CS & IT ENGINEERING

Digital Logic

Logic GATE

Lecture No. 5

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TOPICS TO BE COVERED

02 XNOR GATE

03 Questions Practice

04 Discussion

INVERTER

AND

OR

TTL

ECL

NAND

NOR

TYPE-1 $f = A \cdot \bar{B} \cdot C \cdot \bar{D} \cdots$

$NAND = (2n-2)+K$

$NOR = (3n-3)-K$

TYPE-2 $f = A + \bar{B} + \bar{C} + D + \cdots$

$NAND = (3n-3)-K$

$NOR = (2n-2)+K$

TYPE (3) $AB + CD \longrightarrow$ NAND $= 3$

$(A+B)\cdot(C+D) \longrightarrow$ NOR $\rightarrow 3.$

NAND $\longrightarrow$ function $\longrightarrow$ Implementation

$\hookrightarrow$ SOP

AND - OR

NAND - NAND

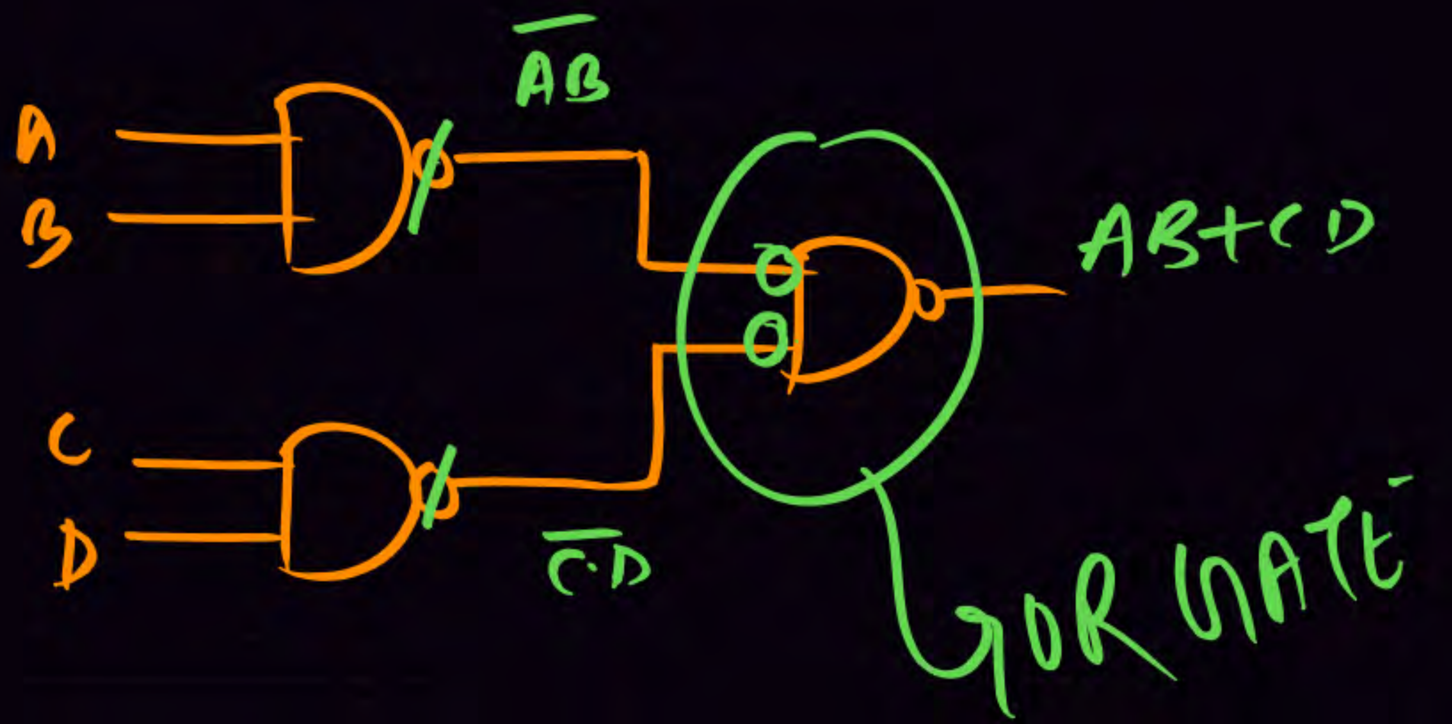
NOR $\longrightarrow$ function $\longrightarrow$ Implementation

$\hookrightarrow$ POS

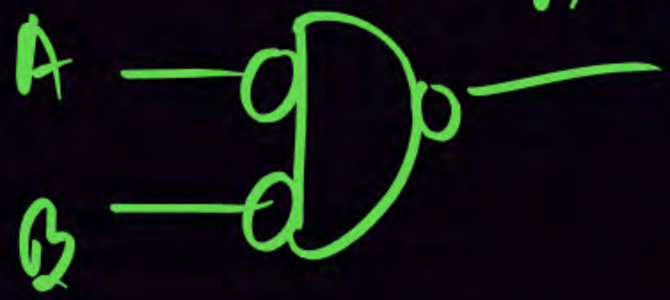
OR - AND

NOR - NOR

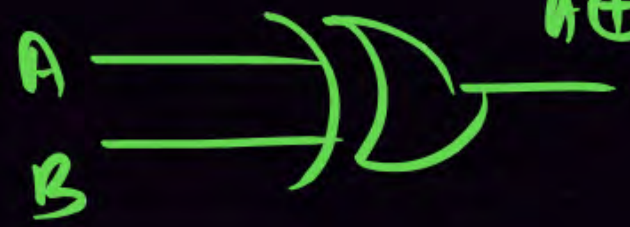
Q



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



X-OR



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

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

$$A \oplus A = 0$$

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

$$A \oplus 0 = A$$

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

$A \oplus A =$ 

$(A \oplus A) \oplus A = A$

$0 \oplus A = A$

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

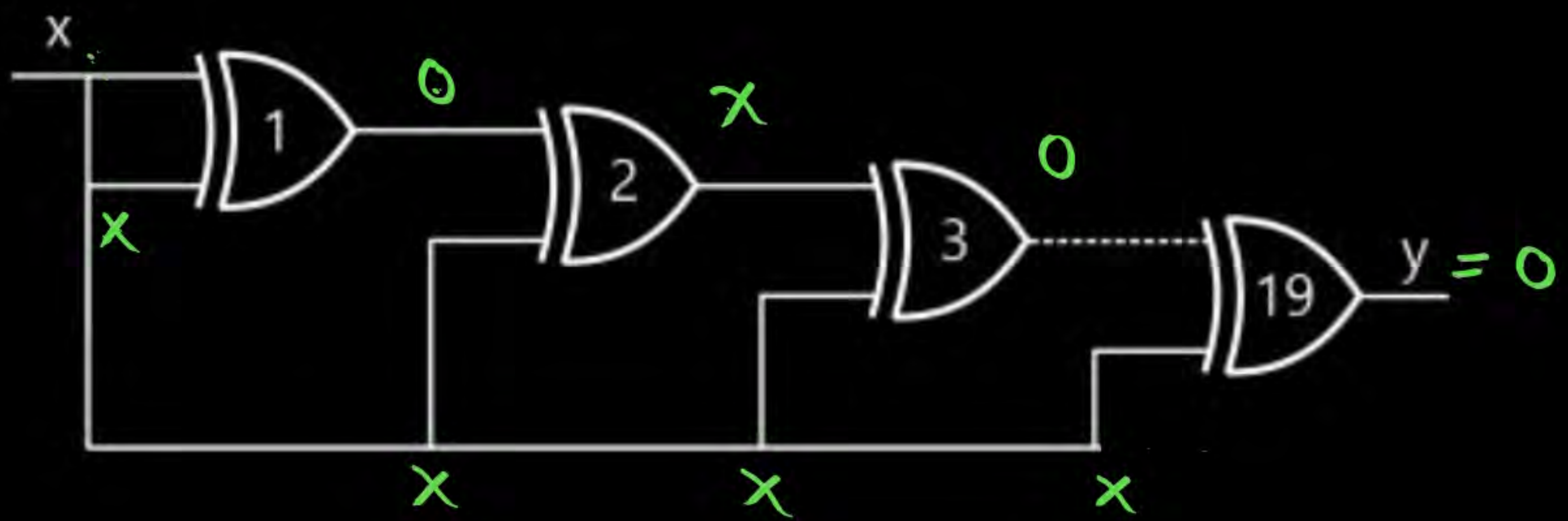
$0 \oplus 0 = 0$

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

$$\boxed{A \oplus B \oplus C = \Sigma m(1,2,4,7)}$$

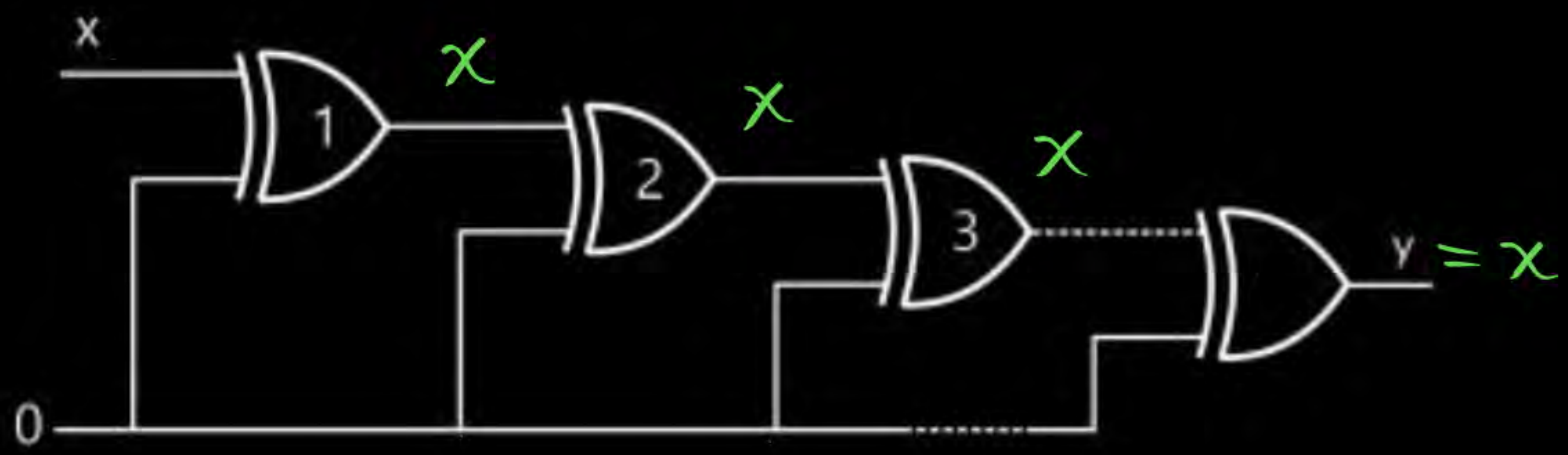
Q.1

Find the output y.



Q.2

Find the output y.



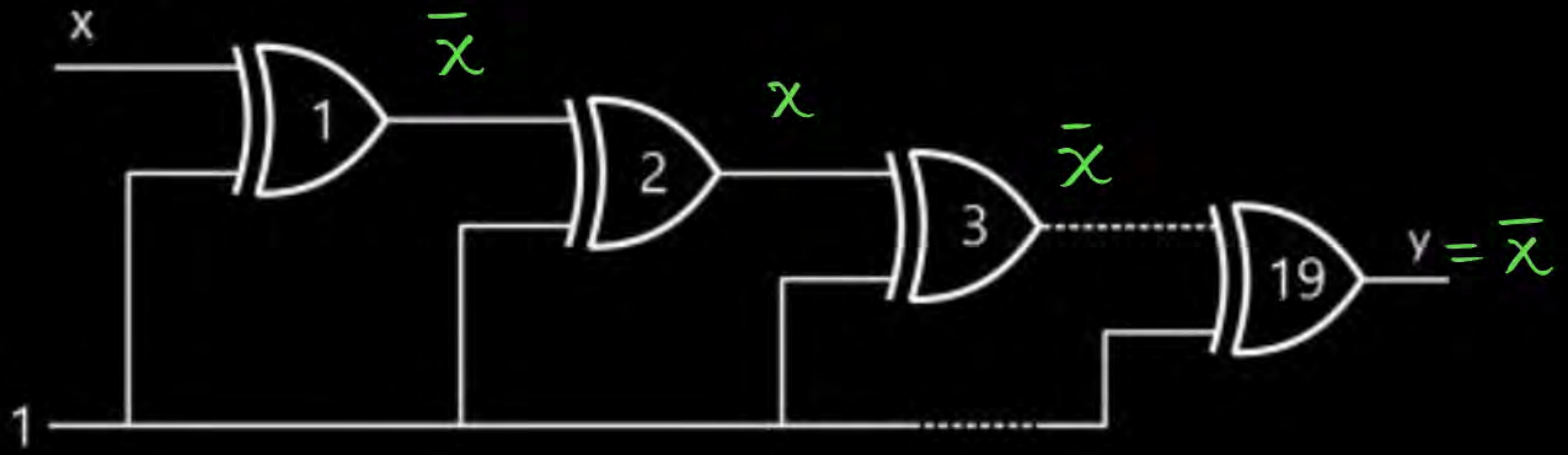
Q.3

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

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

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

Find the output y.



X-NOR GATE

1. Symbol

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

$$A\odot B = \begin{cases} \bar{A}\bar{B}+AB \\ (\bar{A}+B)(A+\bar{B}) \end{cases}$$

2. Truth Table

A	B	y = A ⊙ B
0	0	1
0	1	0
1	0	0
1	1	1

X-NOR GATE

(3) $A = B \quad Y = 1$

$A = \overline{B} \quad Y = 0$

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

X-NOR GATE

(4) $A \odot A = 1$

$A \odot 1 = A$

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

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

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

X-NOR GATE

5

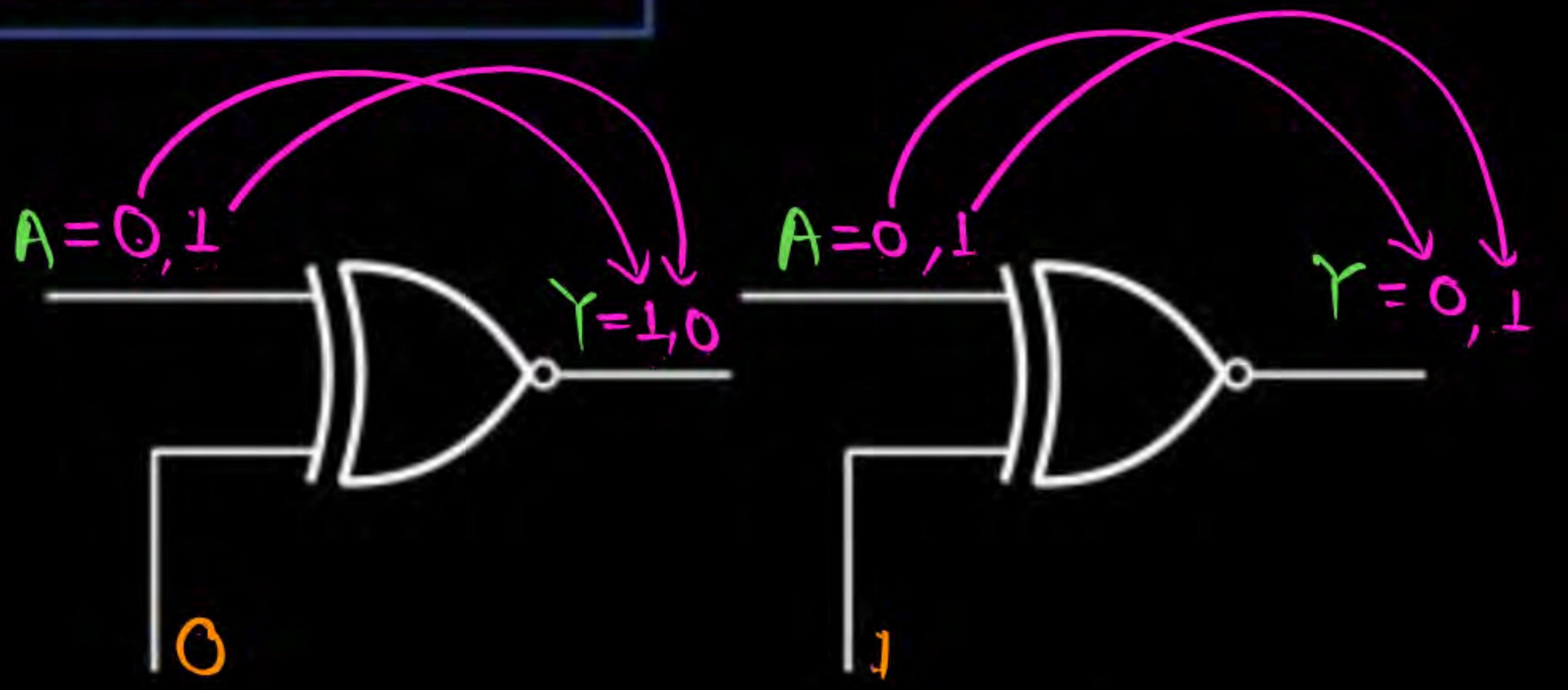
- O/P = 1 when Even no. of 1's are present in the input

- Equal detector
  or Equivalance Logic
  Coincidance Logic

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

X-NOR GATE

6.



"INVERTER"

BUFFER

XOR GATE, X-NOR GATE

- **Commutative Law** → follow karta hai.

  $A \odot B = B \odot A$

X-NOR follows commutative as well as associative Law.

X-NOR

↓

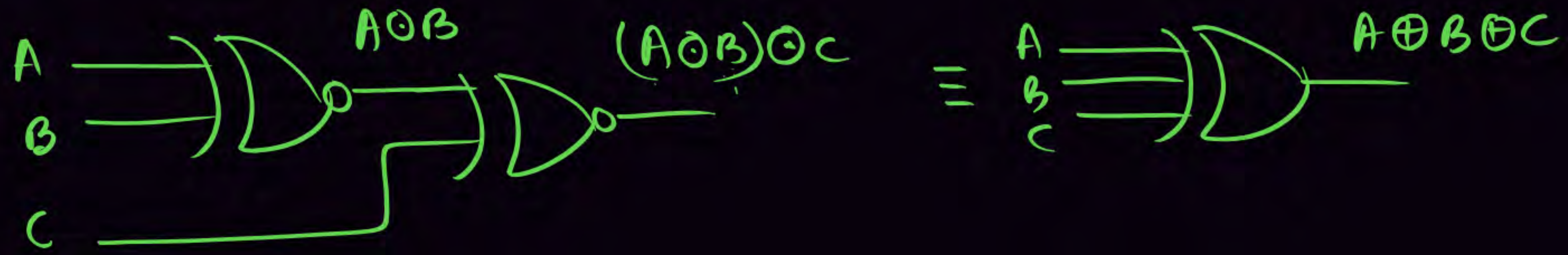
Even no. of input

Even Variable.

for Even input X-NOR GATE

↳ o/p will be high when Even number of 1's are present in the inputs.

Odd variables in X-NOR GATE



o/p high when odd no. of 1's in the inputs.

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

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

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

X-NOR GATE

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

- **Associate Law**

	ABC	A ⊙ B ⊙ C	(A ⊙ B) ⊙ 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

X-NOR GATE

- **For Odd Number of Input**

aisa practical nahi hai.

X-NOR

↳ o/p will be high when Even no. of 1's are connected in the inputs.

O/p high for even no. of 1's in the inputs.

X-OR

O/p will be high when odd no. of 1's in input.

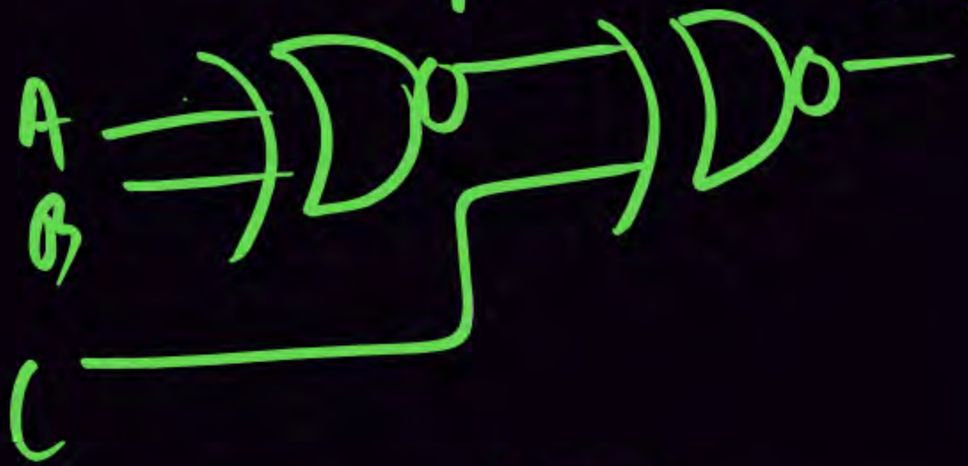
O/p high when even no. of 1's are connected in the inputs.

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

$A \odot B \odot C \odot D$

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

$A \odot B$ $\quad (A \odot B) \odot C$



$\equiv$ 

Alternate Symbol

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

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

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

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

$$\bar{B} = X$$

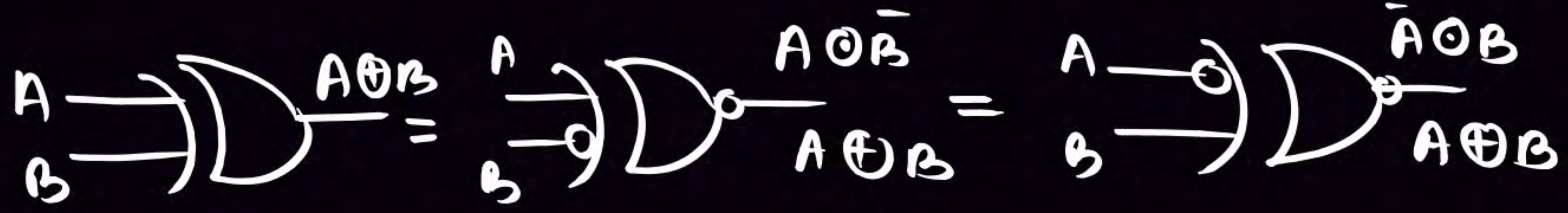
$$A \odot X$$

$$= \bar{A}\bar{X} + AX$$

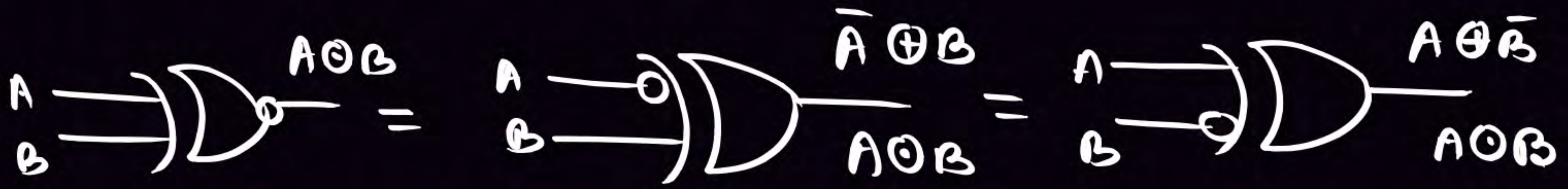
$$= \bar{A}\bar{\bar{B}} + A\bar{B}$$

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

$$= A \oplus B$$



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



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

Q.4

MSQ

The Boolean function given below:

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

which statement is/are correct?

A, C

- (A) It is a OR GATE
- (B) It is a NAND GATE
- (C) It requires 3 NAND gate to implement the function
- (D) It required 2 NAND gates to implement the function

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

$$\overline{A \oplus B} = \bar{X} = A \odot B = \bar{A}\bar{B} + AB$$

$$\Rightarrow (A \oplus B) \oplus AB$$

$$\Rightarrow X \oplus AB$$

$$\Rightarrow \bar{X} \cdot AB + X \cdot \overline{AB}$$

$$\Rightarrow (A \odot B) AB + (A \oplus B)(\bar{A} + \bar{B})$$

$$\Rightarrow (\bar{A}\bar{B} + AB) AB + (\bar{A}B + A\bar{B}) \cdot (\bar{A} + \bar{B})$$

$$\Rightarrow \bar{A}\bar{B} \cdot AB + AB \cdot AB + \bar{A}B \cdot \bar{A} + \bar{A}B \cdot \bar{B} + A\bar{B} \cdot \bar{A} + A\bar{B} \cdot \bar{B}$$

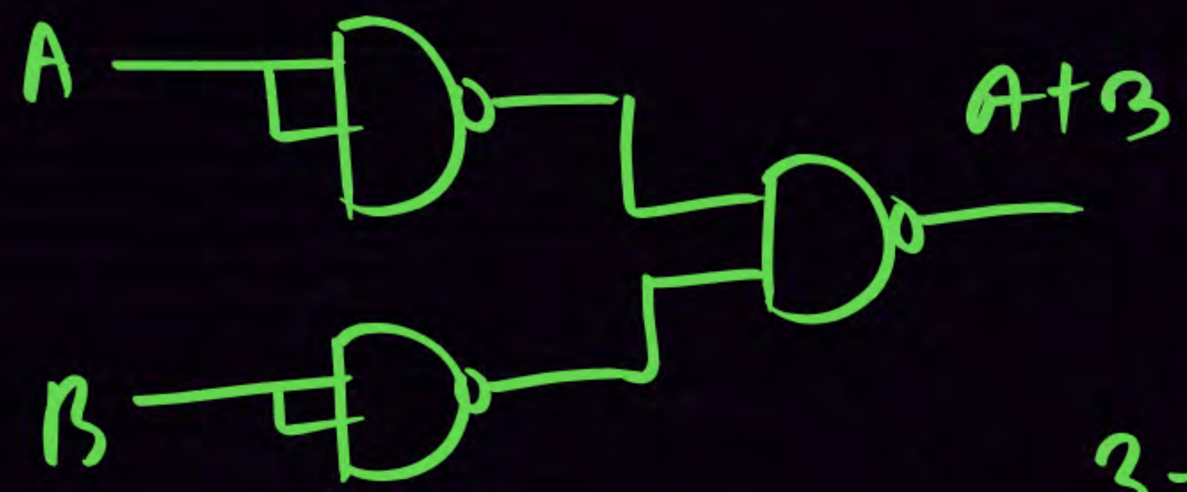
$$\Rightarrow 0 + AB + 0 + 0 + 0 + \bar{A}B + A\bar{B}$$

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

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

$f = A + B$

OR GATE



3-NAND GATE

Q.5

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

(A) $A \oplus B$

(B) $A \odot B$

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

(D) $A + B$

$\cancel{Y = A \oplus (A + B)}$

$\cancel{Y = (A \oplus A) + (A \oplus B)}$

$\cancel{Y = 0 + A \oplus B}$

$\cancel{Y = A \oplus B}$

X-OR does not follow distribution law over OR GATE.

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

$$Y = A \oplus X$$

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

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

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

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

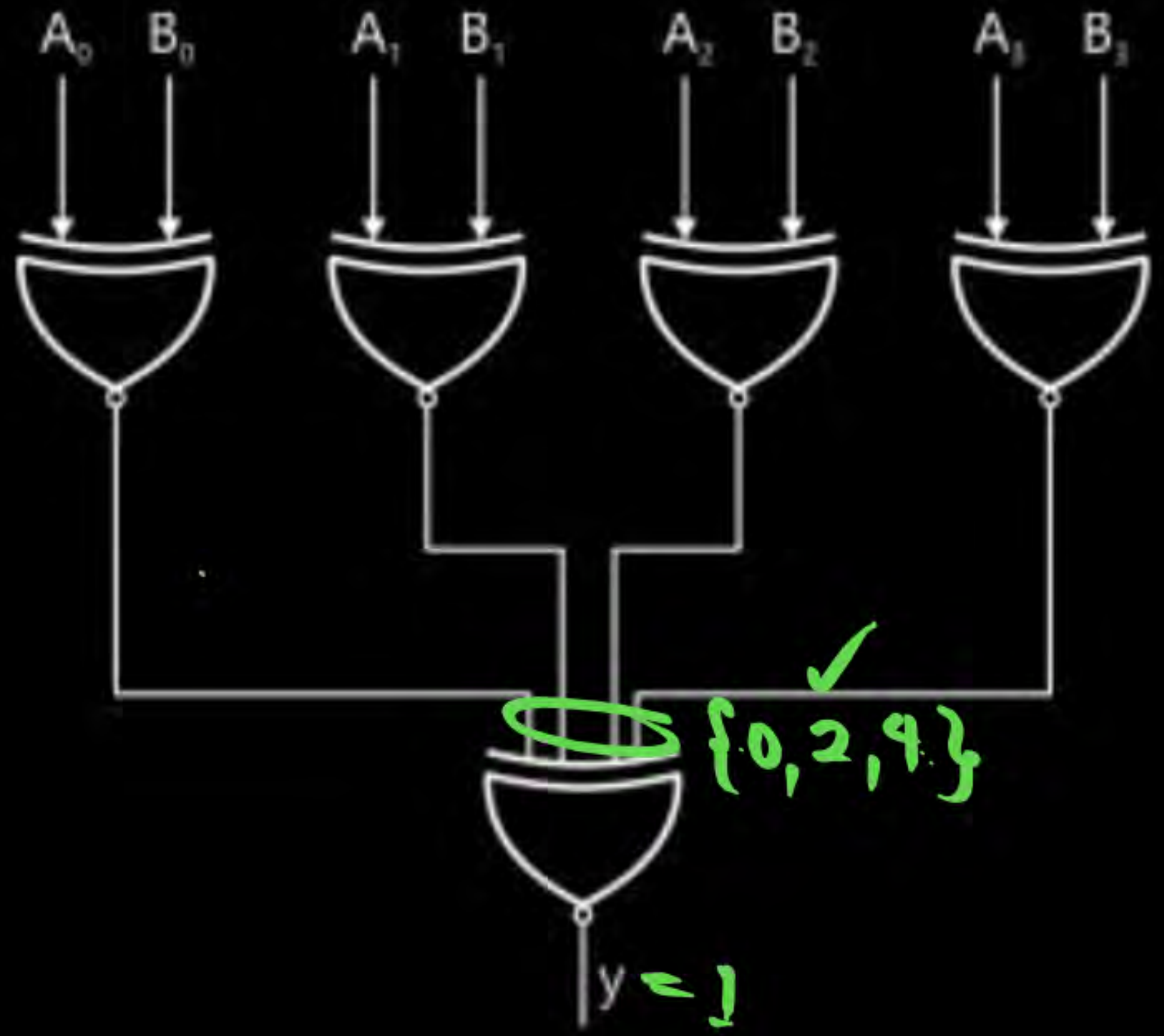
$$= \bar{A}B$$

Q.6

MSQ

A, C

If the output y = 1
Then correct input is/are-



(A) 1111, 0000

(B) 1010, 0111

(C) 0101, 0101

(D) 1100, 1110

Q.7

MCQ

$A \oplus B = P \qquad C \oplus D = Q$

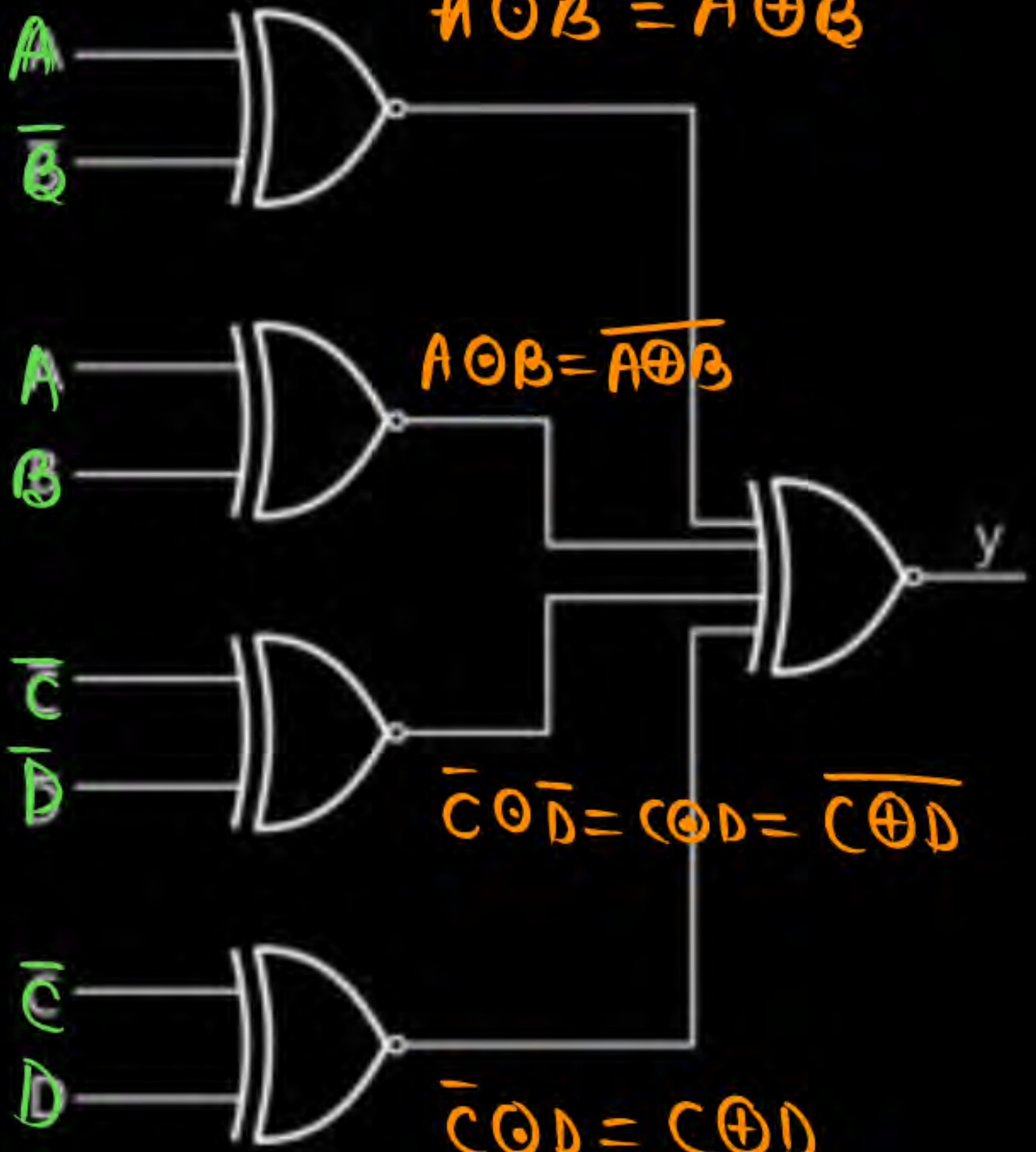
Output y will be-

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

$Y = (P \odot \bar{P}) \odot (\bar{Q} \odot Q)$

$Y = 0 \odot 0$

$Y = 1$



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

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

$\bar{C} \odot \bar{D} = C \odot D = \overline{C \oplus D}$

$\bar{C} \odot D = C \oplus D$

(A) 0

(B) 1

(C) $A \oplus B$

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

MCQ

Which one of the following is NOT a valid identity?

[GATE-2019-CS: M]

(A) $(x + y) \oplus z = x \oplus (y + z)$ ✗

(B) $(x \oplus y) \oplus z = x \oplus (y \oplus z)$ ✓

(C) $x \oplus y = x + y$, if $xy = 0$ ✓

(D) $x \oplus y = (xy + x'y')'$ ✓

$(x \oplus y) \oplus z = x \oplus (y \oplus z)$

→ follow associative Law

$x \oplus y = \bar{x}y + x\bar{y}$

$= (\bar{x} + \bar{y})(x + y)$

$= (\overline{x \cdot y}) \cdot (x + y)$

$= 1 \cdot (x + y) = x + y$

$x \cdot y = 0$

$\overline{x \cdot y} = 1$

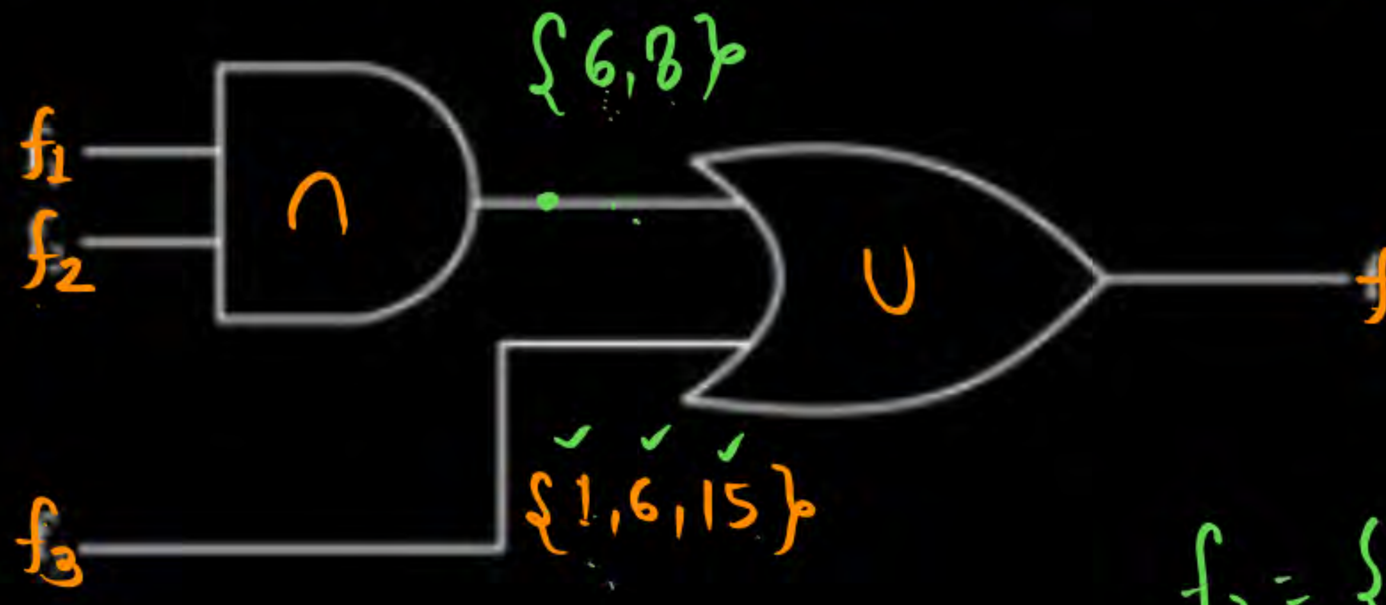
$x \oplus y = \overline{xy + \bar{x}\bar{y}}$

MCQ

Given f1, f3 and f in canonical sum of products form (in decimal) for the circuit

{4,5,6,7,8}

{6,8}



f = {1,6,8,15}

f_2 = {8}

f_2 = {6,8}

$F_1 = \sum m\,(4, 5, 6, 7, 8)$
$F_3 = \sum m\,(1, 6, 15)$
$F \;= \sum m\,(1, 6, 8, 15)$
Then f_2 is

GATE-2008-CS: 1M

(A) $\sum m\,(4, 6)$

(B) $\sum m\,(4, 8)$

(C) $\sum m\,(6, 8)$

(D) $\sum m\,(4, 6, 8)$

MCQ

Consider three 4-variable functions f1, f2 and f3, which are expressed in sum-of-minterms as

$f_1 = \Sigma(0, 2, 5, 8, 14)$, $f_2 = \Sigma(2, 3, 6, 8, 14, 15)$, $f_3 = \Sigma(2, 7, 11, 14)$

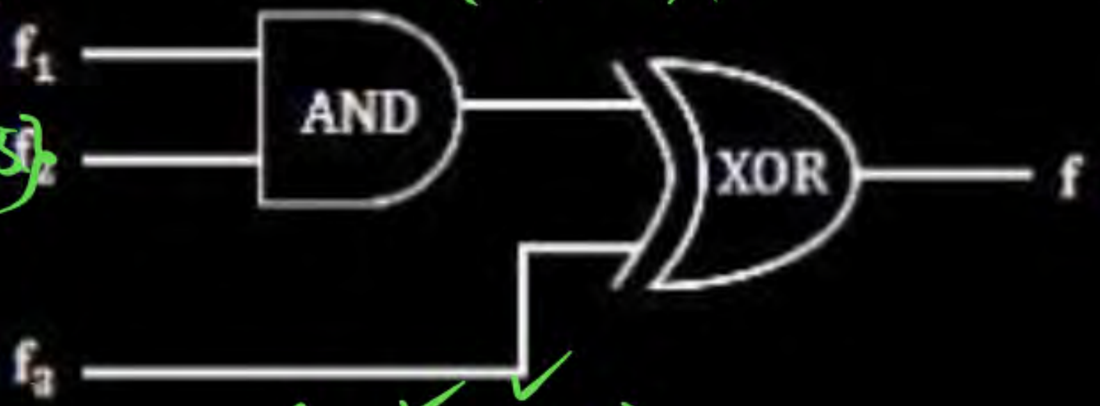
For the following circuit with one AND gate and one XOR gate, the output function f can be expressed as:

[GATE-2019-CS: M]

$\{\cancel{2}, 8, \cancel{14}\}$

$\{0, 2, 5, 8, 14\}$

$\{2, 3, 6, 8, 14, 15\}$



$= \Sigma m(7, 8, 11)$

$\{2, 7, 11, 14\}$

$\{\cancel{2}, 7, 11, \cancel{14}\}$

(A) $\Sigma(2, 14)$

(B) $\Sigma(7, 8, 11)$

(C) $\Sigma(2, 7, 8, 11, 14)$

(D) $\Sigma(0, 2, 3, 5, 6, 7, 8, 11, 14, 15)$

MCQ

Let $\oplus$ and $\odot$ denote the Exclusive OR and Exclusive NOR operations, respectively. Which one of the following is NOT CORRECT?

[GATE-2018-CS: M]

(A) $\overline{P \oplus Q} = P \odot Q$ ✓

(B) $\bar{P} \oplus Q = P \odot Q$ ✓

(C) $\bar{P} \oplus \bar{Q} = P \oplus Q$ ✓

(D) $(P \oplus \bar{P}) \oplus Q = (P \odot \bar{P}) \odot \bar{Q}$ ✓

$1 \oplus Q \qquad 0 \odot \bar{Q}$

$\bar{Q} \neq Q$

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

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

MCQ

Consider the Boolean operator # with the following properties:

$x\#0 = x$, $x\#1 = \bar{x}$, $x\#x = 0$ and $x\#\bar{x} = 1$

Then x#y is equivalent to

[GATE-2016-CS: M]

(A) $x\bar{y} + \bar{x}y$ ✓

(B) $x\bar{y} + \bar{x}\bar{y}$

(C) $\bar{x}y + xy$

(D) $xy + \bar{x}\bar{y}$

$x \# x = 0$ $\quad$ $x \# \bar{x} = 1$

$x \oplus x = 0$ $\quad$ $x \oplus \bar{x} = 1$

$x \oplus 0 = x$ $\quad$ $x \oplus 1 = \bar{x}$

MCQ HW:

Let, $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$ where x_1, x_2, x_3, x_4 are Boolean variables, and $\oplus$ is the XOR operator.

Which one of the following must always be TRUE? [GATE-2016-CS: M]

(A) $x_1x_2x_3x_4 = 0$

(B) $x_1x_3 + x_2 = 0$

(C) $\bar{x}_1 \oplus \bar{x}_3 = \bar{x}_2 \oplus \bar{x}_4$

(D) $x_1 + x_2 + x_3 + x_4 = 0$

MCQ HW

The binary operator ≠ is defined by the following truth table

P	Q	p≠q
0	0	0
0	1	1
1	0	1
1	1	0

Which one of the following is true about the binary operator ≠?

[GATE-2015-CS: M]

(A) Both commutative and associative

(B) Commutative but not associative

(C) Not commutative but associative

(D) Neither commutative nor associative

MCQ HW

Let ⊕denote the Exclusive OR (XOR) operation. Let '1' and 'o' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q:

$$F(P, Q) = ((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0))$$

The equivalent expression for F is

[GATE-2014-CS: M]

(A) $P+Q$

(B) $(P+Q)'$

(C) $P \oplus Q$

(D) $(P \oplus Q)'$

MCQ

Which one of the following expressions does NOT represent exclusive NOR of x and y?

[GATE-2013-CS: M]

(A) $xy + x'y'$ $= x \odot y$

(B) $x \oplus y'$ $= x \odot y$

(C) $x' \oplus y$ $= x \odot y$

(D) $x' \oplus y'$ $= x \oplus y$

MCQ HW ✓

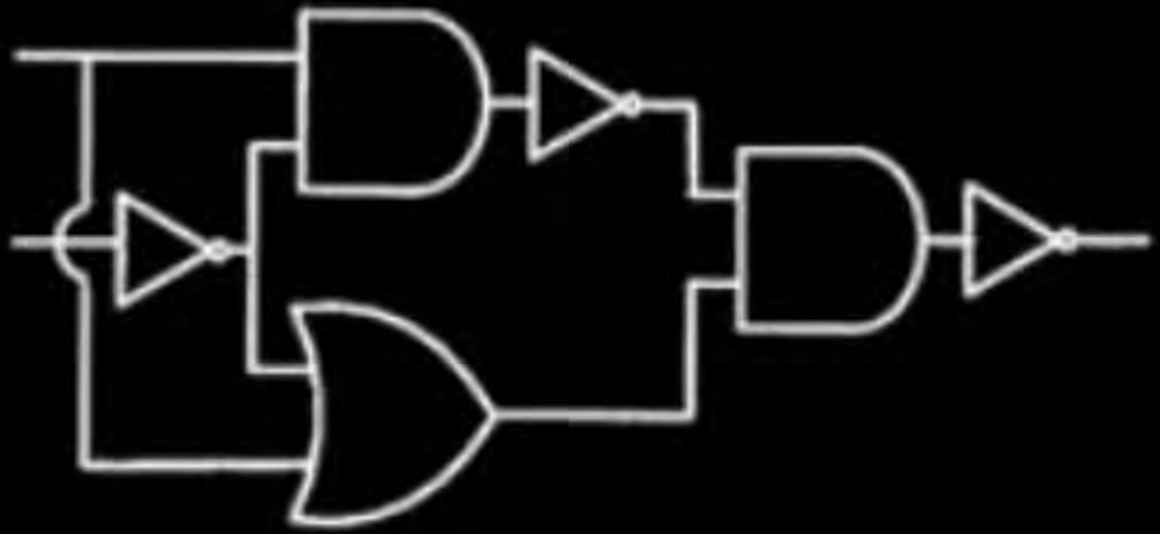
Which one of the following circuits is NOT equivalent to a 2-input XNOR (exclusive NOR) gate?

[GATE-2011-CS: M]

(A) 

(B) 

(C) 

(D) 

Thank you

GW Soldiers !