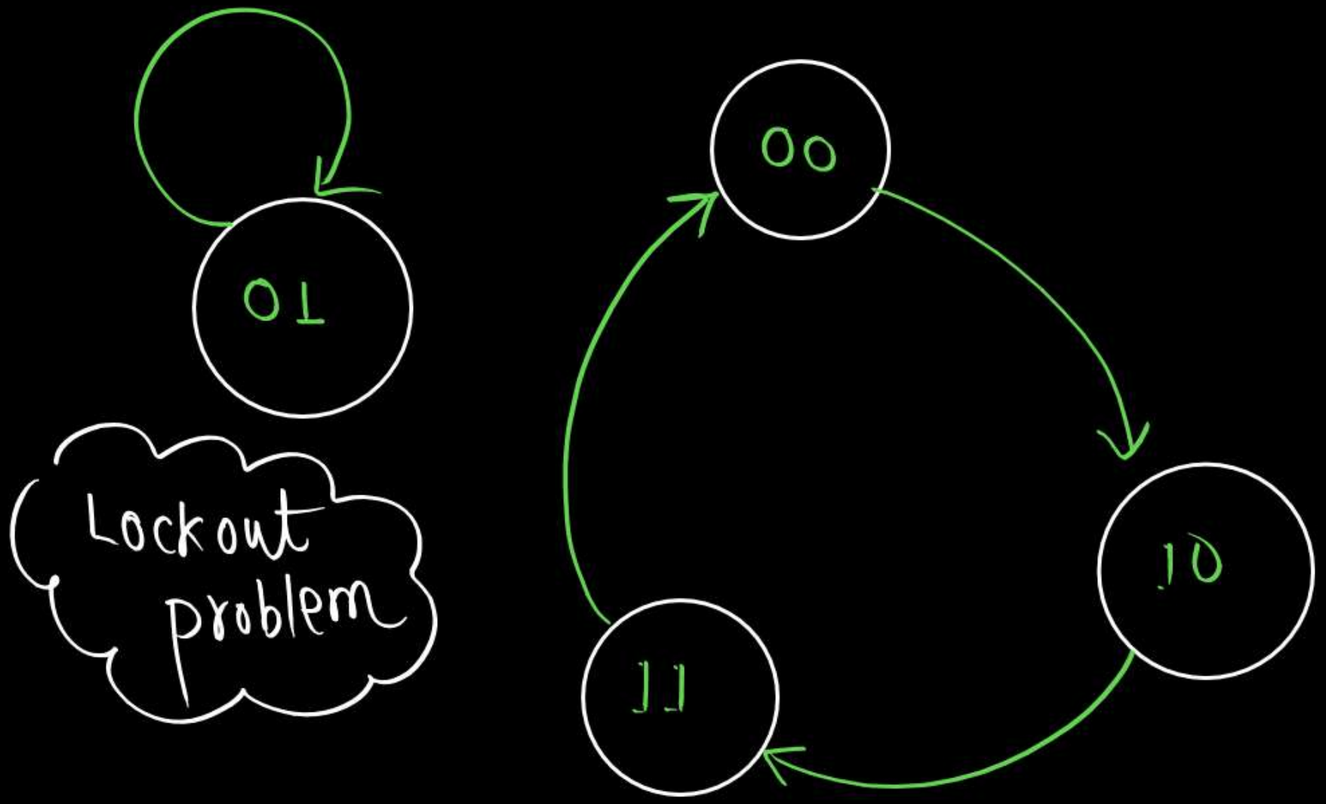
$$T_1 = Q_1 \odot Q_0$$

$T_0 = Q_1 \bar{Q}_0 + Q_1 Q_0$

$$T_0 = Q_1$$



CLOCK	Q_1	Q_0
0	0	0
1	1	0
2	1	1
3	0	0
4	1	0
	1	1


01
Lockout problem
00
10
11

Method ② Without lockout design: $\{00 \rightarrow 10 \rightarrow 11 \rightarrow 00\}$

Step 1:

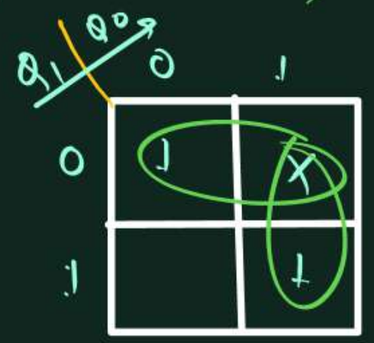
↳ Step 2:

Q_1	Q_0	Q_1^+	Q_0^+	T_1	T_0
0	0	1	0	1	0
0	1	X	X	X	X
1	0	1	1	0	1
1	1	0	0	1	1

Step 3

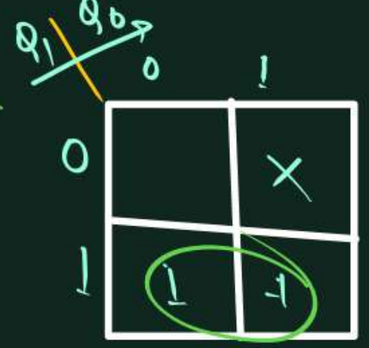
Step 4

T_1 →

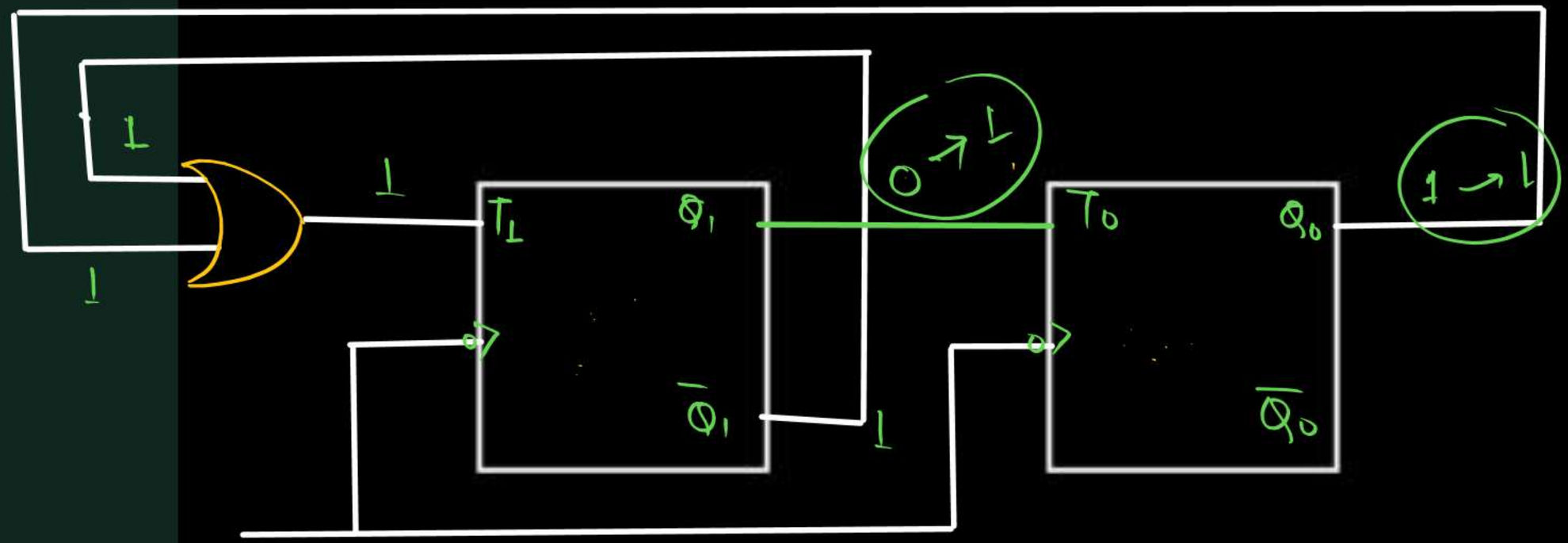


$$T_1 = \bar{Q}_1 + Q_0$$

T_0 →

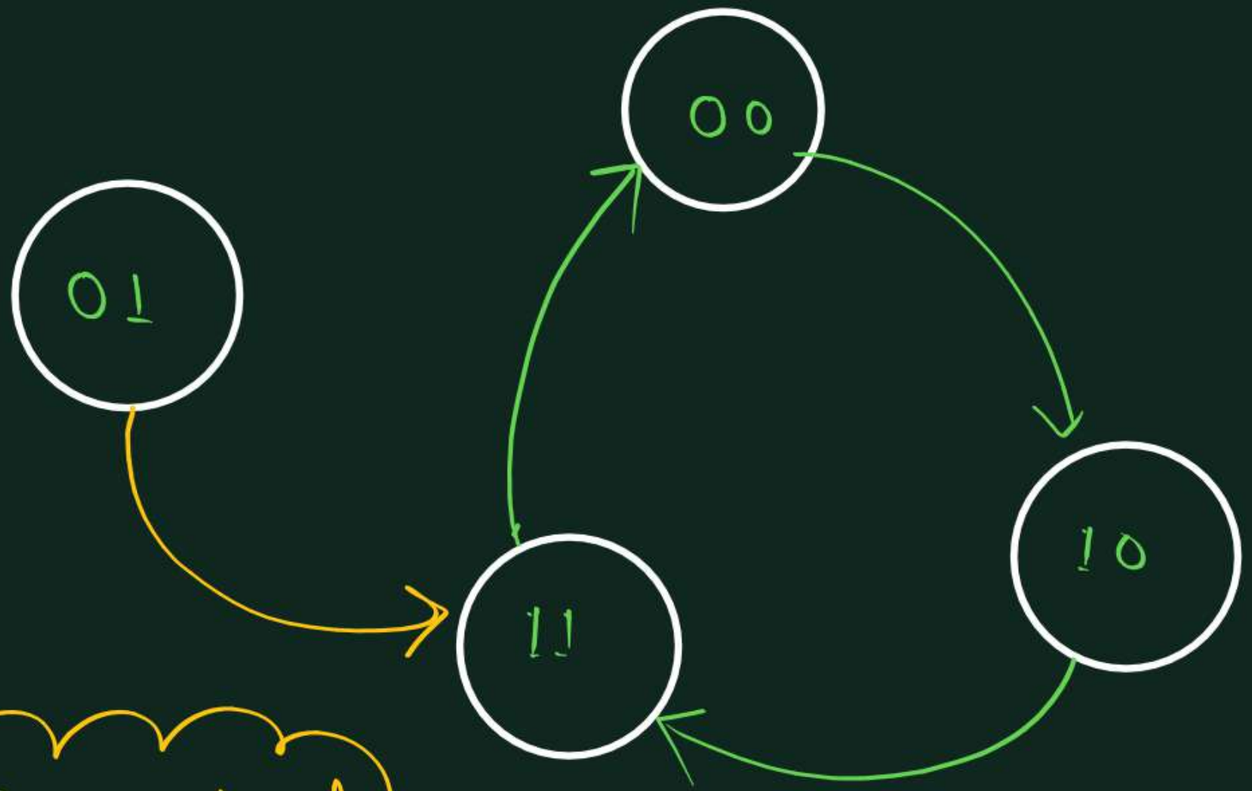


$$T_0 = Q_1$$



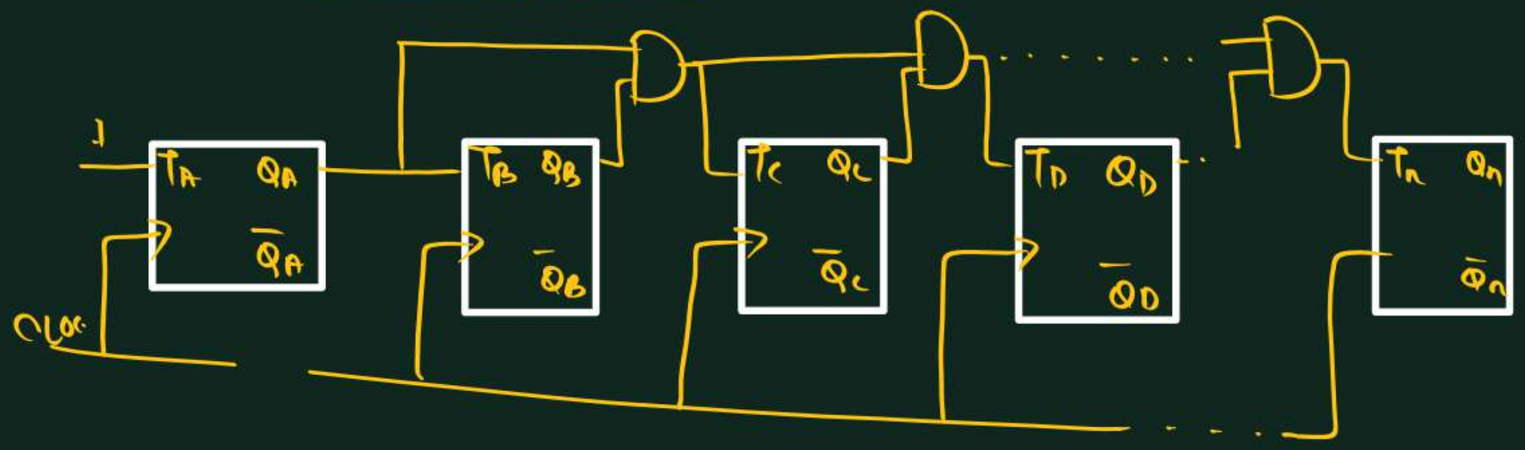
Clock	Q_1	Q_0
0	0	0
1	1	0
2	1	1
3	0	0
4	L	J

01 → unused



No lockout problem

Series carry synchronous counter.



$$t_{CLK} \geq \tau_{pd_{FF}} + (n-2)\tau_{pd_{AND}}$$

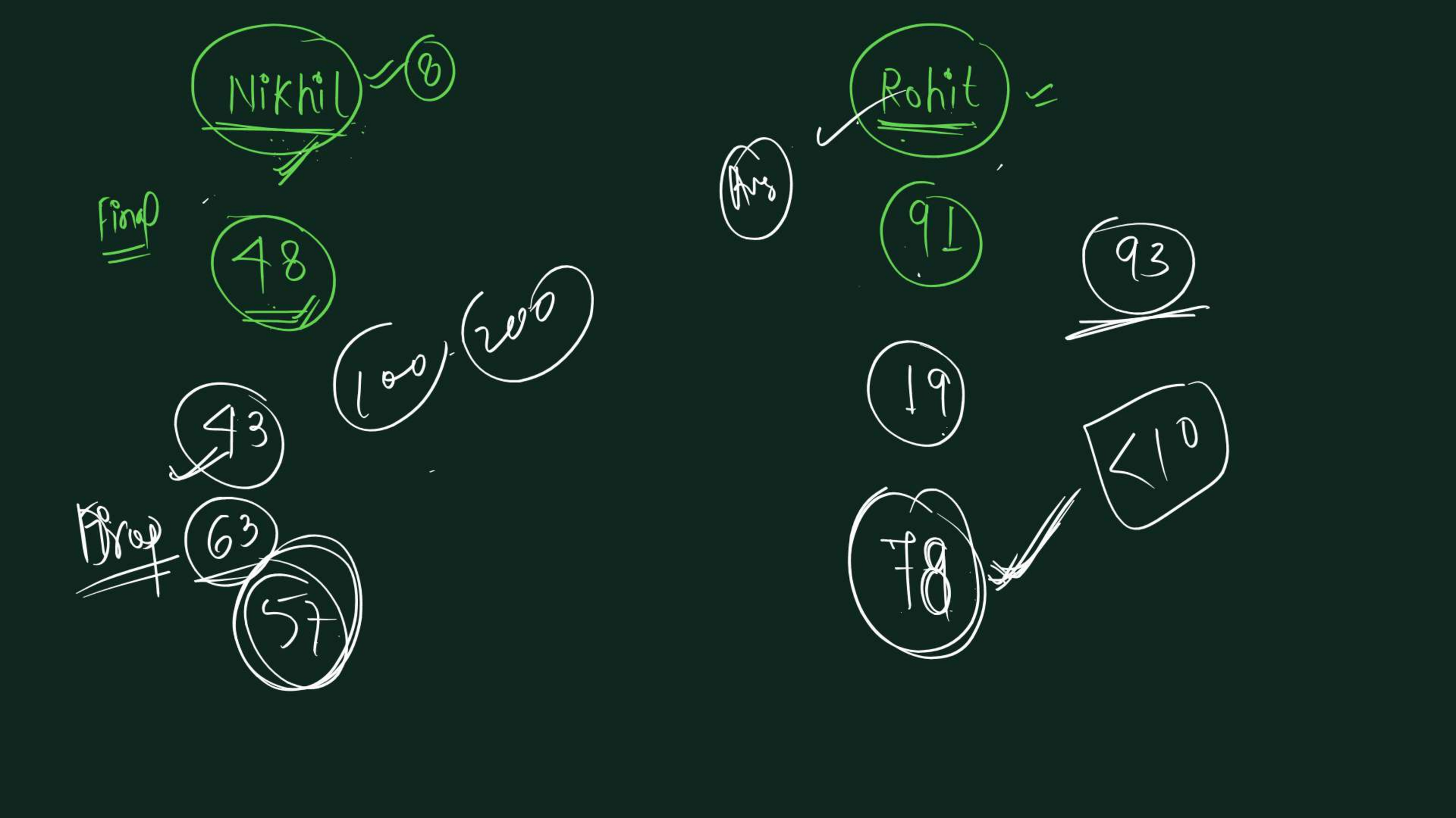
$$f_{CLK} \leq \frac{1}{\tau_{pd_{FF}} + (n-2)\tau_{pd_{AND}}}$$

parallel carry synchronous counter

$$T_{CLK} \geq \tau_{Pd_{ff}} + \tau_{Pd_{AND}}$$

$$f_{CLK} \leq \frac{1}{\tau_{Pd_{ff}} + \tau_{Pd_{AND}}}$$


कामयाबी मुझे ना मिले ये अलग बात हैं।
पर मै मेहनत ही न करुँ ये गलत बात हैं।


Nikhil
8
Rohit
Aug
91
93
Final
48
100
200
43
19
<10
Final
63
78
57

Q

Design a Synchronous Counter by using T Flip Flop which count the sequence

HW

$0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 0$

NUMBER SYSTEM

- BASE CONVERSION
- MAGNITUDE REPRESENTATION

जो मुस्कुरा रहा है उसे दर्द ने पाला होगा
जो चल रहा है उसके पाँव में छाला होगा
बिना संघर्ष के इंसान चमक नहीं सकता
जो जलेगा उस दिये में तो उजाला होगा

Can't Say

(12C)

13, 14, 15, 16

BASE(RADIX)

$(101)_x$ $(120)_{x=13,14,15,16}$

BASE(RADIX)	DIGIT
2	0, 1
3	0, 1, 2
4	0, 1, 2, 3
5	0, 1, 2, 3, 4
6	0, 1, 2, 3, 4, 5
7	0, 1, 2, 3, 4, 5, 6,
Octal 8	0, 1, 2, 3, 4, 5, 6, 7
9	0, 1, 2, 3, 4, 5, 6, 7, 8

BASE(RADIX)	DIGIT
Decimal 10	0 - 9
11	0 - 9, A
12	0 - 9, A, B
13	0 - 9, A, B, C
14	0 - 9, A, B, C, D
15	0 - 9, A, B, C, D, E
16	0 - 9, A - F

$10^2\ 10^1\ 10^0$

$(523)_{10}$

Coffiient

$5\times10^2+2\times10^1+3\times10^0$

$(a_3\ a_2\ a_1\ a_0)_r$

$r^3\quad r^2\quad r^1\quad r^0$

$a_3\quad a_2\quad a_1\quad a_0$

Binary

$(1011)_2$

2^3	2^2	2^1	2^0
1	0	1	1

Any Base to Decimal Conversion:

$$\begin{matrix} r^3 & r^2 & r^1 & r^0 & r^{-1} & r^{-2} \\ a_3 & a_2 & a_1 & a_0 \cdot & a_{-1} & a_{-2} \end{matrix}_r = (\ ?\ )_{10}$$

$$\left[(a_3 \times r^3) + (a_2 \times r^2) + (a_1 \times r^1) + (a_0 \times r^0) + (a_{-1} \times r^{-1}) + (a_{-2} \times r^{-2})\right]_{10}$$

Ex① **Binary to Decimal**

$$\begin{matrix} 2^3 & 2^2 & 2^1 & 2^0 & 2^{-1} & 2^{-2} \\ 1 & 0 & 1 & 1 \cdot & 1 & 1 \end{matrix}_2 = (\ ?\ )_{10}$$

$$(1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 1\times2^{-2})_{10}$$

$$8 + 0 + 2 + 1 + 0.5 + 0.25 \Rightarrow (11.75)_{10}$$

Ex. Octal to Decimal

$8^2\ 8^1\ 8^0$

$(623)_8 = (?)_{10}$

$6\times8^2 + 2\times8^1 + 3\times8^0$

$= 6\times64 + 16 + 3$

$= (403)_{10}$

Ans

Ex. Hexadecimal to Decimal

$16^2\ 16^1\ 16^0$

Q $(A2F)_{16} = (?)_{10}$

$A\times16^2 + 2\times16^1 + F\times16^0$

$10\times16^2 + 2\times16 + 15$

$(2607)_{10}$

Ans

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

Any Base to Decimal Conversion:

Ex. Determine the base of the numbers in each case for the following operations to be correct:

a) 14/2 = 5

b) 54/4 = 13

c) 24 + 17 = 40

$\frac{x+4}{2} = 5$

$x+4 = 10$

$\boxed{x=6}$

(a) $\left(\frac{14}{2}\right)_x = (5)_x$

$\frac{(14)_x}{(2)_x} = (5)_x$

$\frac{1\times x^1 + 4\times x^0}{2\times x^0} = 5\times x^0$

(b) $\left(\frac{54}{4}\right)_x = (13)_x$

$\frac{(54)_x}{(4)_x} = (13)_x$

$\frac{5\times x^1 + 4\times x^0}{4\times x^0} = 1\times x^1 + 3\times x^0$

$5x+4 = 4[x+3]$

$5x+4 = 4x+12$

$\boxed{x=8}$

$$24 + 17 = 40$$

$$(24)_x + (17)_x = (40)_x$$

$$[2x x^1 + 4x^0] + [1x x^1 + 7x x^0] = [4x x^1 + 0x x^0]$$

$$2x + 4 + x + 7 = 4x$$

$$x = 11$$

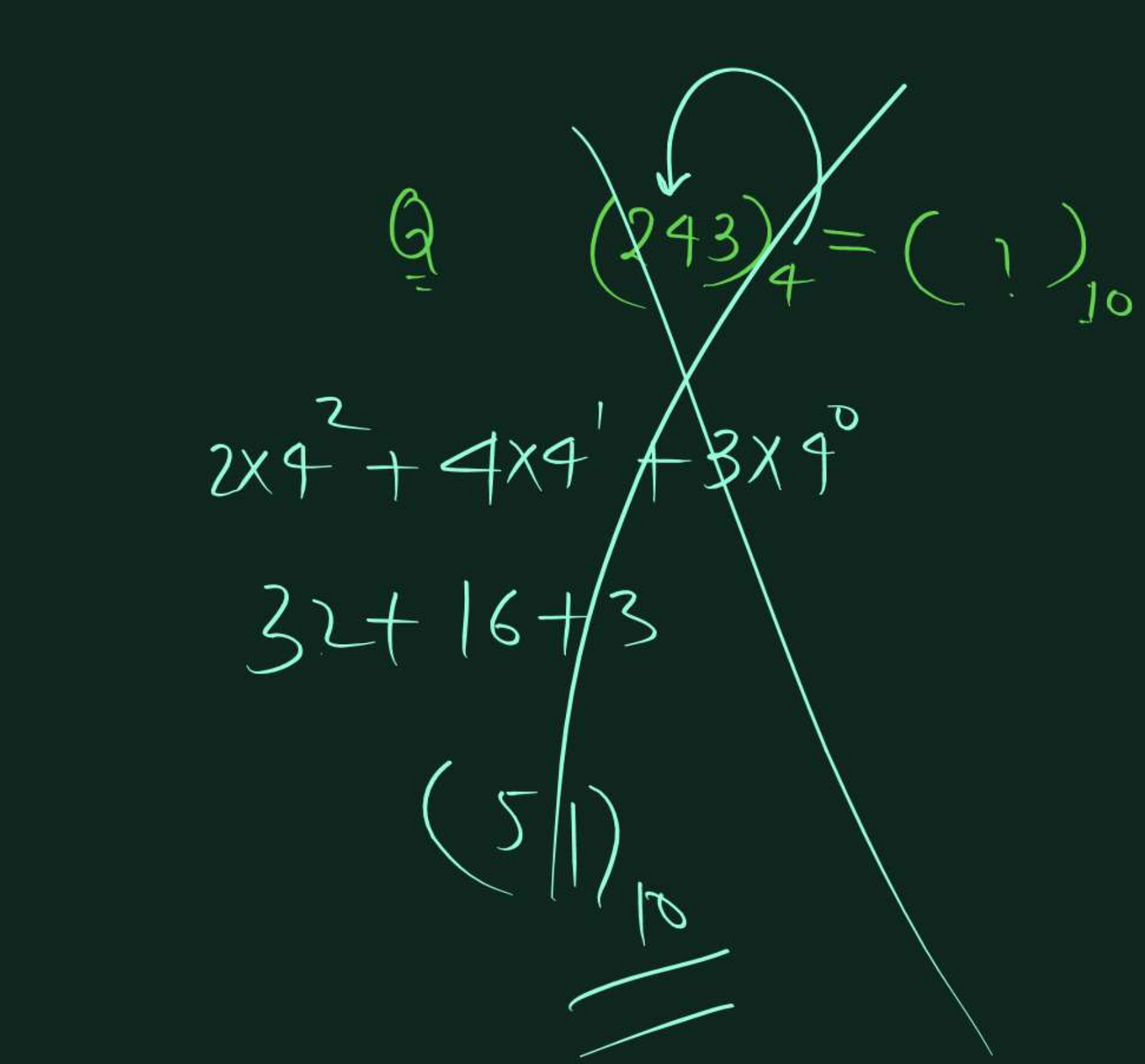
Ans

Q $(432)_5 = (\ ?\ )_{10}$

$4 \times 5^2 + 3 \times 5^1 + 2 \times 5^0$

$100 + 15 + 2$

$(117)_{10}$ Ans



Written in wrong format

Decimal to Any Base Conversion

$$(a_3 a_2 a_1 a_0 \cdot a_{-1} a_{-2} a_{-3})_{10} = (\ ?\ )_\gamma$$

γ	$a_3\ a_2\ a_1\ a_0$	R
		x_0
		x_1
		x_2
		x_3

$0 \cdot a_{-1} a_{-2} a_{-3} \times \gamma = b_0 \cdot a_{-4} a_{-5} a_{-6}$ $\quad b_0$

$0 \cdot a_{-4} a_{-5} a_{-6} \times \gamma = b_1 \cdot a_{-7} a_{-8} a_{-9}$ $\quad b_1$

$0 \cdot a_{-7} a_{-8} a_{-9} \times \gamma = b_2 \cdot a_{-10} a_{-11} =$ $\quad b_2$

$$(x_3 x_2 x_1 x_0 \cdot b_0 b_1 b_2)_\gamma$$

Ans

Decimal to Any Base Conversion

Ex. Decimal to Binary

$(13.75)_{10} = (?)_2$

$r = 2$

2	13	R
2	6	1
2	3	0
	1	1

$0.75 \times 2 = 1.5$ → 1

$0.5 \times 2 = 1.0$ → 1

$(13.75)_{10} = (1101.11)_2$

Ans

Decimal to Any Base Conversion

Ex. Convert the number given below in decimal to Binary, 4th order, octal, Hexadecimal

(1) 319.6875

$(319.687)_{10} = (\quad)_2$

2	319	R

$0.687 \times 2 =$

$(319.687)_{10} = (\quad)_8$

8	319	R

$0.687 \times 8 =$

Decimal to Any Base Conversion

(1) $319.6875 = (\ ?\ )_2$

$(100111111.1011)_2$ Ans

Ans.

		R
2	319	
2	159	1
2	79	1
2	39	1
2	19	1
2	9	1
2	4	1
2	2	0
	1	0

↑

$0.6875 \times 2 = 1.375 \Rightarrow 1$

$0.375 \times 2 = 0.75 = 0$

$0.75 \times 2 = 1.5 = 1$

$0.5 \times 2 = 1.0 = 1$

Decimal to Any Base Conversion

$(319.6875)_{10} = (\ ?\ )_4$

4	319	R
4	79	3
4	19	3
4	4	3
4	1	0
	0	1

$0.6875 \times 4 = 2.75 = 2$

$0.75 \times 4 = 3.0 \quad 3$

$= (10333.23)_4$

Ans

Decimal to Any Base Conversion

$(319.6875)_{10} = (\ ?\ )_8$

8	319	R
8	39	7
8	4	7
	0	4

$0.6875 \times 8 = 5.5 = 5$

$0.5 \times 8 = 4.0 = 4$

$\Rightarrow (477.54)_8$

Ans

Decimal to Any Base Conversion

$(319.6875)_{10} = (?)_{16}$

Hexadecimal

16	319	R
16	19	15 → F
16	1	3
	0	1

$0.6875 \times 16 = 11.0$ 11(B)

$\Rightarrow (13\ F.B)$

$(13F.B)_{16}$ Ans

#DECJ

₹100 NOTE

Ex $(1011)_2 = (\ ?\ )_4$

Method (1) $(1011)_2 \longrightarrow (\ )_{10}$

$(1011)_2 = (11)_{10} = (23)_4$

$(\ )_{10} \longrightarrow (\ )_4$

$(1011)_2 = (\ )_{10}$

$1\times2^3+0\times2^2+1\times2^1+1\times2^0$

$(11)_{10} \longrightarrow (\ )_4$

4	11	R
	2	3
		2

Method (2)

$(1011)_2 = (\quad)_4$

$4 = 2^2$ → 2 bits.

10	11
2	3

$(1011)_2 = (23)_4$

Ans

Ex $(2331)_4 = (\ ?\ )_2$

↳ $4 = 2^2 =$

Mentos jindgi

$[10111101]_2$

Ans

Ex. $(3201)_4 = (\quad)_8$

Method ① Aam zindgi.

$(3201)_4 \Rightarrow (\quad)_{10} \Longrightarrow (\quad)_8$

Method ② Mendos zindgi.

$(3201)_4 \longrightarrow (\quad)_2 \longrightarrow (\quad)_8$

$4 = 2^2$ → 2 bits

$8 = 2^3$ → 3 bits

$(11100001)_2$

3 4 1

$(341)_8$ Ans

Q $(745)_8 = (\ ?\ )_{16}$

Method 1. Nam Zindgi [Normal Army]

$(745)_8 \longrightarrow (\ )_{10} \longrightarrow (\ )_{16}$

Method 2. Mendos zindgi [CJ Army]

$(745)_8$ → 3 → 3 bits

$(\ \ )_{16}$

$16 = 2^4$ → 4 → 4 bits group.

$(1E5)_{16}$

Decimal to Any Base Conversion

Ex. 1. A number is 120 in octal (that is, base 8) notation. The same number is decimal (base 10) notation would be

A. 56

B. 80

C. 86

D. NONE

Decimal to Any Base Conversion

Ex. 2. Representation of $(23.14)_6$ in base 5 number system will be ____
(upto two decimal)

$$(23\cdot14)_6 = (\ ?\ )_5$$

$$(23.14)_6 = (\ .\ )_{10}$$

$$\left(2\times6^{1}+3\times6^{0}+1\times6^{-1}+4\times6^{-2}\right)_{10}$$

$$(15.277)_{10} = (\ )_5$$

Solution. $(23.14)_6 = [(2 \times 6^1) + (3 \times 6^0) + (1 \times 6^{-1}) + (4 \times 6^{-2})] = (15.277)_{10}$

5	15	0
	3	3

$\Rightarrow (15)_{10} = (30)_5$

0.277 × 5 = 1 .385

0.385 × 5 = 1 .925

$\Rightarrow (0.277)_{10} = (0.11)5$

Hence

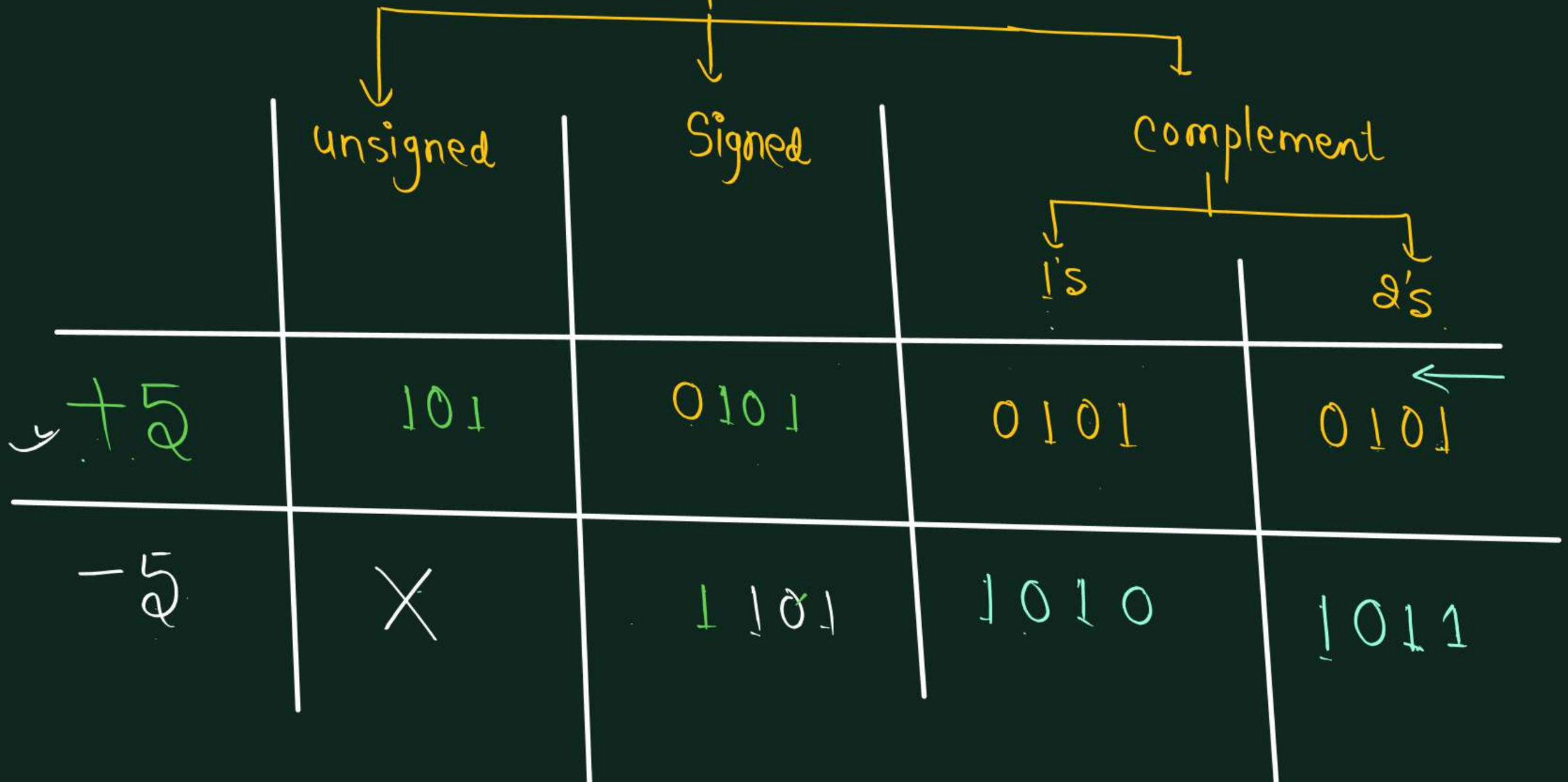
$(15.277)_{10} = (30.11)_5$

$(30.11)_5$

Ans

		8	4	2	1
0	→	0	0	0	0
1	→	0	0	0	1
2	→	0	0	1	0
3	→	0	0	1	1
4	→	0	1	0	0
5	→	0	1	0	1
6	→	0	1	1	0
7	→	0	1	1	1

Magnitude Representation.



1's complement ⟶ Decimal

0 0 0 0 1 1 0 1 ⟶ +13

0 0 0 0 0 ⟶ +0

0 0 0 1 1 0 0 1 ⟶ +25

1 1 1 1 ⟶ −0

1 1 0 1 0 0 1 ⟶ −22

0 1 0 1 1 0

1 1 1 1 1 1 0 1 0 0 1 ⇒ −22

0 0 0 0 0 0 1 0 1 1 0

22

2's complement → Decimal

Q① 01101 → +13

Q② 00011001 → +25

Q③ 10100 1 → −23

23 ← 01011

Q④ 11111 10100 1 → −23

00010 1 1 1

Q⑤ 0000 → +0

Q⑥ 1111 → −1

0001

EX. −13 in 2's complement will be-

A. 1 1 1 0 1

B. 0 1 1 0 1

C. 1 0 0 1 0

D. NONE

+13 → 0 1 1 0 1 ←

−13 1 0 0 1 1

EX. If $(12x)_3 = (123)_x$ then the value of x is

A. 3

B. 3 or 4

C. 2

D. None of these

$(123)_x$

$3^2\ 3^1\ 3^0 \qquad x^2\ x^1\ x^0$

$(12x)_3 = (123)_x$

$x = ?$

$(1\times3^2+2\times3^1+x\times3^0)_{10} = (1\times x^2+2\times x+3\times x^0)_{10}$

$9+6+x = x^2+2x+3$

$15+x = x^2+2x+3$

$x^2+x-12=0$

$x^2+x-12=0$

$(x+4)(x-3)=0$

$x=-4 \qquad x=3$

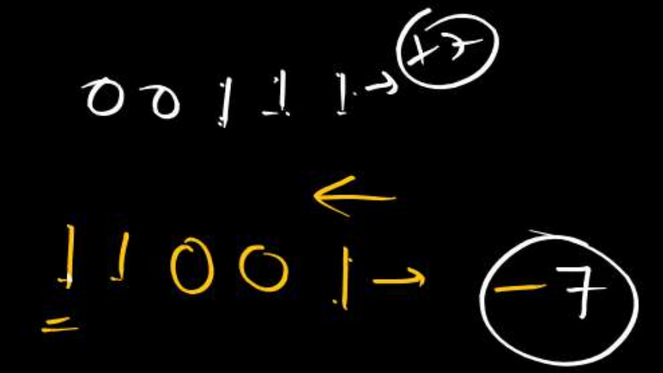
Ex. 11001, 1001 and 111001 correspond to the 2's complement representation of which one of the following sets of number?

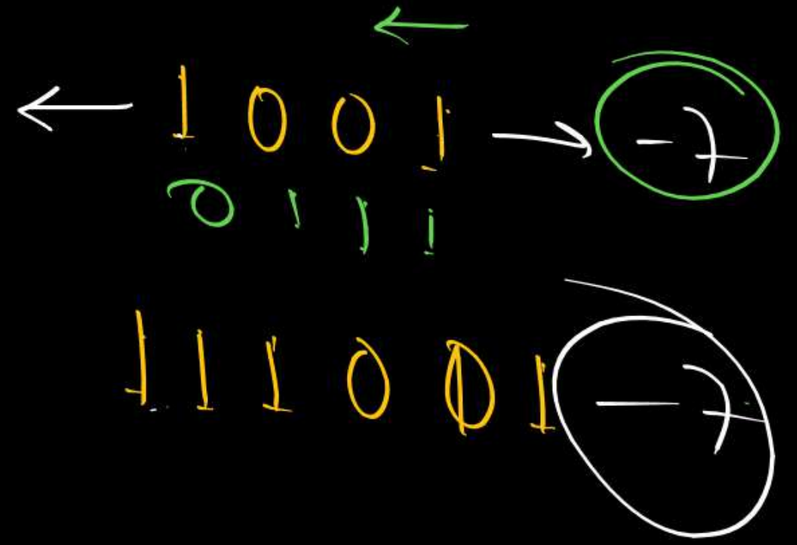
A. 25,9 and 57 respectively

B. -6, -6 and -6 respectively

C. -7, -7 and -7 respectively

D. -25, -9 and -57 respectively





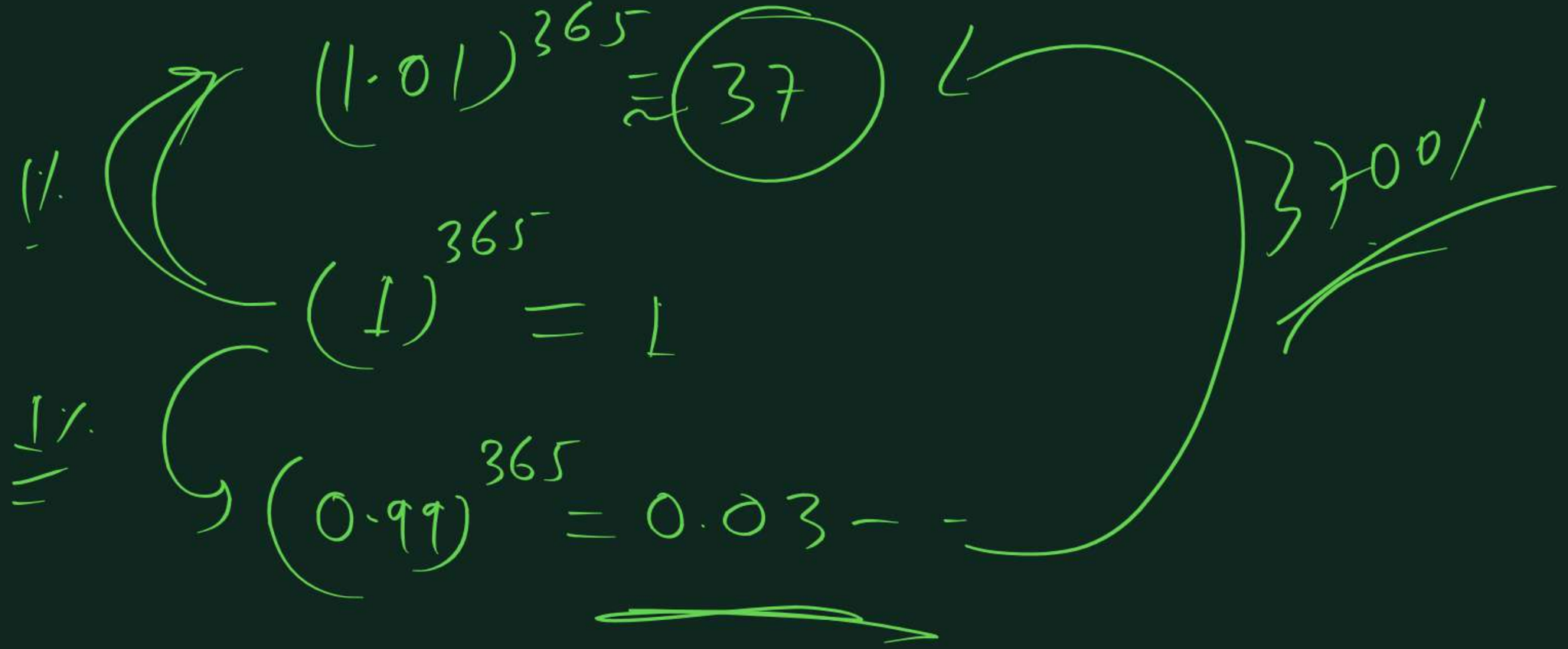
$1000

20 years

1 → Maydoor

999

1000


$(1.01)^{365} \approx 37$
1%
3700%
$(1)^{365} = 1$
1%
$(0.99)^{365} = 0.03 - -$


THANK
YOU!