EC/EE/CS/IN

Digital Electronics

LOGIC GATE NOR, XOR,XNOR GATE

LECTURE NO. 2

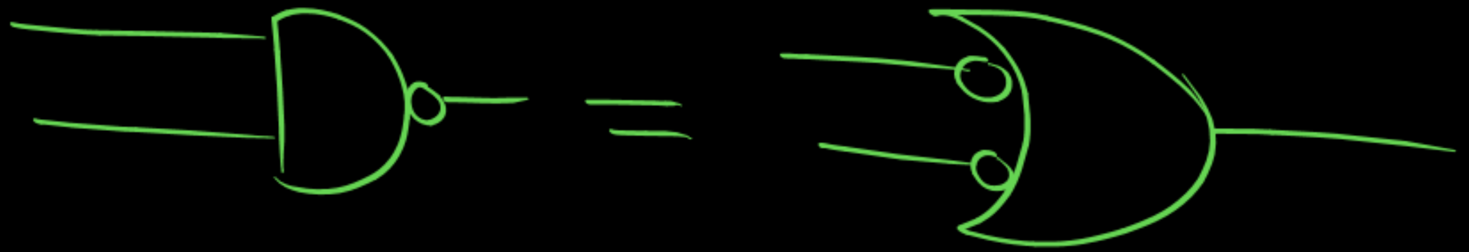
Chandan Jha Sir (CJ Sir)

रख हौसला वो मंजर
भी आयेगा,
प्यासे के पास चल के
समन्दर भी आयेगा,
थक कर न बैठ ऐ
मंजिल के मुसाफिर,
मंजिल भी मिलेगी...
और मिलने का मज़ा
भी आयेगा।

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



NAND = Bubbled OR

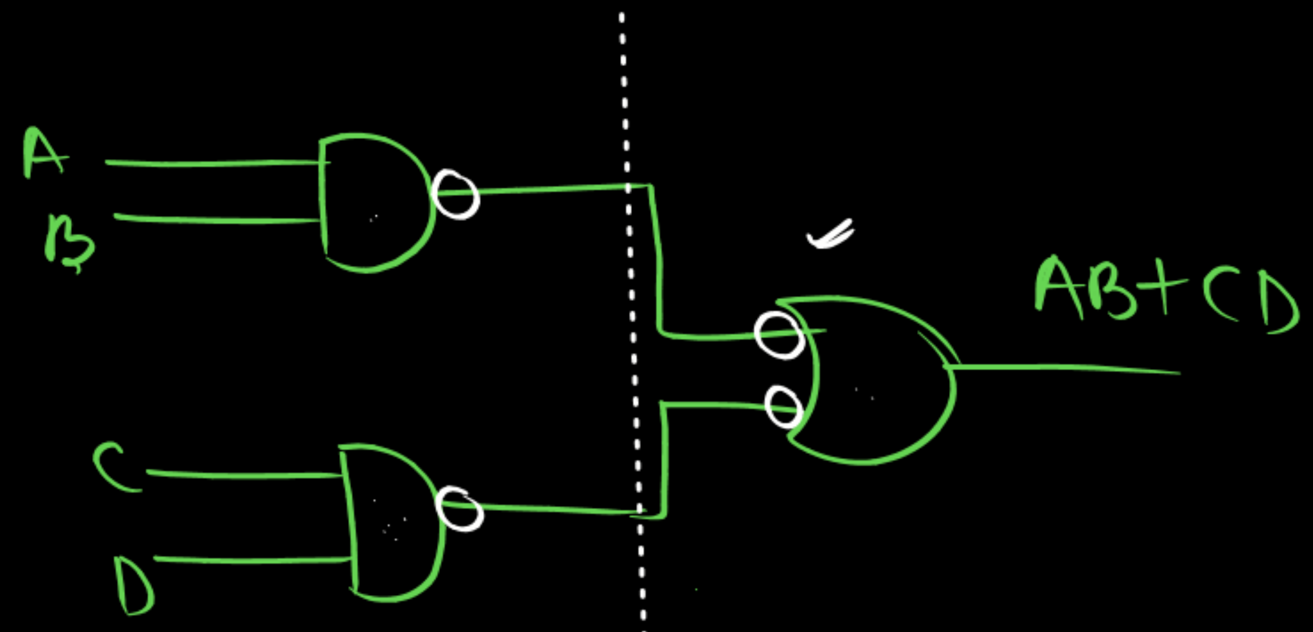
Q.1 Find the minimum number of two input NAND required to implement the function given below:

$$f = AB + CD$$

AOI

↳ AND-OR-Inverter

3



Level-1 — Level 2

AND — OR

NAND — NAND

3 $\overline{\overline{\text{NAND}}}$ ✓

Function

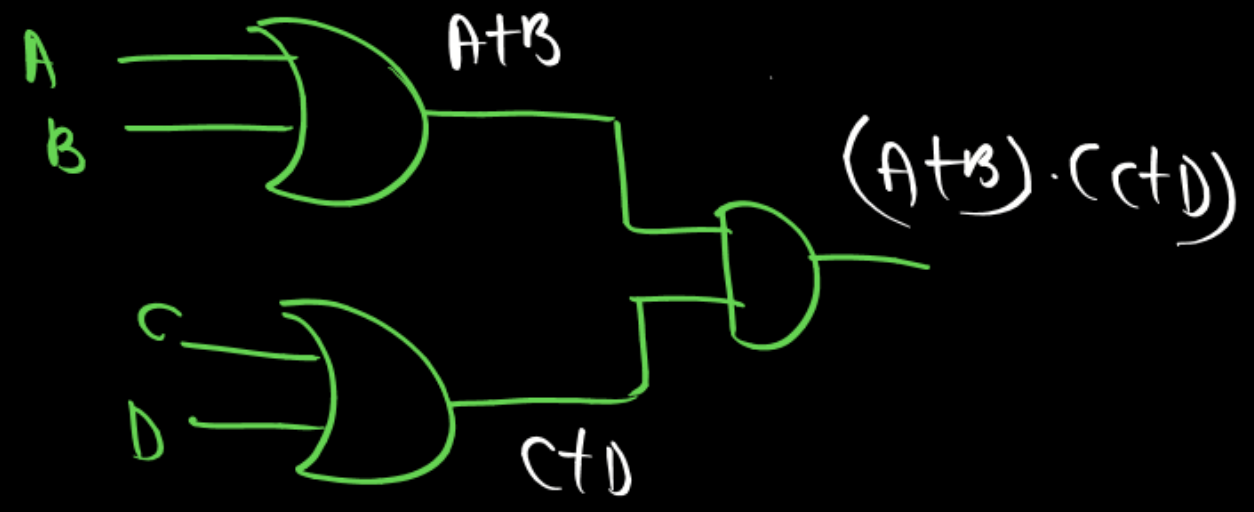
SOP — Sum of Product — NAND

POS — Product of Sum — NOR

<u>SOP</u>

$f = \underline{AB} + \underline{CD}$ → <u>SOP</u>

<u>Ex.</u> $f = (A+B)\cdot(C+D)$

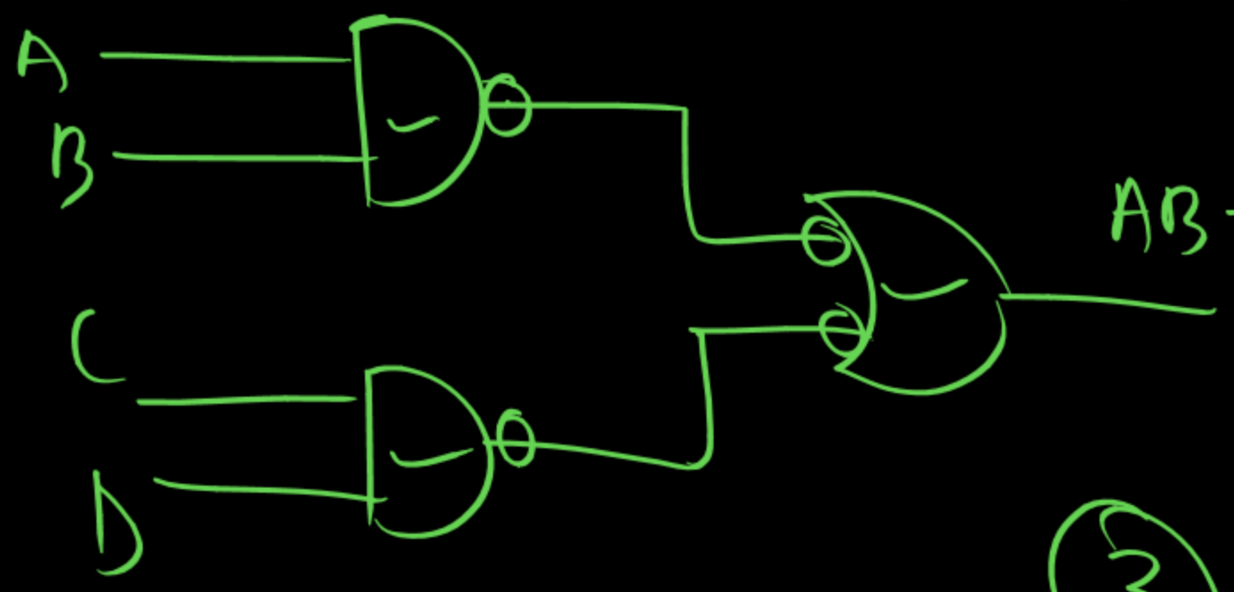


Case(3)

AB+CD → SOP

AOI

NAND



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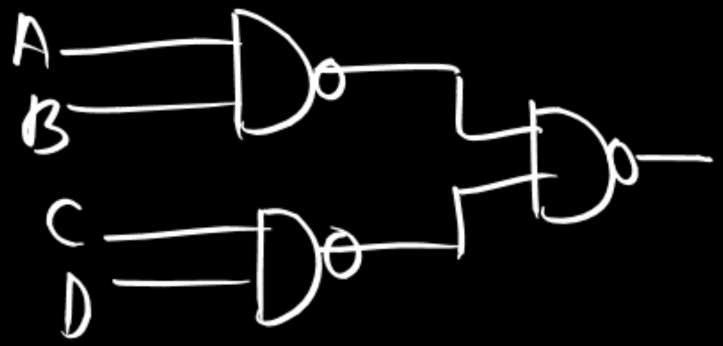
AND-OR

NAND-NAND

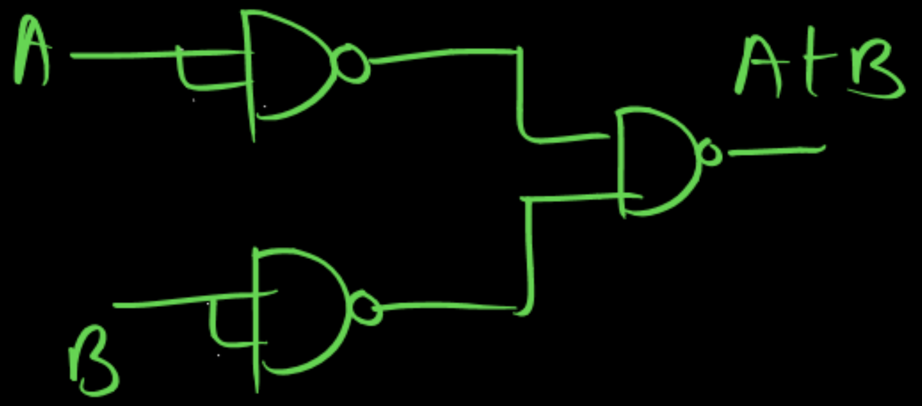
When ever minimum number of two input NAND Gates are asked write the Function in SOP Form & implement it by using AOI(AND-OR-INVERTER) which is a two level AND-OR Implementation which is exactly equal to NAND – NAND Implementation.

$f = A \cdot A + B \cdot B$

$\boxed{f = AB + CD}$ → 3



$f = A + B \longrightarrow \text{OR}$



$A+B \Rightarrow \underline{\underline{3}}$

$AB+CD \Rightarrow 3$

Q2. Find the minimum number of two input NAND required to implement the function given below:

$f(A, B, C) = A\bar{B} + BC$

$A\bar{B} + BC$

$3 + 1$

$= 4$

A 3

B 4

C 5

D 7

Q3. Find the minimum number of two input NAND GATE required to implement the Boolean function-

$f = AB + CD + F$

x

$f = x + F$

$x = AB + CD$

A 9

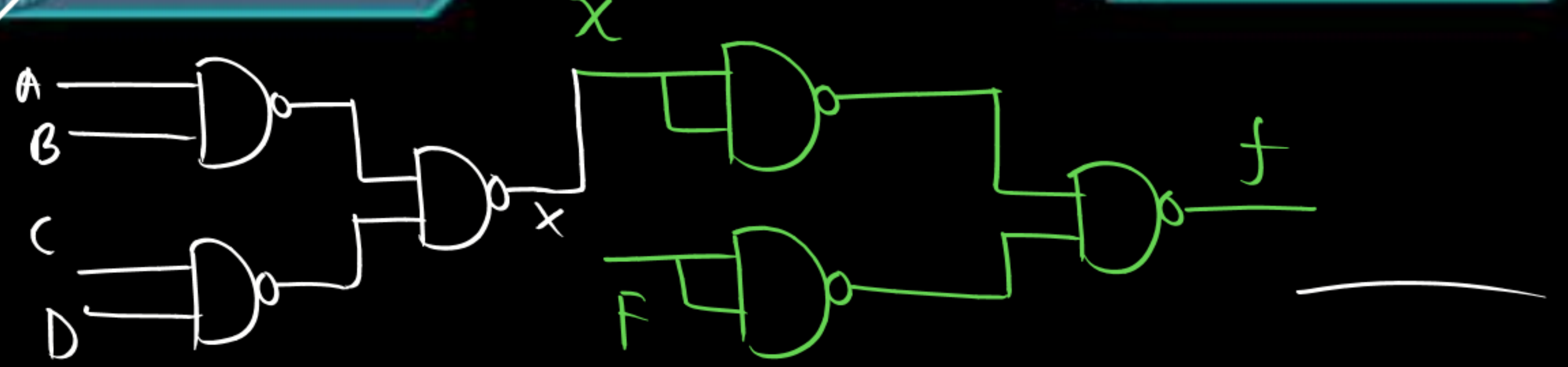
B 8

C 6

D 12

AB+CD → 3

A+B — 3



Q.4. Find the minimum number of two input NAND GATE required to implement the function-

$$f(A, B, C, D) = AB + BC + CD + DA$$

(A) 9

(B) 8

(C) 6

(D) 12

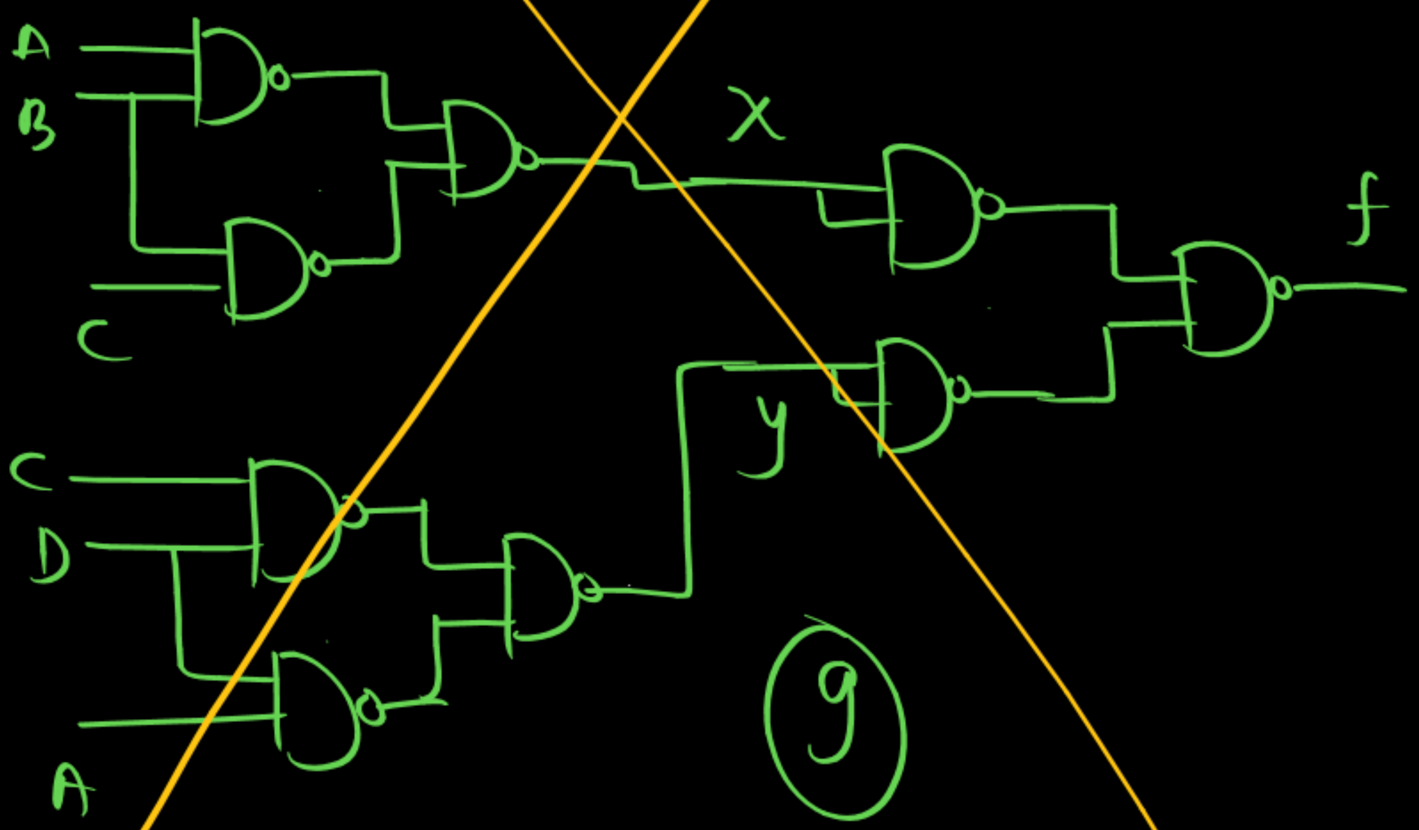
$$\underbrace{AB+BC}_{x} + \underbrace{CD+DA}_{y}$$

T-1 $\Rightarrow$

$f = x + y$

$x = AB + BC$

$y = CD + DA$



9

T-2

$$\overline{AB+BC} + \overline{CD+DA}$$

$$(A+C)B + D(A+C)$$

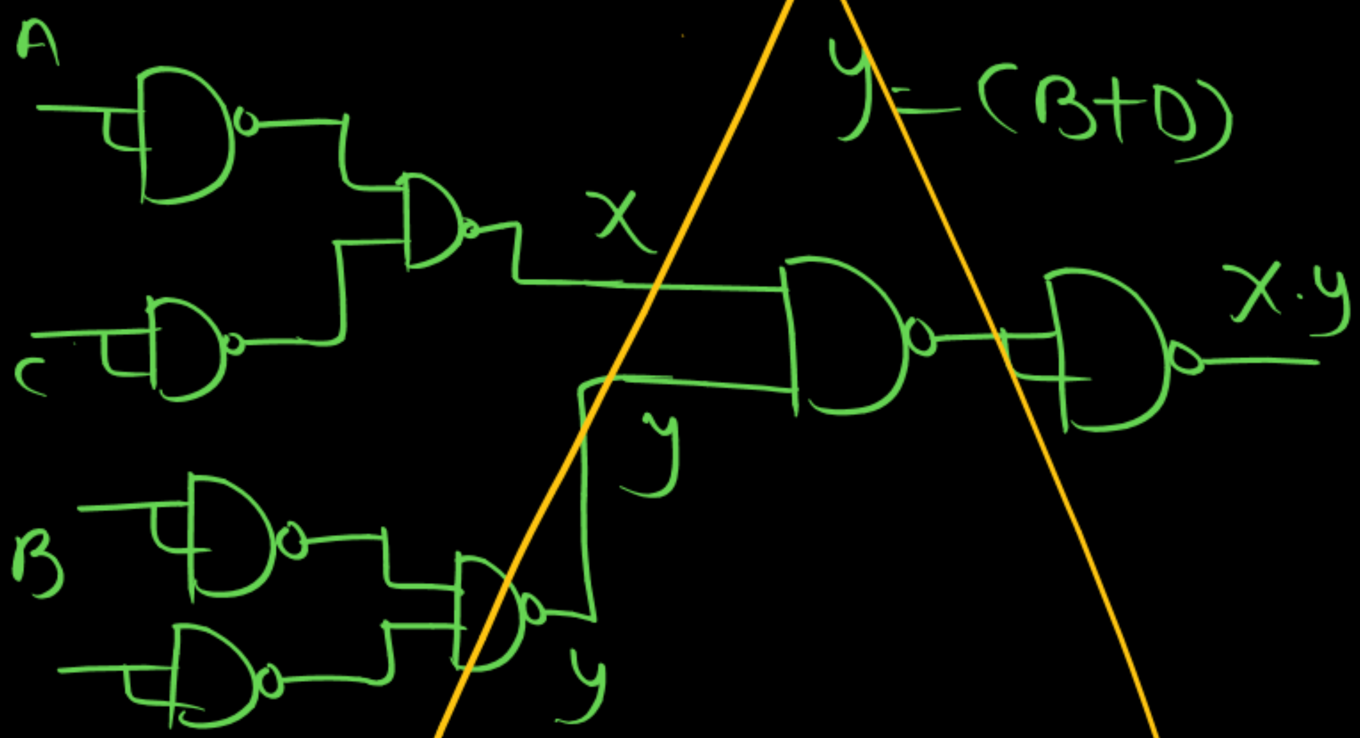
$$\underbrace{(A+C)}_{3}\underbrace{(B+D)}_{3} \quad 2$$

$\rightarrow 8$

$f = x \cdot y$

$x = (A+C)$

$y = (B+D)$



(Q-3)

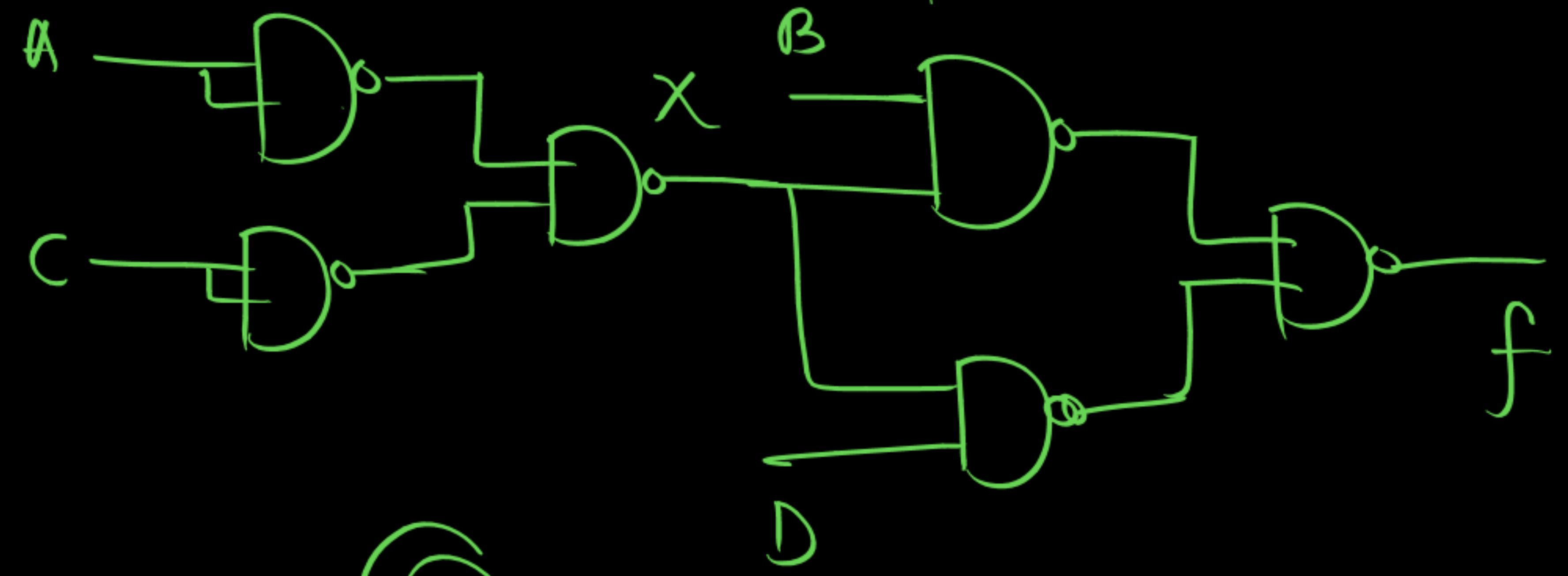
$f = AB + BC + CD + DA$

$= B(A+C) + D(A+C)$

$A + C = X$

$f = \underbrace{BX + DX}_{3}$

$3 \xleftrightarrow{+} 3 \longrightarrow 6$



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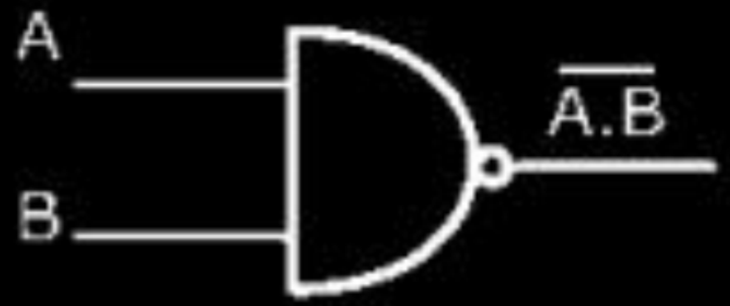
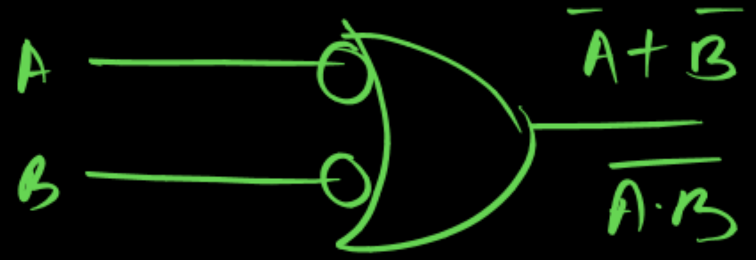
6

NAND GATE

1. Symbol

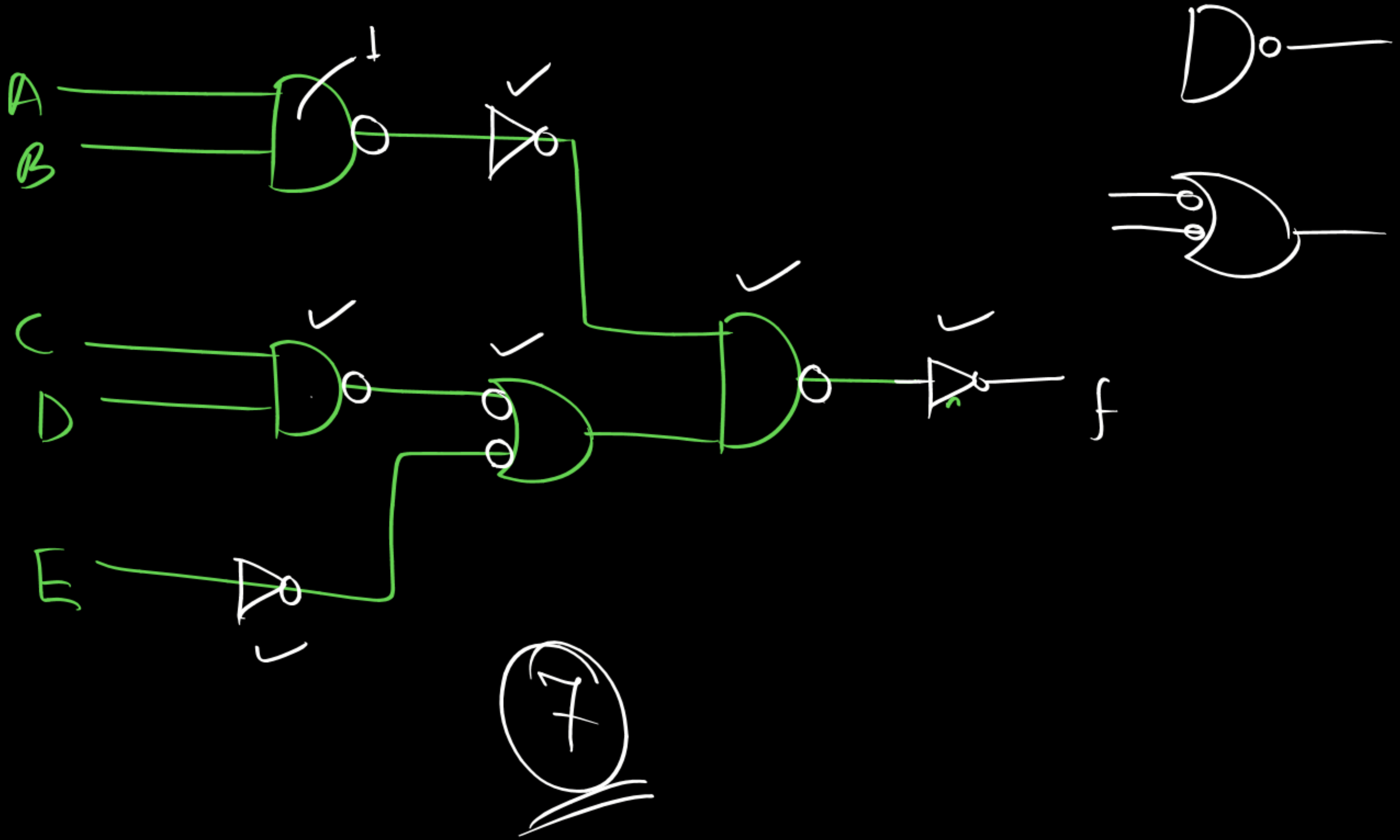




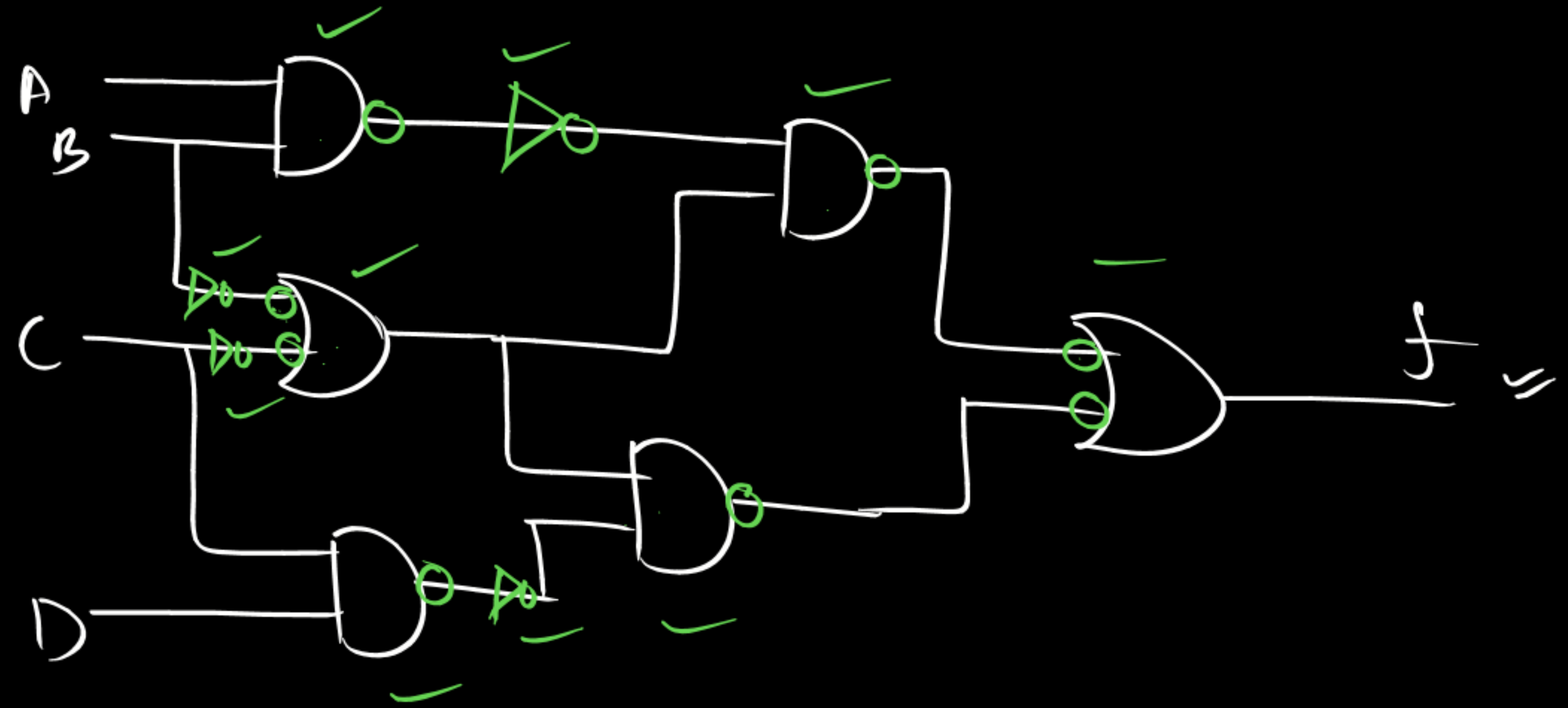
2. Truth Table

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Minimum no. of NAND?



Q



Case-(1)

$A \cdot B \cdot C \cdot D \cdots$

case (2)

$A + B + C + \cdots$

case (3)

$\underline{AB + CD}$

3

Case (4)

Function Implementation

Bubbled

NOR GATE

1. Symbol

Bubbled AND $\equiv$ NOR

D-Morgan's Law

$$\begin{cases} \overline{A+B} = \bar{A}\cdot\bar{B} \\ \overline{A\cdot B} = \bar{A}+\bar{B} \end{cases}$$

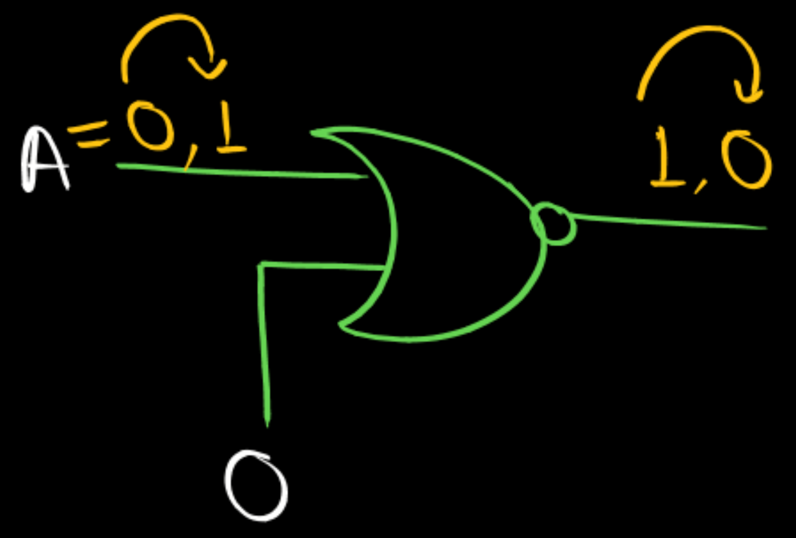
2. Truth table

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

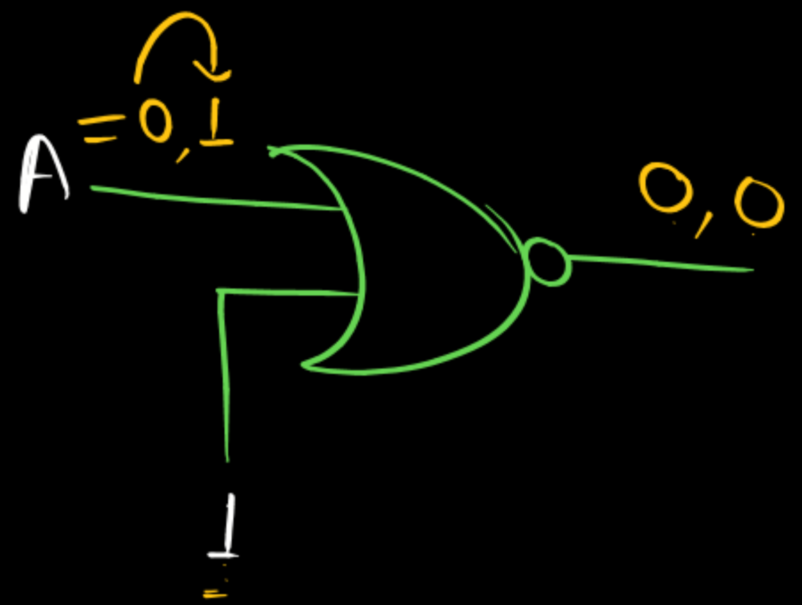
NOR

NOR GATE

3. Enable/Disable



Control '0' Enabled



Control '1' Disabled

NOR GATE

4. Commutative law ✓

$$\overline{A+B} \equiv \overline{B+A}$$

Associative Law ×

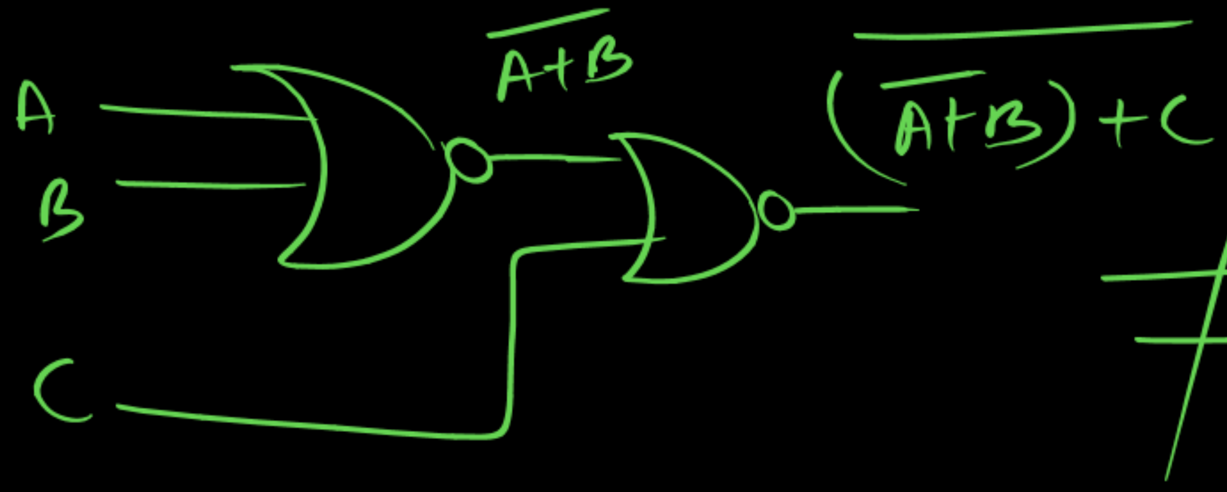
$$\overline{\overline{(A+B)}+C} \neq \overline{A+\overline{(B+C)}}$$

$\left\{\begin{matrix} \text{NAND} \\ \text{NOR} \end{matrix}\right\}$ Universal logic

$\overline{\overline{A \cdot B}}$

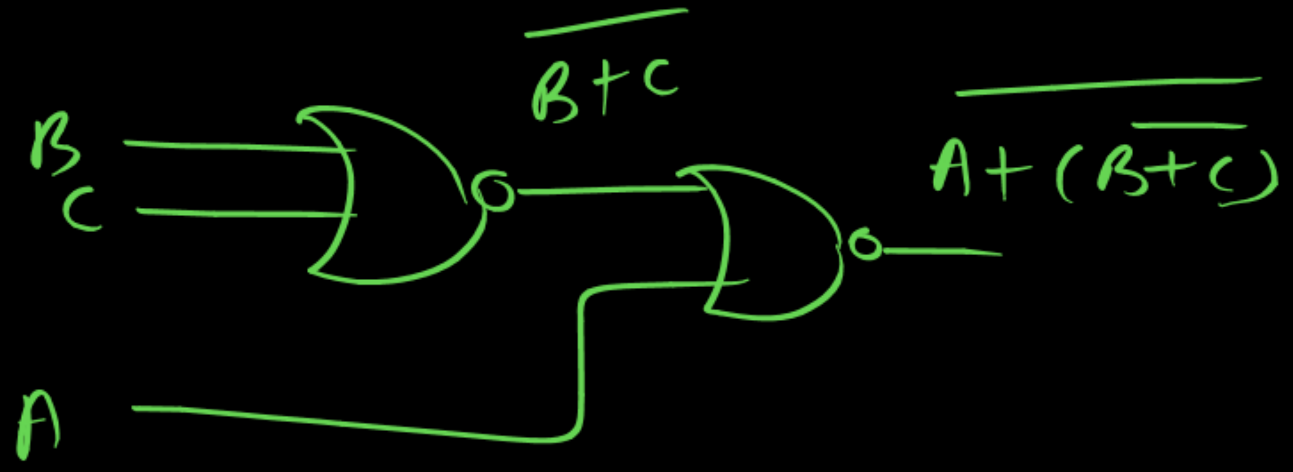
$\overline{A+B}$

function



A
B
C
$\overline{A+B}$
$\overline{(\overline{A+B})+C}$

$\neq$



B
C
A
$\overline{B+C}$
$\overline{A+(\overline{B+C})}$

NOR GATE

MCQ

Ex.1. Which of the following option(~~s~~) i~~s/ar~~e called universal logic?

(A) NAND

(B) NOR

(C) Both A & B

(D) None

NAND
NOR

NOR GATE

MCQ

Ex.2. Which of the following option(~~s~~) is/~~are~~ called universal logic?

(A) NAND

(B) NOR

(C) AND

(D) OR

NOR GATE

MSQ

Ex.3. Which of the following option(s) is/are called universal logic?

A $\overline{(A + B)}$ NOR

B $\overline{(A . B)}$ NAND

C $(A + \overline{B})$

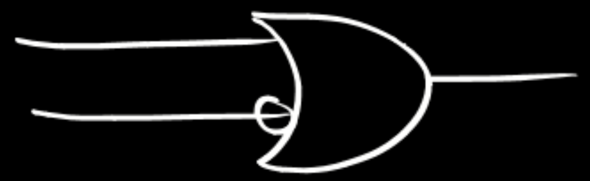
D ~~All of the above~~

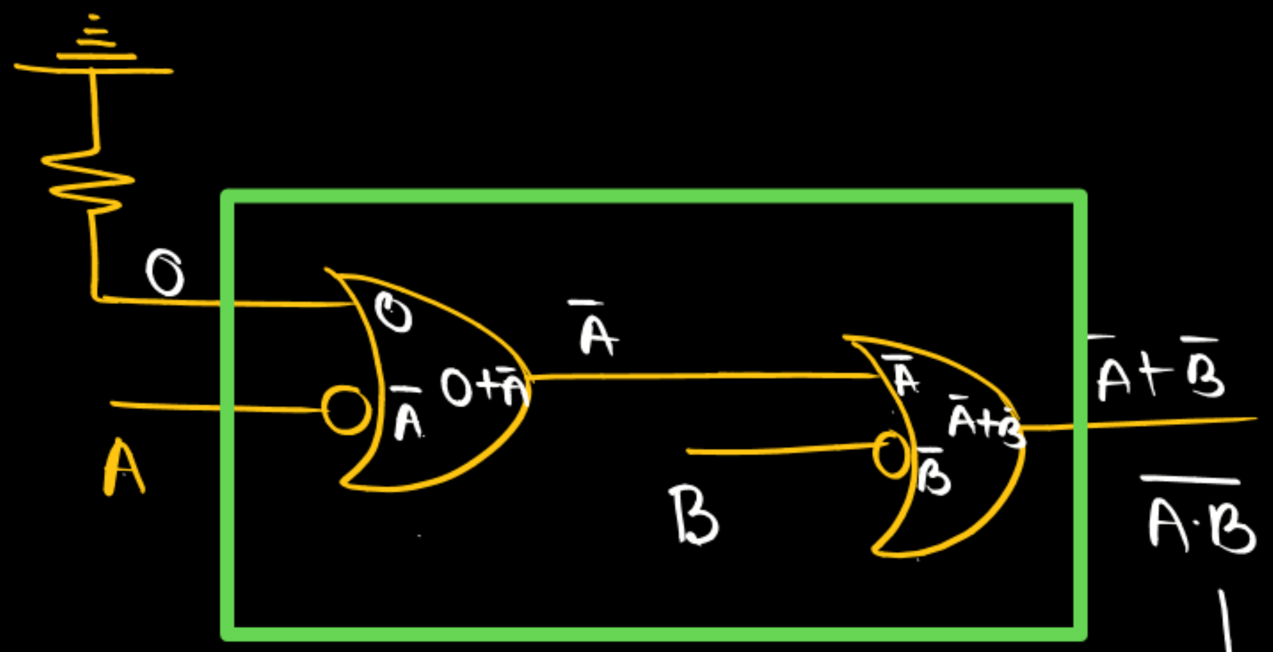
$A \cdot \overline{B}$

$A + \bar{B}$ ✓

$\overline{A \cdot B}$

$\bar{A} + \bar{B}$ ✓

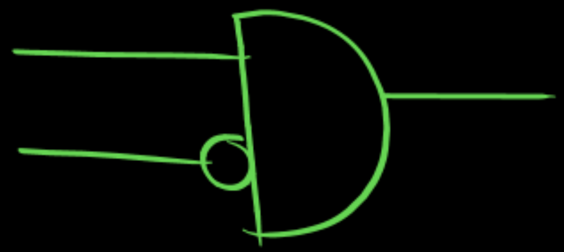


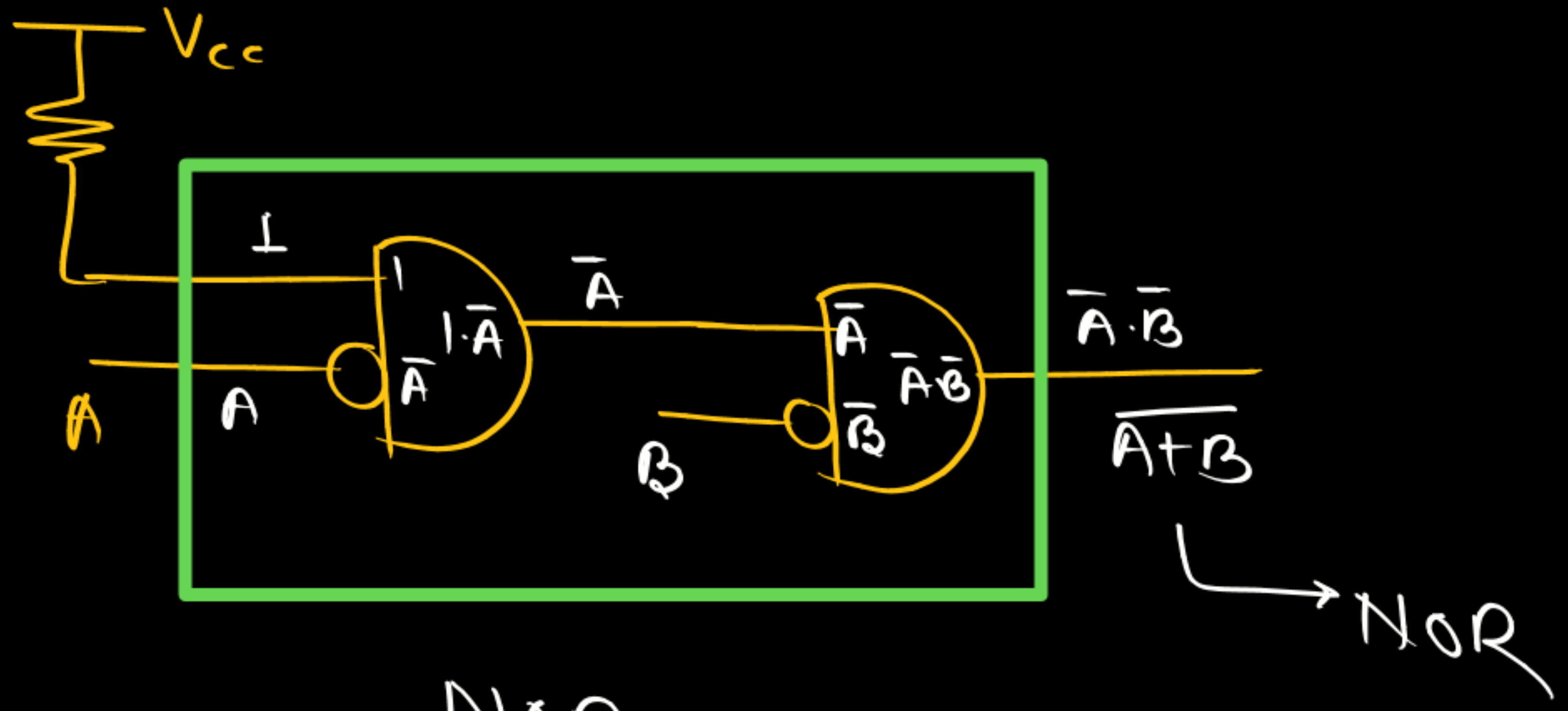


NAND

$\to$ NAND

$A \cdot \overline{B}$





NOR

$$\left\{\begin{array}{c} \overline{A+B} \\ \overline{A\cdot B} \\ \overline{A}\cdot\overline{B} \\ \overline{A}+\overline{B} \\ A+\overline{B} \\ \overline{A}+B \\ A\cdot\overline{B} \\ \overline{A}\cdot B \end{array}\right\}$$

NAND/NOR

10 → 6

4 - ans

Tech

3 hours

Team

Strong

Success

कछुआ	✓	X	✓	X	✓
खरगोश	X	✓	X	✓	✓

365

UACE 3 hours

100/100

2 → 3

32

XOR GATE

A	B	$y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

$$\begin{cases} A = B & y = 0 \\ A = \overline{B} & y = 1 \end{cases}$$

O/p = 1 when odd no. of 1's are present in the inputs

$$A \oplus A = 0$$

$$A \oplus 0 = A$$

$$A \oplus \bar{A} = 1$$

$$A \oplus 1 = \bar{A}$$

$$0 \oplus 0 = \bar{0} \cdot 0 + 0 \cdot \bar{0}$$

$$1 \cdot 0 + 0 \cdot 1$$

$$0 + 0 = 0$$

Ex If

$$A \oplus B = C$$

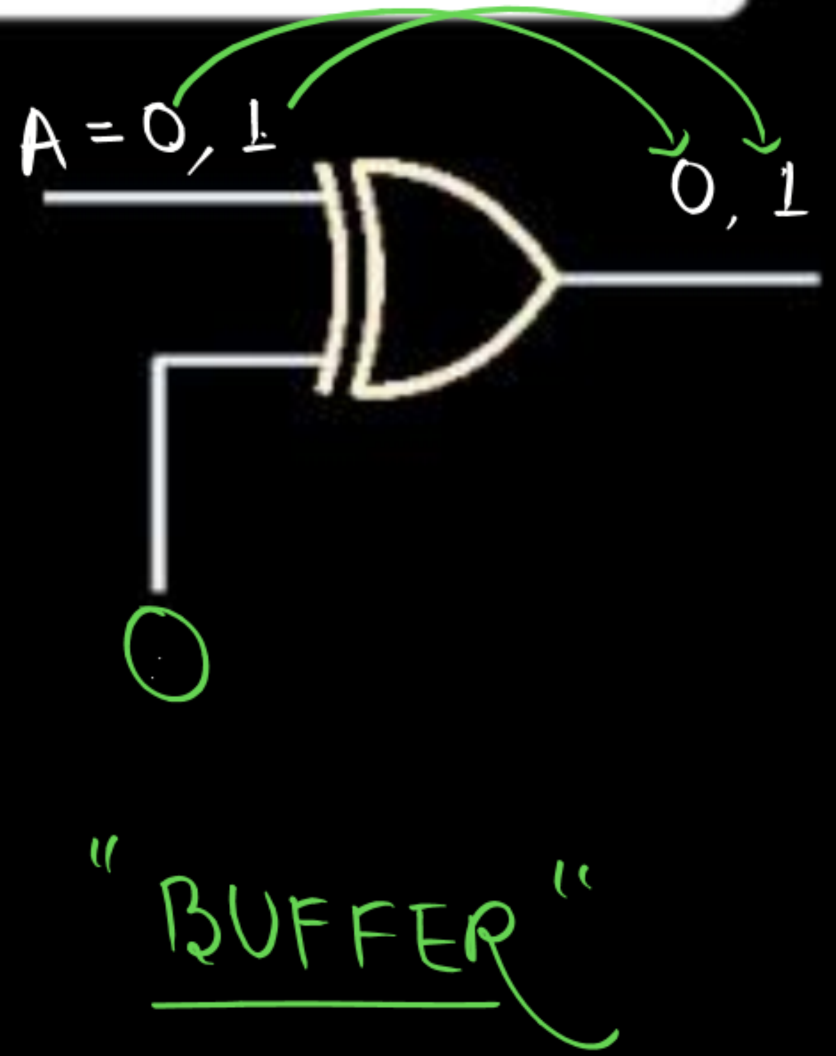
Then $A \oplus C = ?$

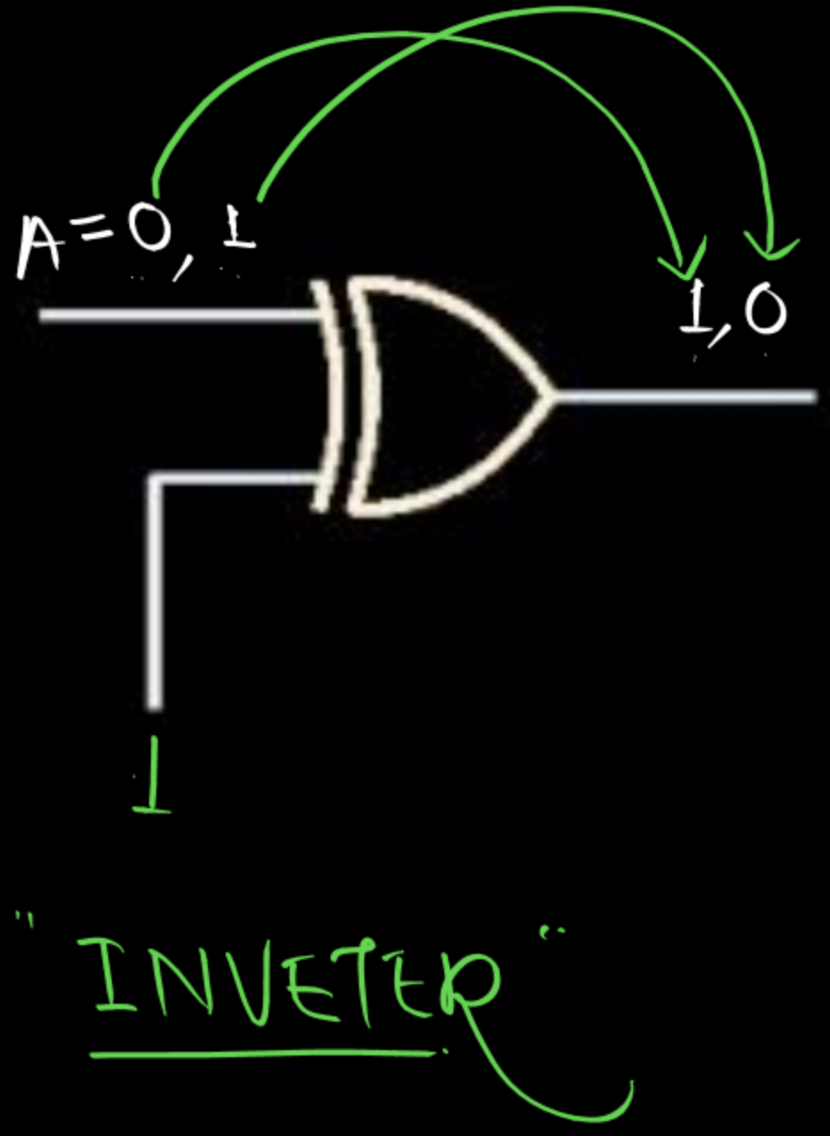
$$A \oplus C = B$$

$$B \oplus C = A$$

$$A \oplus B \oplus C =$$

XOR GATE





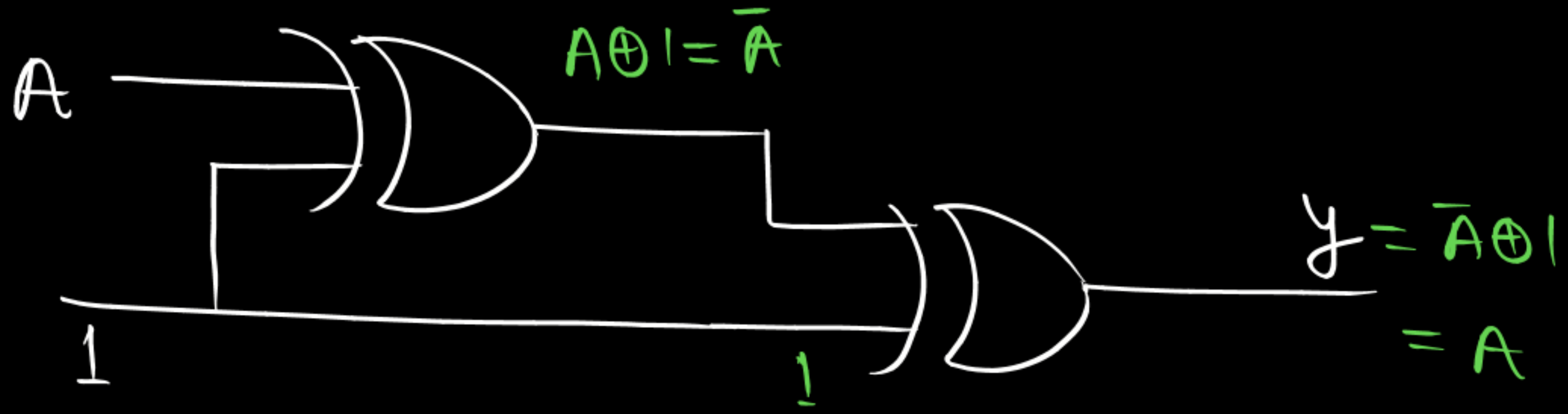
$$A \oplus A = 0$$

$$A \oplus A \oplus A = A$$

$$A \oplus A \oplus A \oplus A = 0$$

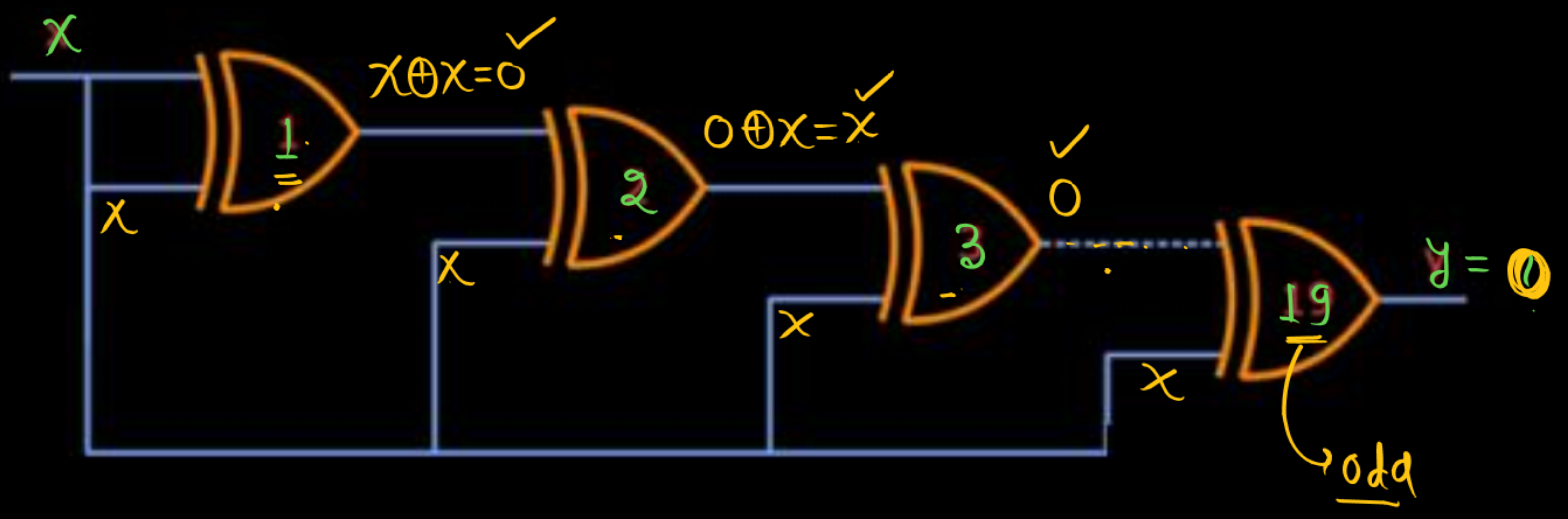
$$A \oplus A \oplus A \cdots \oplus A = \begin{cases} 0 & \text{Even no. of } A \\ A & \text{Odd no. of } A \end{cases}$$

Q



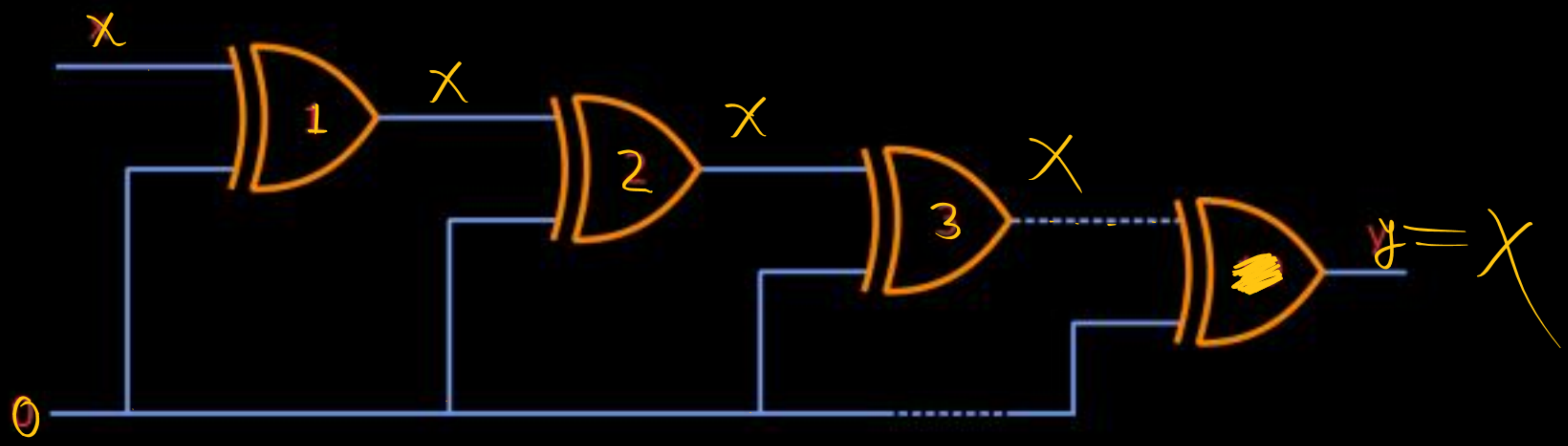
XOR GATE

Ex. 1



XOR GATE

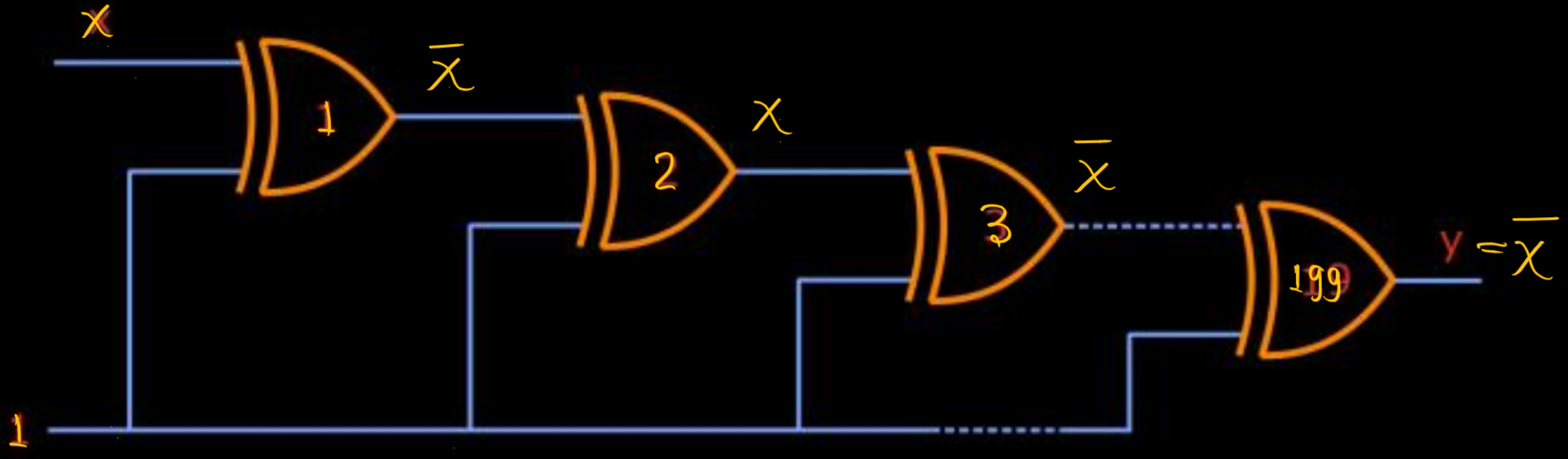
Ex. 2



XOR GATE

Ex. 3

$1 \oplus x = \bar{x}$ $\quad$ $\bar{x} \oplus 1 = x$



XOR GATE

7. X-OR follows the commutative as well as associative Law

$A \oplus B = B \oplus A$ $\Rightarrow$ commutative Law

$A \oplus B \oplus C = (A \oplus B) \oplus C$ Associative Law

$$\underbrace{(A \oplus B) \oplus C = A \oplus (B \oplus C)}$$

Associative Law

XOR GATE

Decimal	ABC	$A \oplus B \oplus C$	$(A \oplus B) \oplus C$
0	0 0 0	0	0
1	0 0 1	1	1
2	0 1 0	1	1
3	0 1 1	0	0
4	1 0 0	1	1
5	1 0 1	0	0
6	1 1 0	0	0
7	1 1 1	1	1

$$A \oplus B \oplus C = \sum m(1,2,4,7)$$

minimized

XNOR GATE

$$A \odot B = \overline{A \oplus B}$$

$$= \bar{A}\bar{B} + AB$$

$$\begin{cases} A = B & y = 1 \\ A = \bar{B} & y = 0 \end{cases}$$

A	B	y = A ⊙ B
0	0	1
0	1	0
1	0	0
1	1	1

→ Equivalance logic

→ Coincidance logic

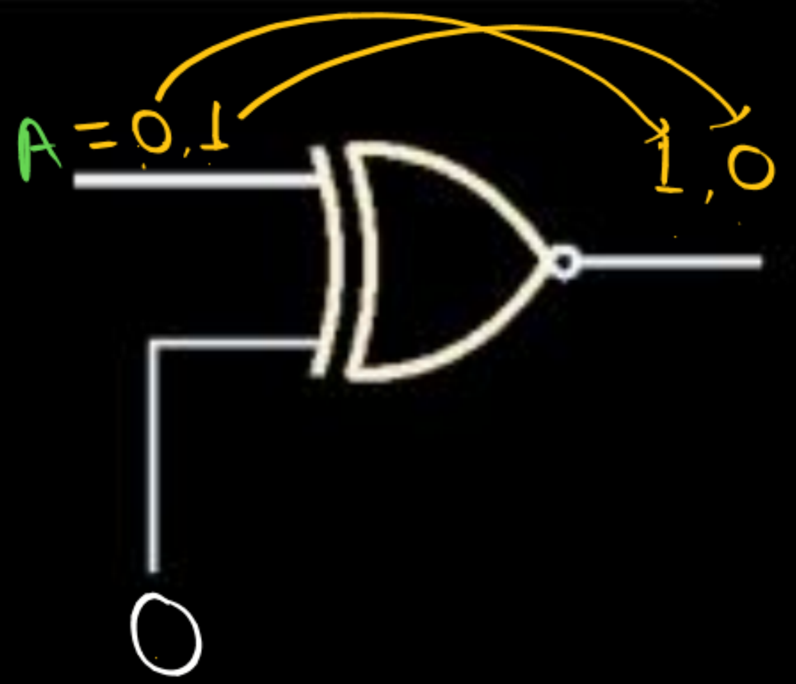
$$A \odot A = 1$$

$$A \odot 1 = A$$

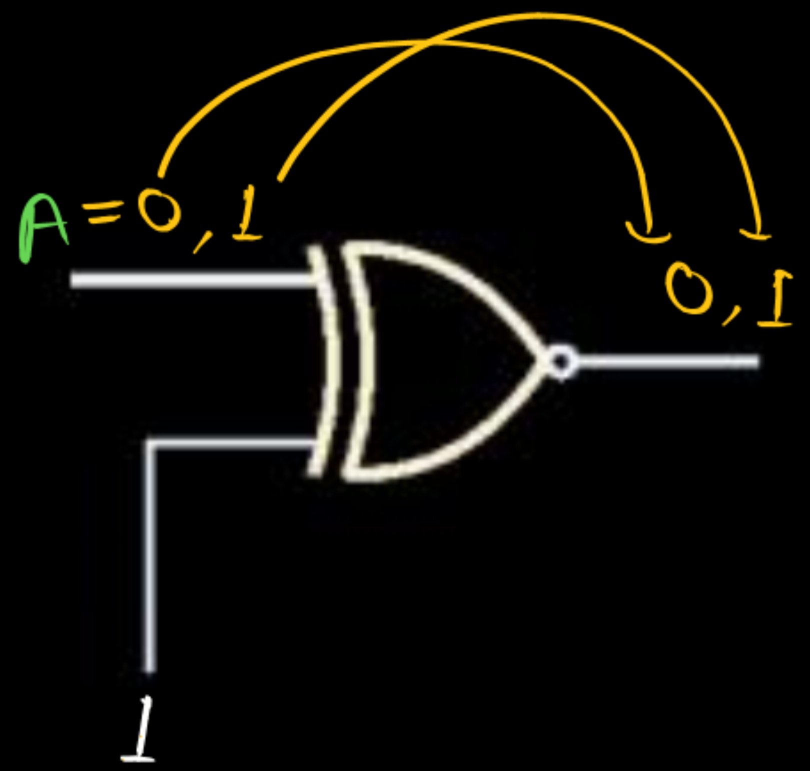
$$A \odot \bar{A} = 0$$

$$A \odot 0 = \bar{A}$$

XNOR GATE



INVERTER



BUFFER

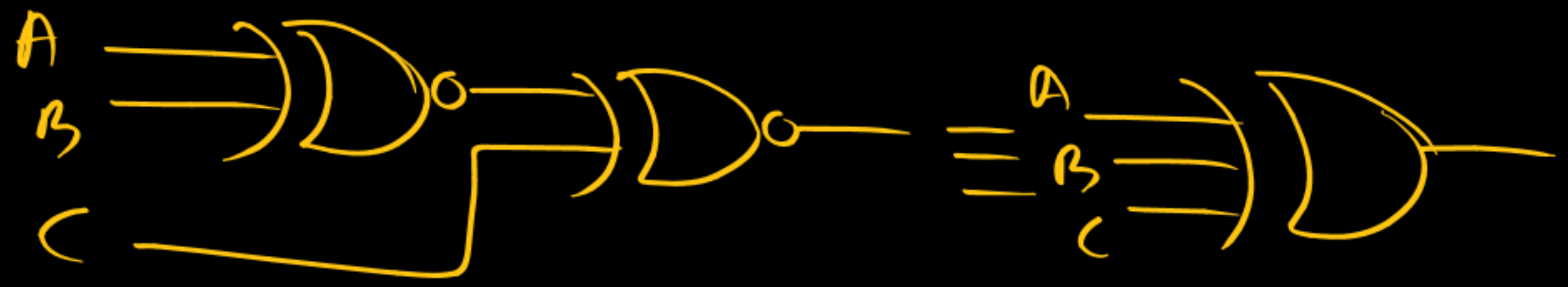
X-NOR

→ Commutative Law ✓

Associative Law ✓

$$A \odot B = \overline{A \oplus B}$$

$$(A \odot B) \odot C = A \oplus B \oplus C$$



$$A \odot B \odot C \odot D = \overline{A \oplus B \oplus C \oplus D}$$

31 Oct

XNOR GATE

	A	B	C	$A \odot B \odot C$	$(A \odot B) \odot C$
0	0	0	0		0
1	0	0	1		1
2	0	1	0		1
3	0	1	1		0
4	1	0	0		1
5	1	0	1		0
6	1	1	0		0
7	1	1	1		1

$$(A \odot B) \odot C = \sum m(1,2,4,7)$$
$$= A \oplus B \oplus C$$

Even Variable X-NOR

$$A \odot B = \overline{A \oplus B}$$

$$A \odot B \odot C \odot D = \overline{A \oplus B \oplus C \oplus D}$$

Binod

Output will be high when Even no. of inputs are high.

Odd Variables X-NOR

$$(A \odot B) \odot C = A \oplus B \oplus C$$

Output will be high when Odd no. of 1's are present in the inputs.

MSQ

Q1. The Boolean function given below:

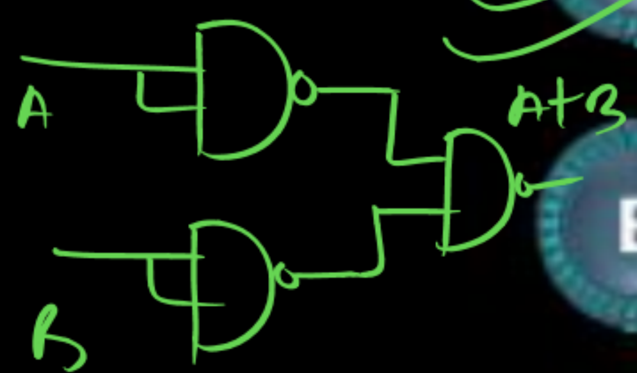
$$f(A, B) = A \oplus B \oplus AB = A + B$$

OR

which statement is/are correct?

A, C

A It is a OR GATE



3

B It is a NAND GATE

B It requires 3 NAND gate to implement the function

B It required 2 NAND gates to implement the function

$$\bar{A}A = 0$$

$$f = A \oplus B \oplus AB$$

$$\Rightarrow A \oplus B = X$$

$$= X \oplus AB$$

$$= \bar{X}\, AB + X \cdot \overline{AB}$$

$$= \overline{A \oplus B} \cdot AB + (A \oplus B) \cdot \overline{AB}$$

$$= (A \odot B) \cdot AB + (A \oplus B)\, \overline{AB}$$

$$= (\bar{A}\bar{B} + AB)\, AB + (\bar{A}B + A\bar{B})(\bar{A} + \bar{B})$$

$$= \overset{0}{\cancel{\bar{A}\bar{B} \cdot AB}} + \overset{AB}{\cancel{AB\, AB}} + \overset{\bar{A}B}{\cancel{\bar{A}B\, \bar{A}}} + \overset{0}{\cancel{\bar{A}B\, \bar{B}}} + \overset{0}{\cancel{A\bar{B}\bar{A}}} + \overset{A\bar{B}}{\cancel{A\bar{B}\, \bar{B}}}$$

$$= 0 + AB + \bar{A}B + 0 + A\bar{B}$$

$$= AB + \bar{A}B + A\bar{B}$$

$$= B(A + \bar{A}) + A\bar{B}$$

$$= B + A\bar{B}$$

$$= (A + B)(B + \bar{B})$$

$$= A + B$$

$$A + B$$

MCQ

Q2. Minimized expression will be $Y = A \oplus (A + B)$

(A) $A \oplus B$

(B) $A \odot B$

(C) $\bar{A} \cdot B$

(D) $A + B$

$$A \oplus (A+B)$$
$$A \oplus A + A \oplus B$$
$$0 + A \oplus B$$
$$A \oplus B$$

$$A \oplus (A+B)$$
$$\bar{A}(A+B) + A(\overline{A+B})$$
$$\bar{A} \cdot A + \bar{A}B + A(\bar{A} \cdot \bar{B})$$
$$0 + \bar{A}B + 0$$
$$= \bar{A}B$$

$$A \oplus (A+B) \qquad A+B = X$$

$$A \oplus X$$

$$\overline{A}X + A\overline{X}$$

$$\overline{A}(A+B) + A(\overline{A+B})$$

MSQ

A, C

Q.3 If the output y = 1

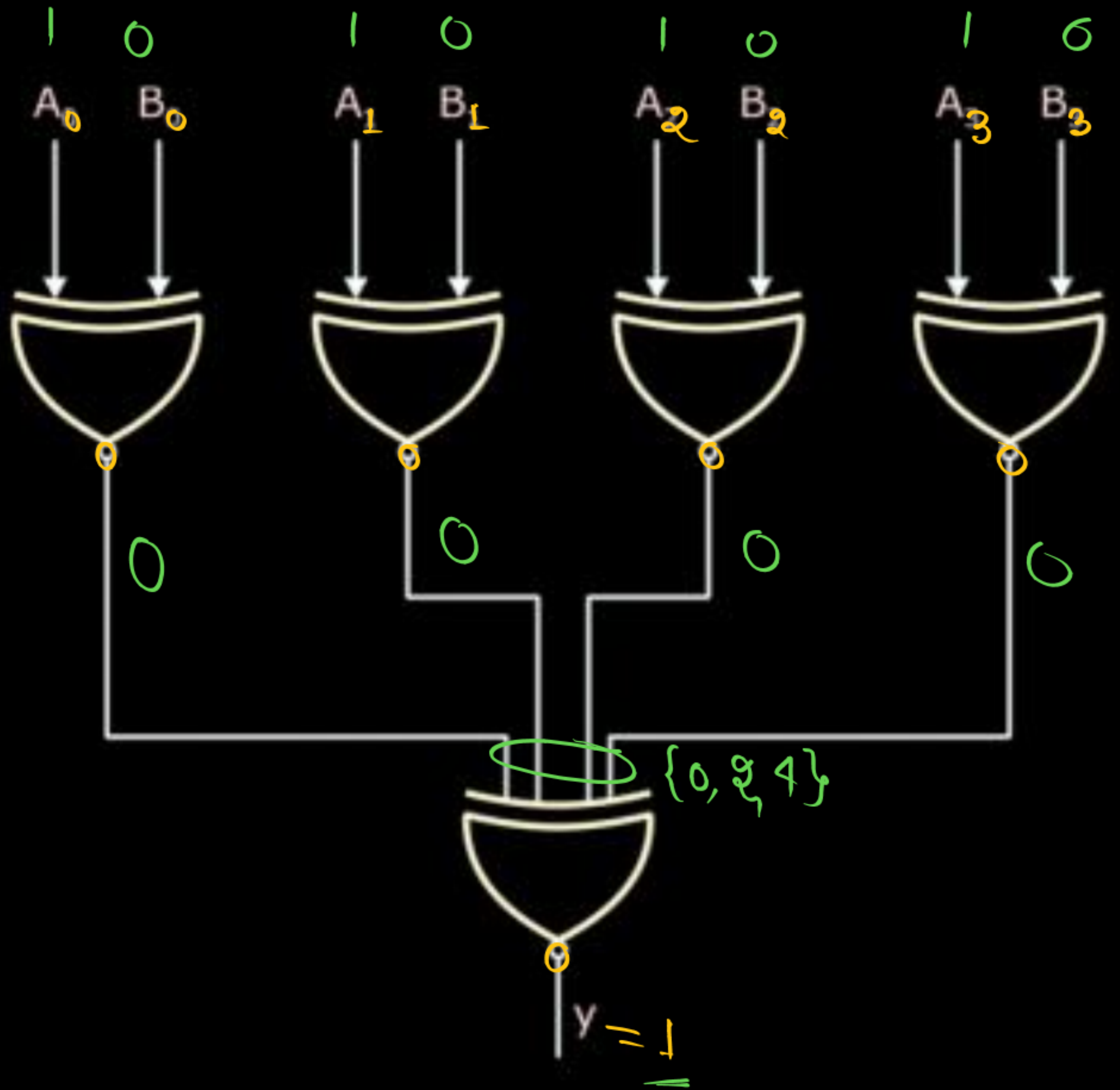
Then correct input is/are-

A) 1111, 0000

B) 1010, 0111

C) 0101, 0101

D) 1100, 1110



DECJ

NOTE

$A \odot B = \bar{A}\bar{B} + AB$

X-NOR

$\bar{A} = X$

$\bar{A} \oplus B$

$X \oplus B$

$\bar{X}B + X\bar{B}$

$\bar{\bar{A}}B + \bar{A}\bar{B}$

$AB + \bar{A}\bar{B} = A \odot B$

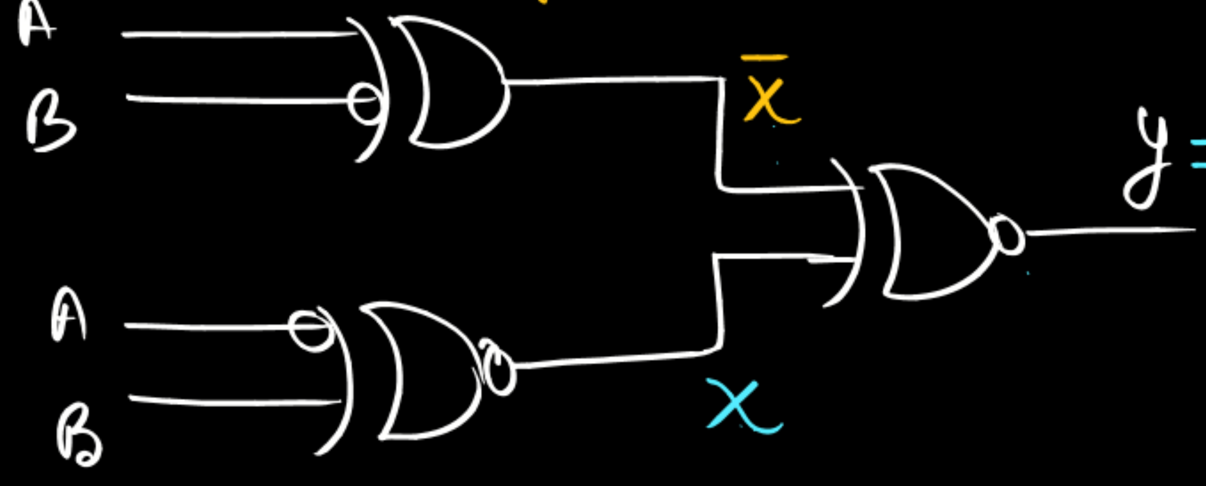
$A \odot B = \overline{A \oplus B} = \bar{A} \oplus B = A \oplus \bar{B} = \bar{A} \odot \bar{B}$

$A \oplus B = \bar{A} \odot B = A \odot \bar{B} = \bar{A} \oplus \bar{B}$

Q

$A \oplus B = X$

$A \oplus \bar{B} = A \odot B = \overline{A \oplus B}$



$\bar{A} \odot B$

$= A \oplus B = X$

$y = \bar{X} \odot X$

$=$

MCQ

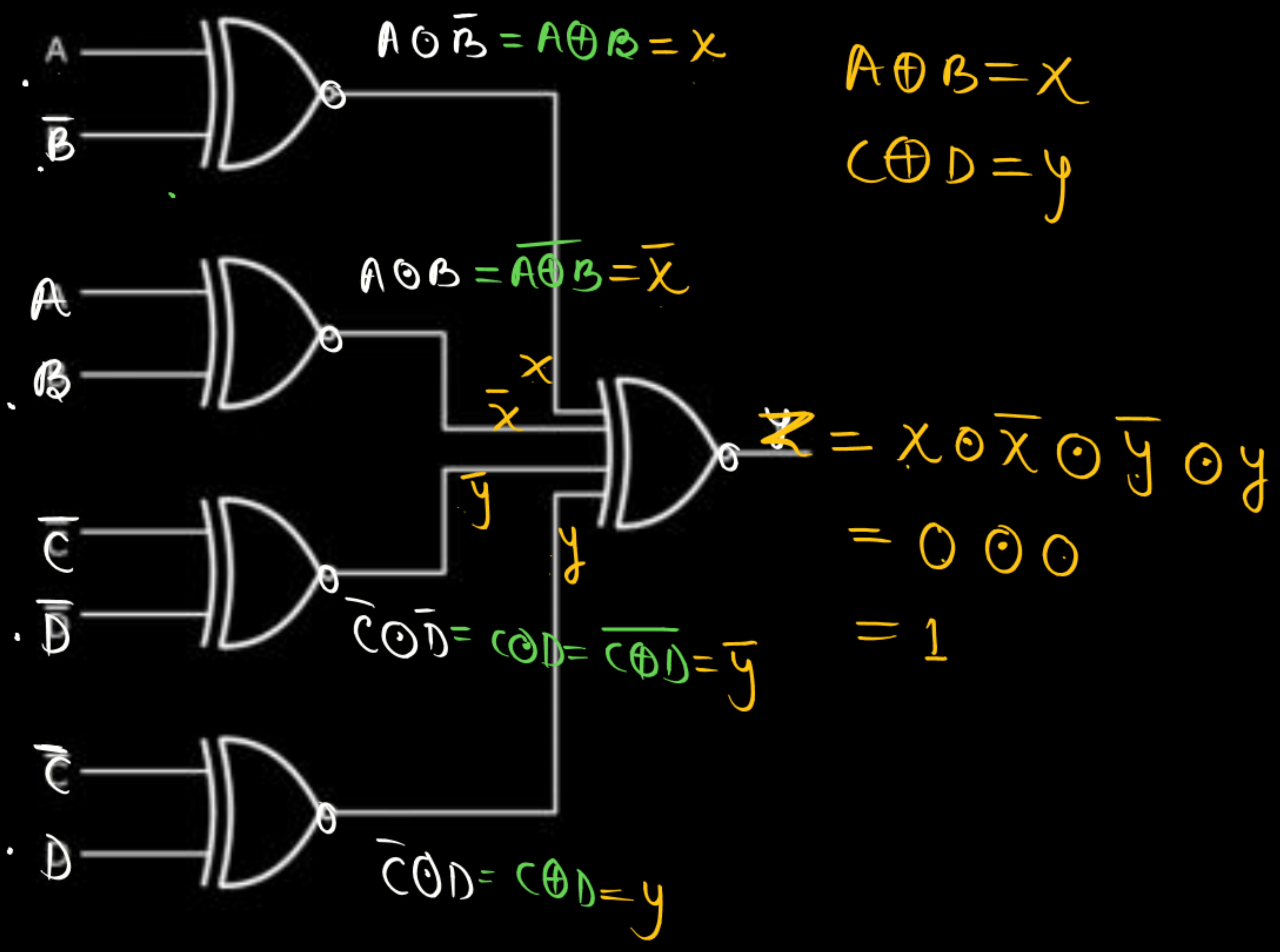
Q.4. Output y will be-

(A) 0

(B) 1

(C) $A \oplus B$

(D) $A \oplus B \oplus C \oplus D$



$A \oplus B = x$

$C \oplus D = y$

60

30

F8AM

Digital with CJ sin