CS & IT ENGINEERING

DIGITAL LOGIC

Combinational Circuit

Lecture No. 5

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TOPICS TO BE COVERED

01 MULTIPLEXER

02 QUESTION PRACTICE

03 DISCUSSION

MULTIPLEXER

1. $2^n \times 1$
2. AND-OR logic
3. universal Logic

Recape

- Design a 2 × 1 MUX
- Design a 4 × 1 MUX

$$\Rightarrow \left\{ \begin{array}{l} 8\times 1 \text{ MUX} \\ 16\times 1 \text{ MUX} \end{array} \right\}$$

10 min

15 min

MULTIPLEXER

Q.1 Design 4 × 1 MUX using 2 × 1 MUX.

$$2\times1\ \text{MUX} \xrightarrow[2+1=3]{\frac{4}{2}+\frac{2}{2}} 4\times1\ \text{MUX}$$

3 → Ans

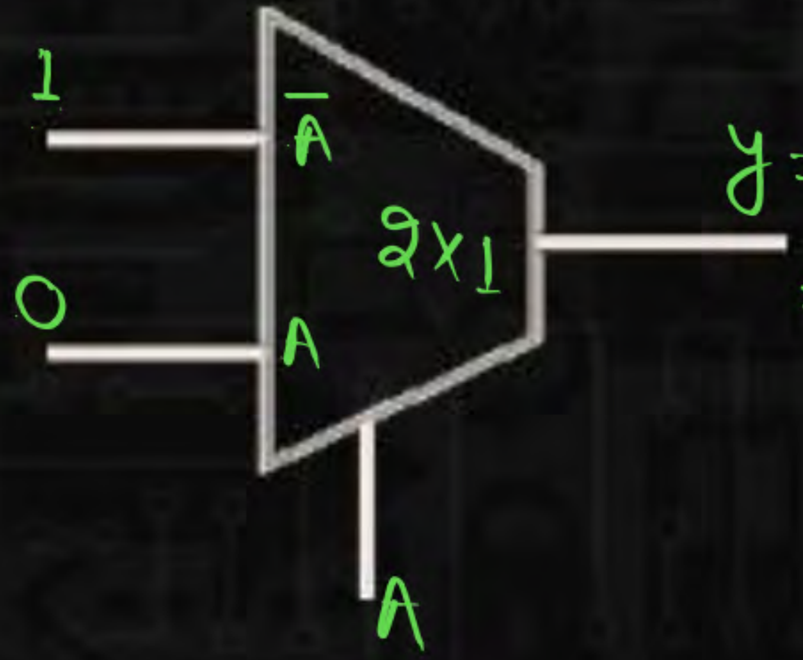
MULTIPLEXER

Q.2 Design 64 × 1 MUX using 8 × 1 MUX.

$$8\times1 \xrightarrow[8+1=9]{\frac{64}{8}+\frac{8}{8}} 64\times1$$

Type 2- Mux as a Universal Logic

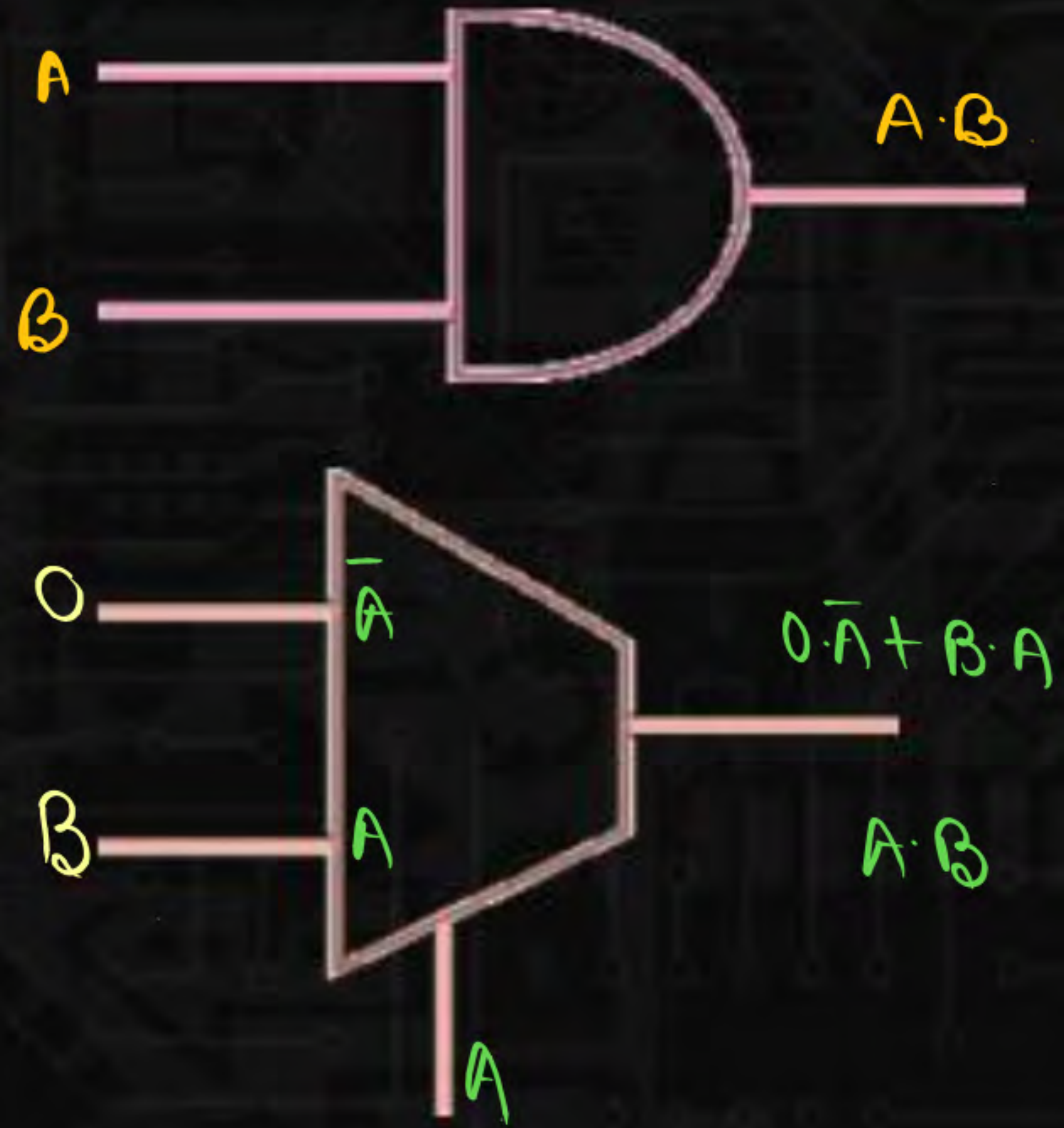
1. Not Gate



$$y = 1\cdot\bar{A} + 0\cdot A$$
$$= \bar{A}$$

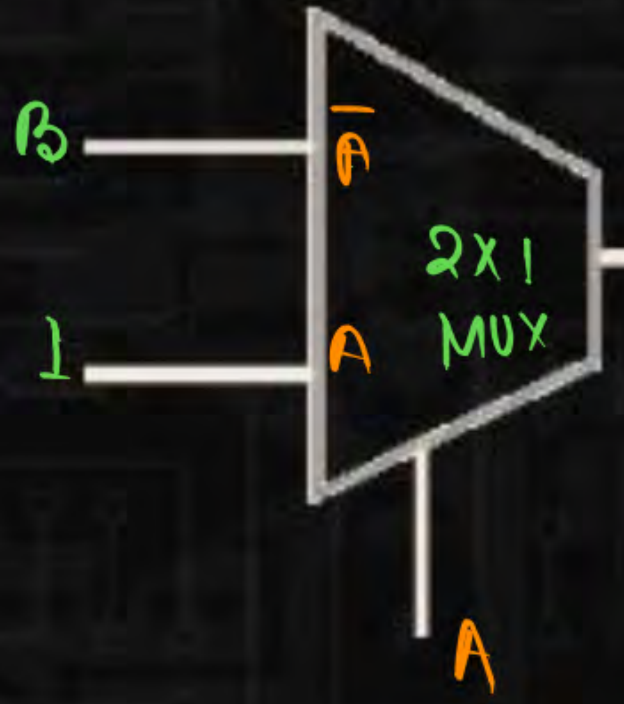
MULTIPLEXER

2. AND GATE



MULTIPLEXER

3. OR GATE



$\bar{A}\cdot B + A\cdot 1$

$A + \bar{A}B$

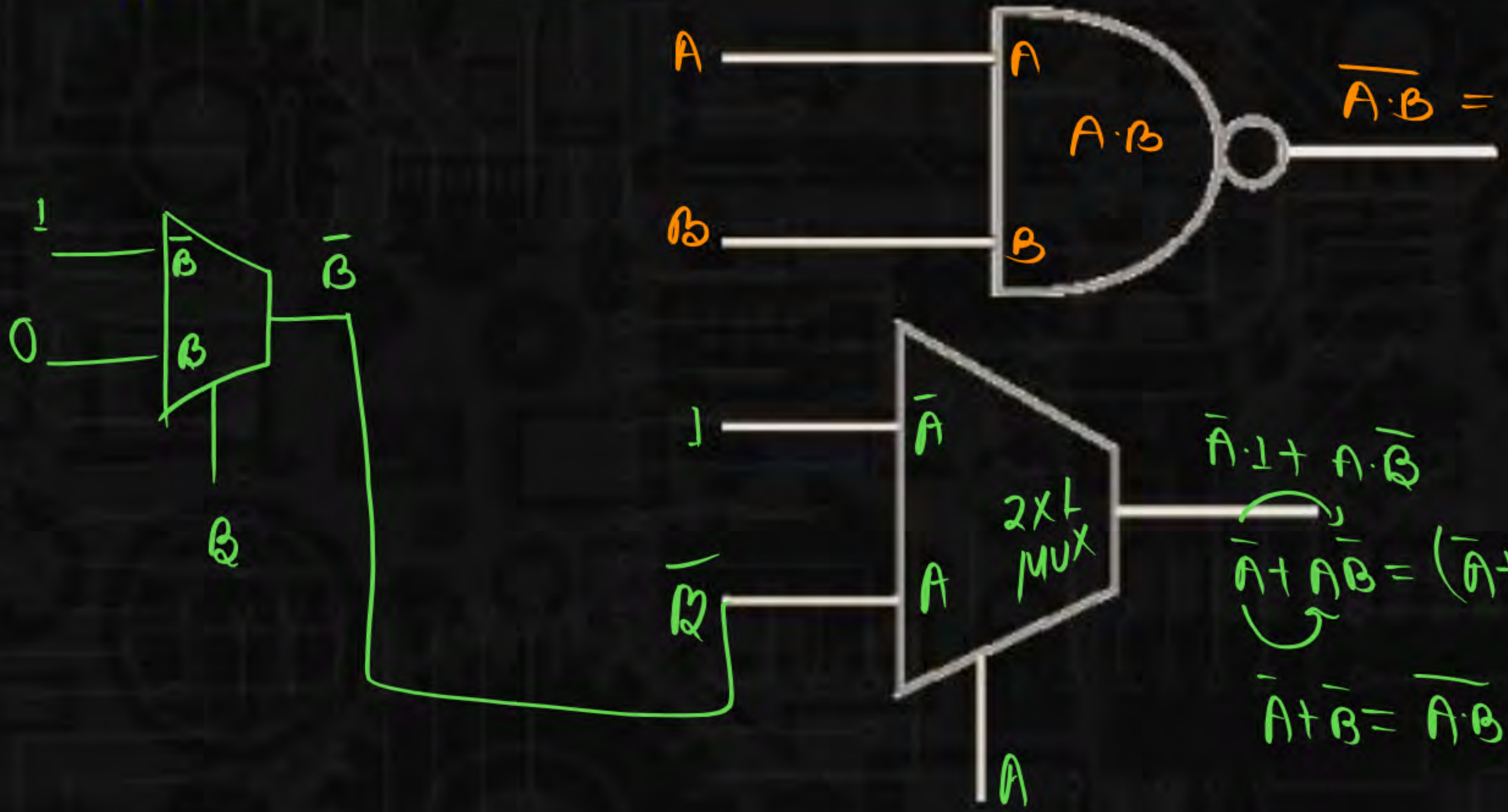
$(A+\bar{A})\cdot(A+B)$

$\boxed{A+B}$

MULTIPLEXER

Two 2x1 are required

4. NAND GATE



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

$\bar{A} \cdot 1 + A \cdot \bar{B}$

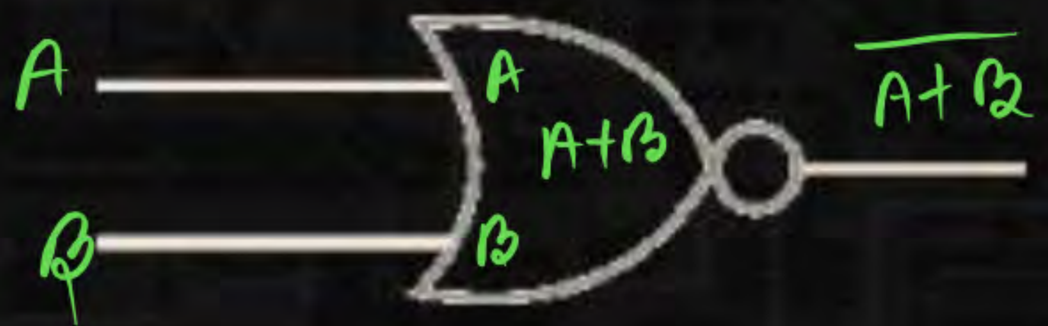
$\bar{A} + A\bar{B} = (\bar{A} + A)(\bar{A} + \bar{B})$

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

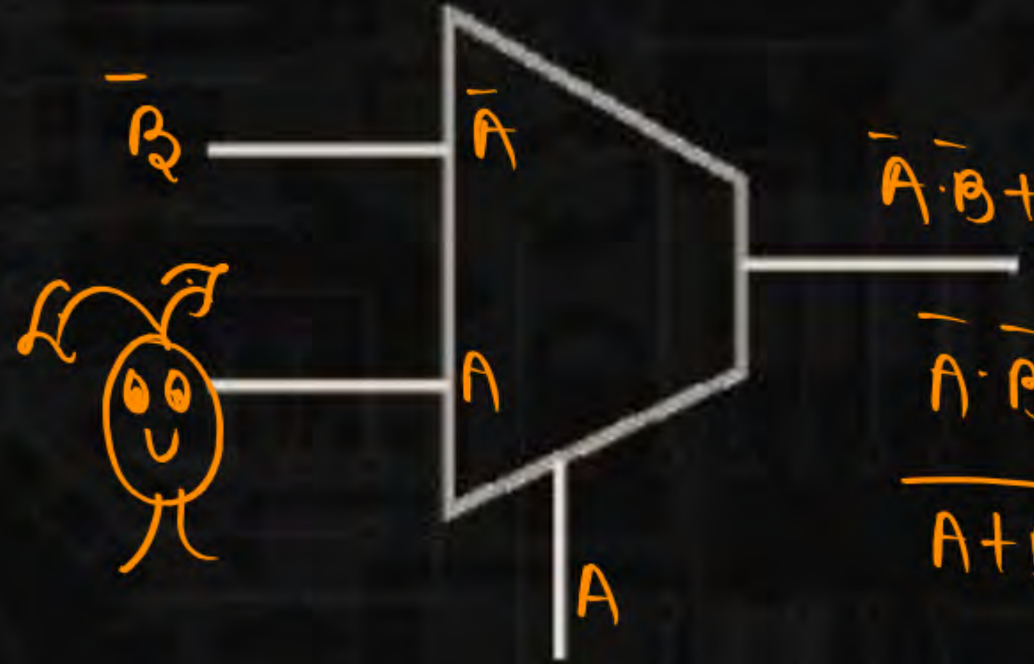
MULTIPLEXER

5. NOR GATE

Two 2x1 MUX are required.



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



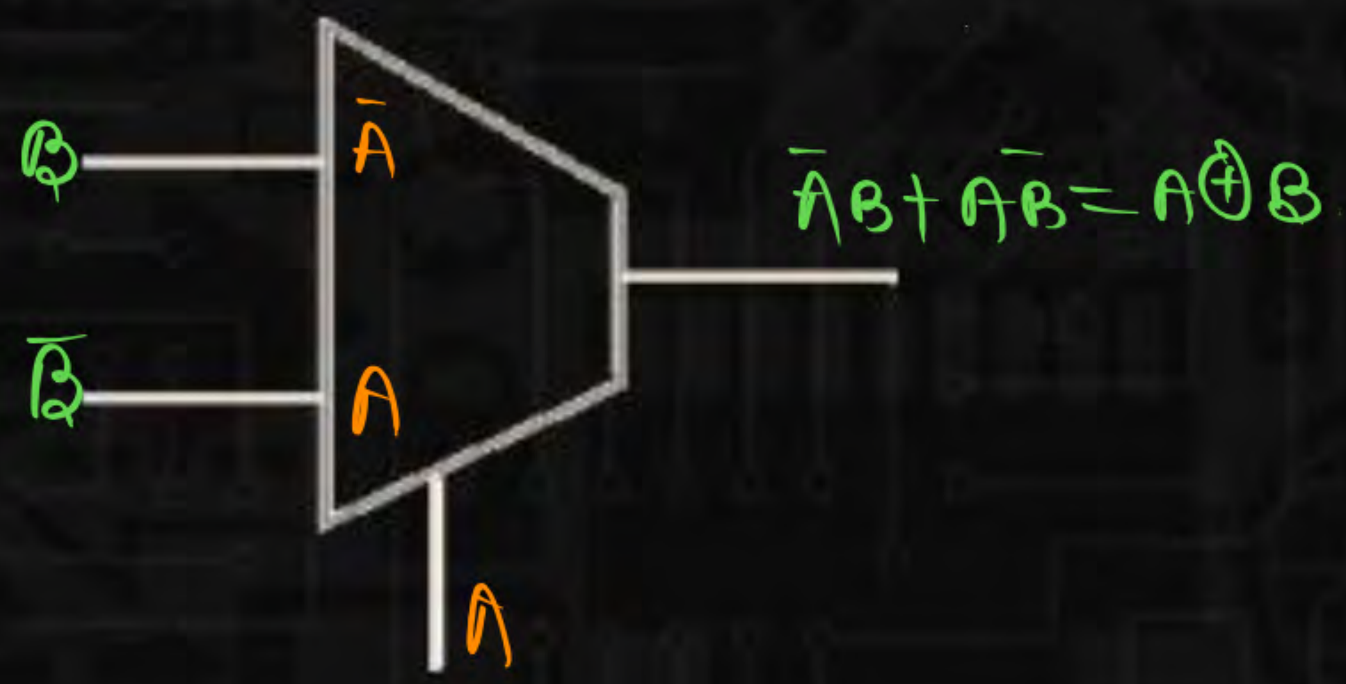
$\bar{A}\cdot\bar{B} + A\cdot 0$

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

$\overline{A+B}$

MULTIPLEXER

6. X-OR GATE



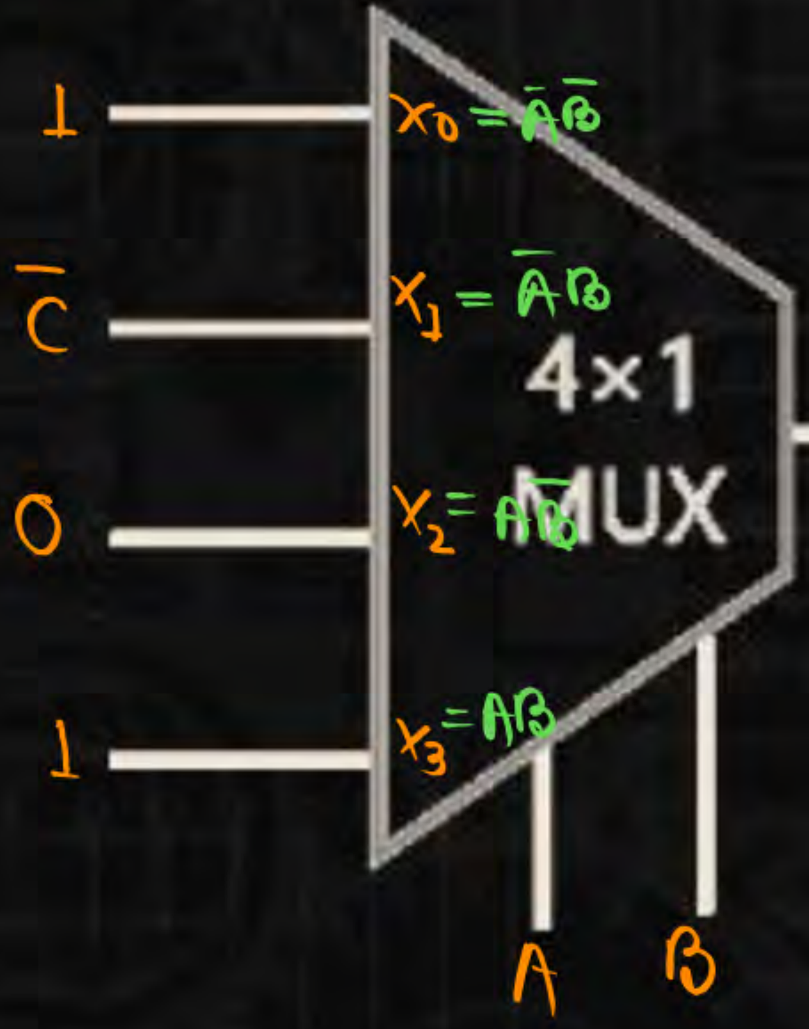
7. X-NOR GATE

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

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

Type 3- Minimization

Q. Find the output f.



$A \backslash BC$	$\bar{B}\bar{C}$ 00	$\bar{B}C$ 01	BC 11	$B\bar{C}$ 10
$\bar{A}$ 0	1 (0)	1 (1)	(3)	1 (2)
A 1	(4)	(5)	1 (7)	1 (6)

$$f = \bar{A}\cdot\bar{B}\cdot 1 + \bar{A}B\bar{C} + A\bar{B}\cdot 0 + A\cdot B\cdot 1$$

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

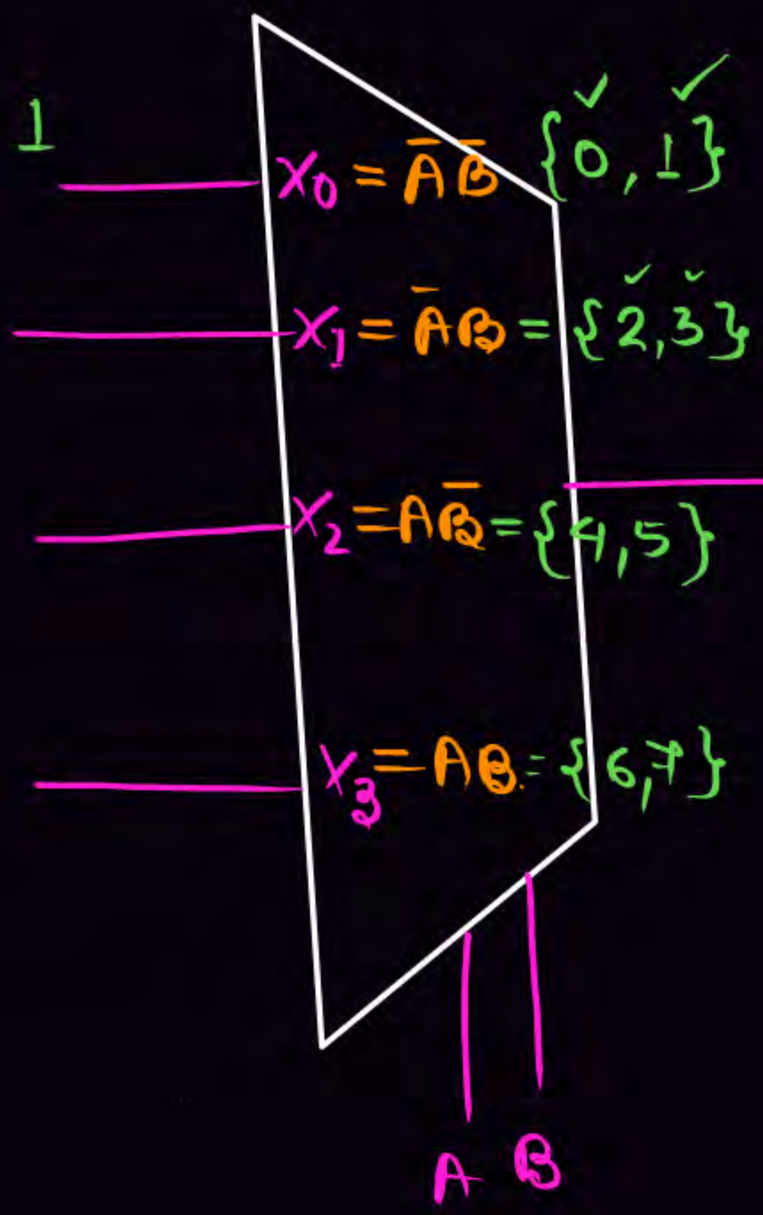
$$f = \bar{A}\bar{B}(\bar{C}+C) + \bar{A}B\bar{C} + AB(\bar{C}+C)$$

$$f = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C} + AB\bar{C} + ABC$$

$$= \Sigma m(0,1,2,6,7)$$

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

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



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

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

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

$$= \Sigma m(0,1$$

$\bar{A}\bar{B}\bar{C} \rightarrow 0$

$\bar{A}\bar{B}C \rightarrow 1$

$\bar{A}B\bar{C} \rightarrow 2$ ✓

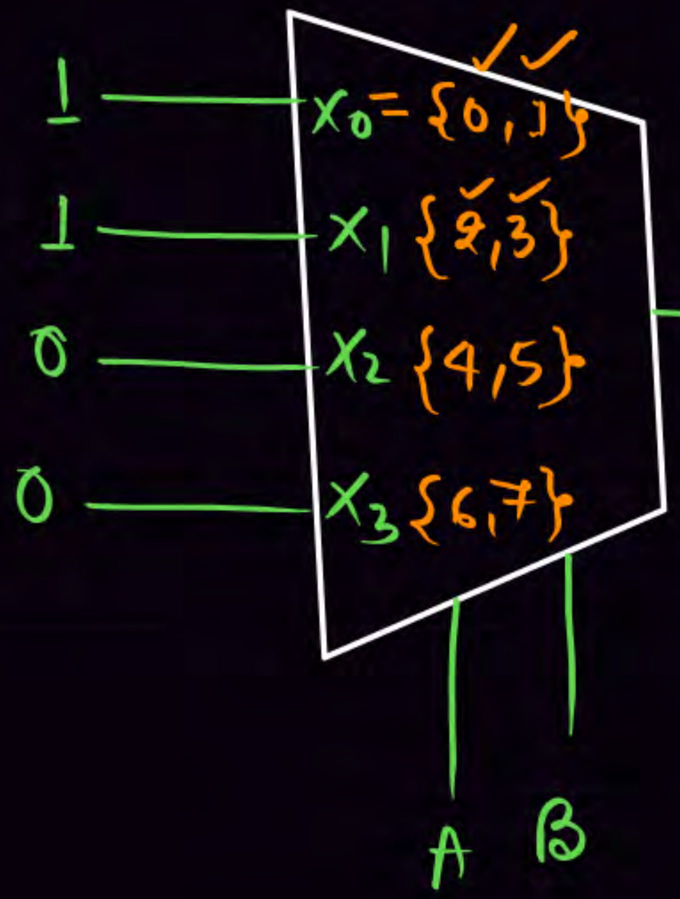
$\bar{A}BC \rightarrow 3$ ✓

$A\bar{B}\bar{C} \rightarrow 4$

$A\bar{B}C \rightarrow 5$

$AB\bar{C} \rightarrow 6$

$ABC \rightarrow 7$

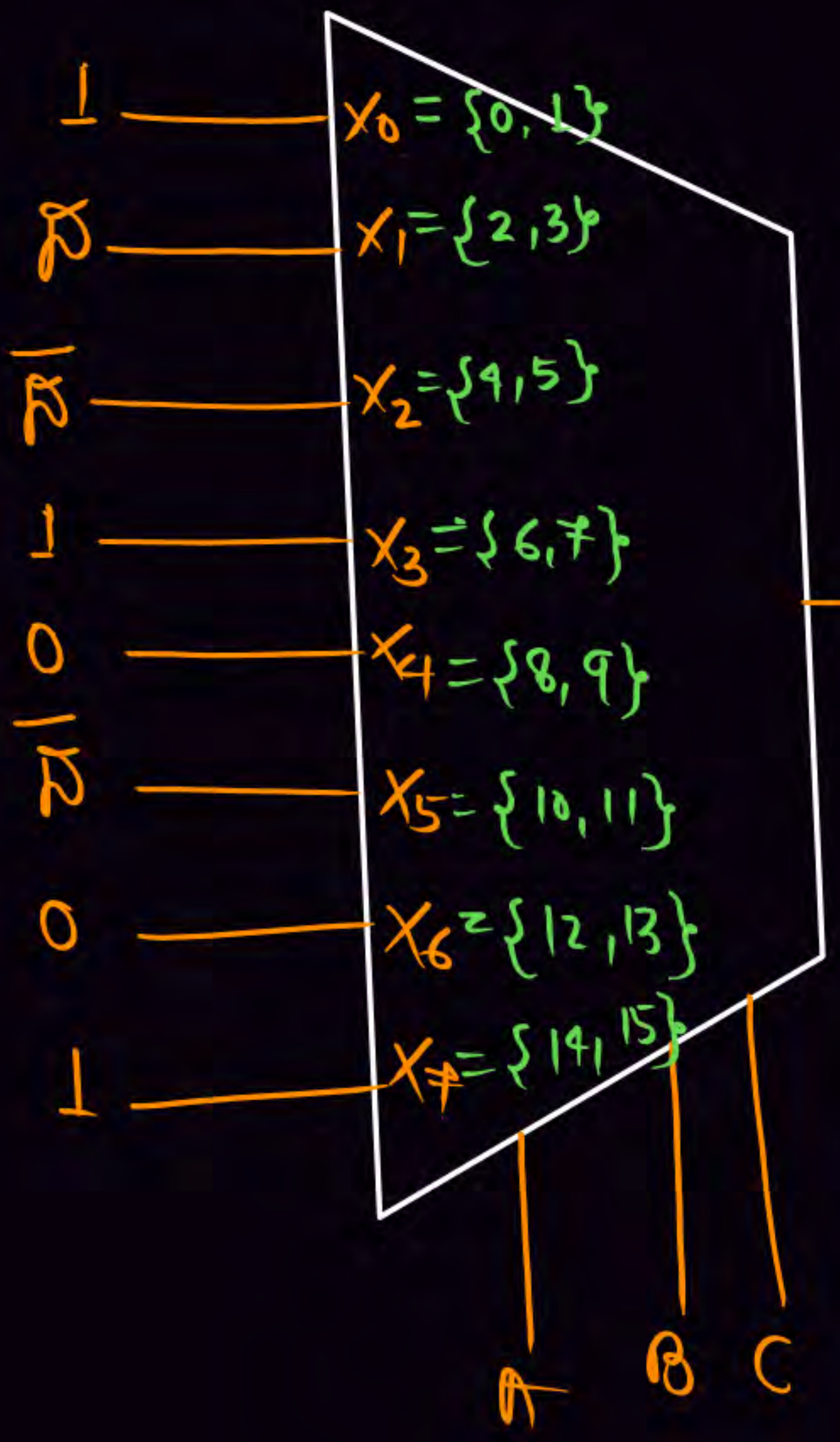


$$f(A,B,C) = \Sigma m(0,1,2,3)$$

A \ BC

$\bar{A}$	1	1	1	1
A				

$\underline{\text{Ans}} = \bar{A}$



$$f(A, B, C, D) = \Sigma m(0, 1, 3, 4, 6, 7, 10, 14, 15)$$

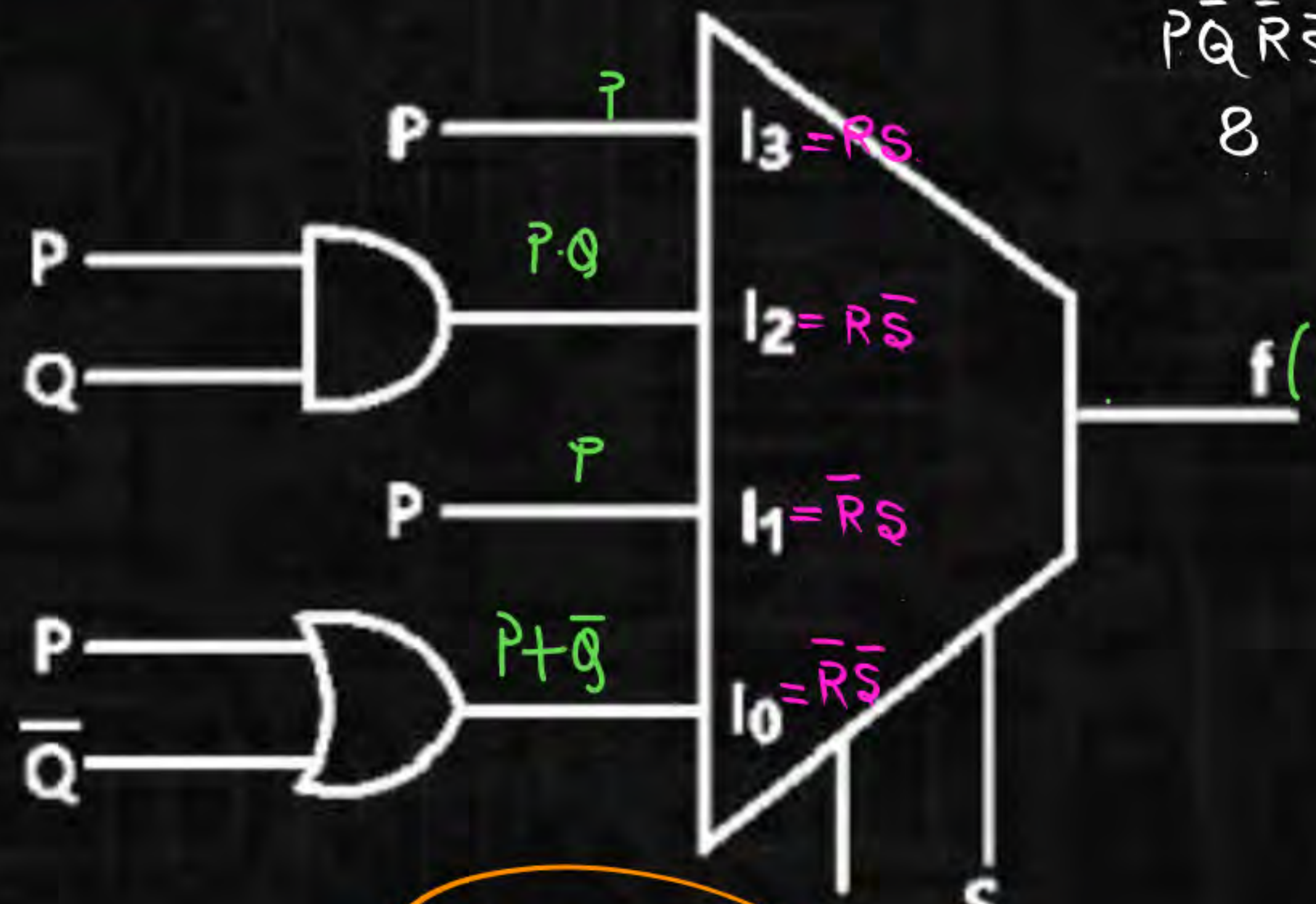
AB \ CD	00	01	11	10
00	1	1	1	
01			1	1
11			1	1
10				1

$BC + \bar{A}\bar{C}\bar{D} + \bar{A}\bar{B}D$
$+ AC\bar{D}$

MULTIPLEXER

PYQ

Q. Find the output f.



$PQ + PS + \bar{Q}\bar{R}\bar{S} \rightarrow$ Ans

$$f(P,Q,R,S) = (P+\bar{Q})\bar{R}\bar{S} + P\cdot\bar{R}S + PQR\bar{S} + PRS.$$

$$= P\bar{R}\bar{S} + \bar{Q}\bar{R}\bar{S} + P\bar{R}S + PQR\bar{S} + PRS$$

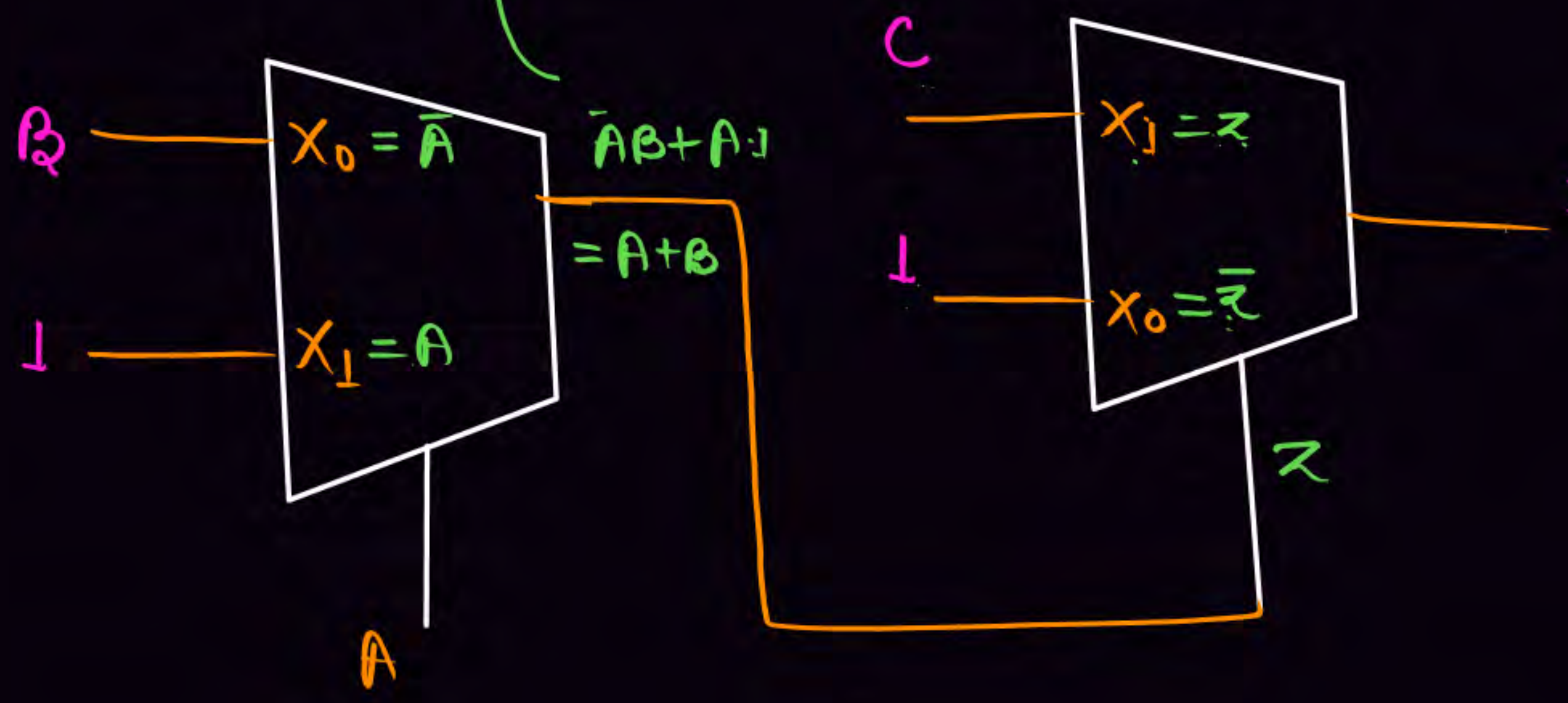
$P\bar{Q}\bar{R}\bar{S}$ 8, $PQ\bar{R}\bar{S}$ 12, $\bar{P}\bar{Q}\bar{R}\bar{S}$ 0, $P\bar{Q}\bar{R}\bar{S}$ 8, $P\bar{Q}\bar{R}S$ 9, $PQ\bar{R}S$ 13, $PQR\bar{S}$ 14, $P\bar{Q}RS$ 11, $PQRS$ 15

$$f(P,Q,R,S) = \Sigma m(0,8,9,11,12,13,14,15)$$

PQ \ RS	00	01	11	10
00	1			
01				
11	1	1	1	1
10	1	1	1	

Type-4 cascading

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



$$Z = A+B \qquad \bar{Z} = \overline{A+B}$$

$$f(A,B,C) = ?$$

$$= C\cdot Z + \bar{Z} = (\bar{Z}+C)(\bar{Z}+Z)$$

$$= \bar{Z} + C$$

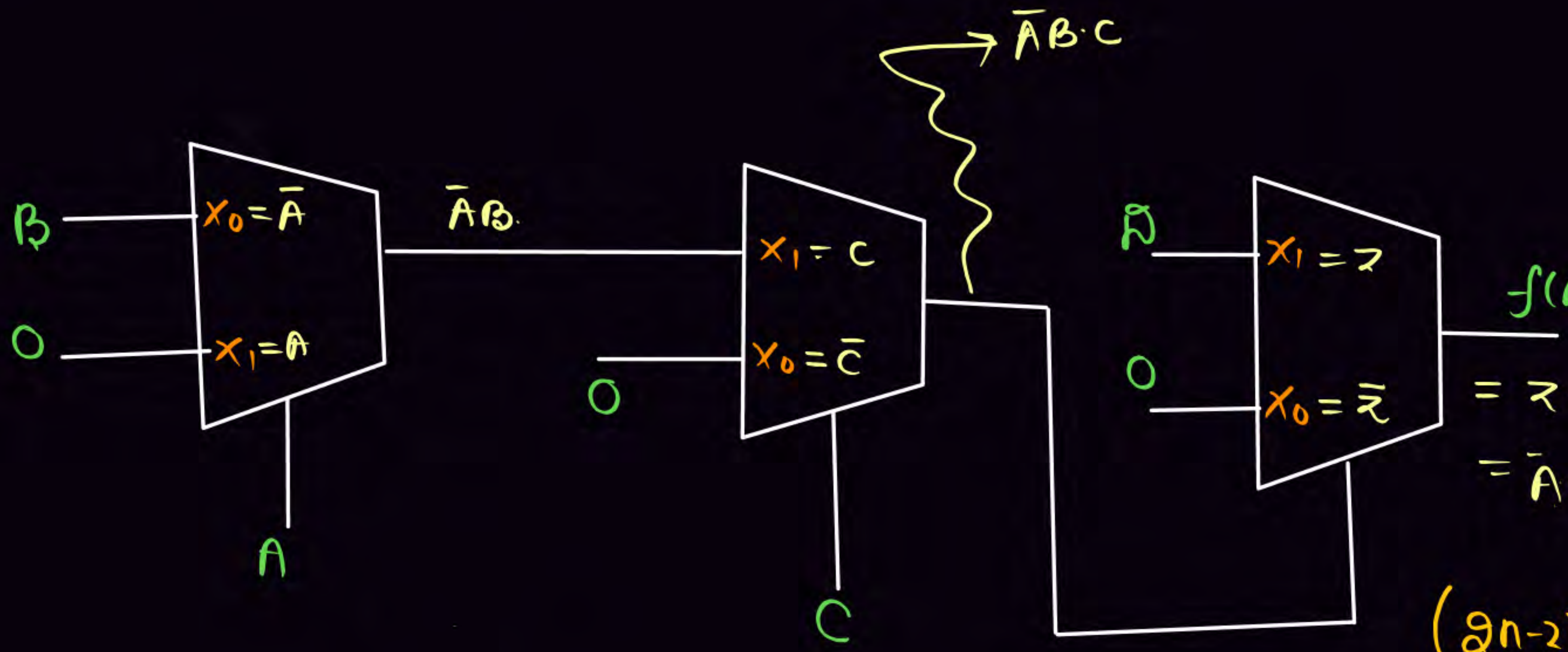
$$= \overline{A+B} + C$$

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

Ans

$$A+B = Z$$

Ex.



$$f(A,B,C,D) = Z \cdot \bar{D} = \bar{A}BC\bar{D}$$

$$\bar{A}BC = Z$$

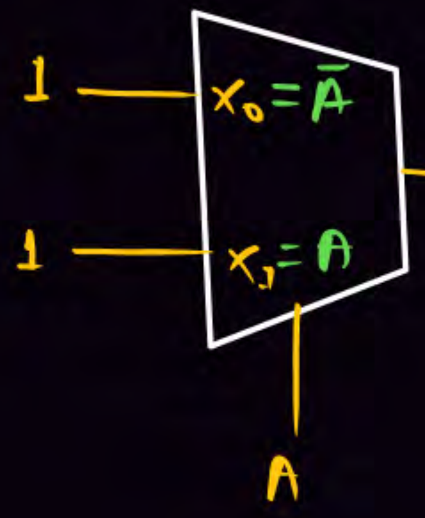
$$(2n-2)+K$$

$$(2\times 4-2)+1$$

$$8-2+1$$

7 Ans

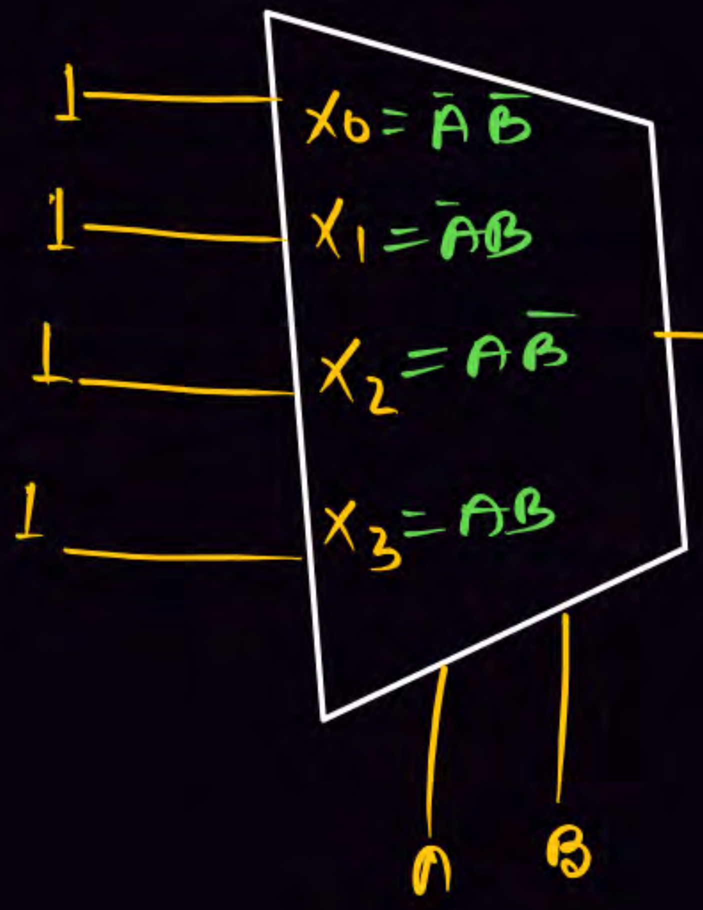
Q



$f = \bar{A} + A$

$= 1$

Q



$f(A, B)$

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

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

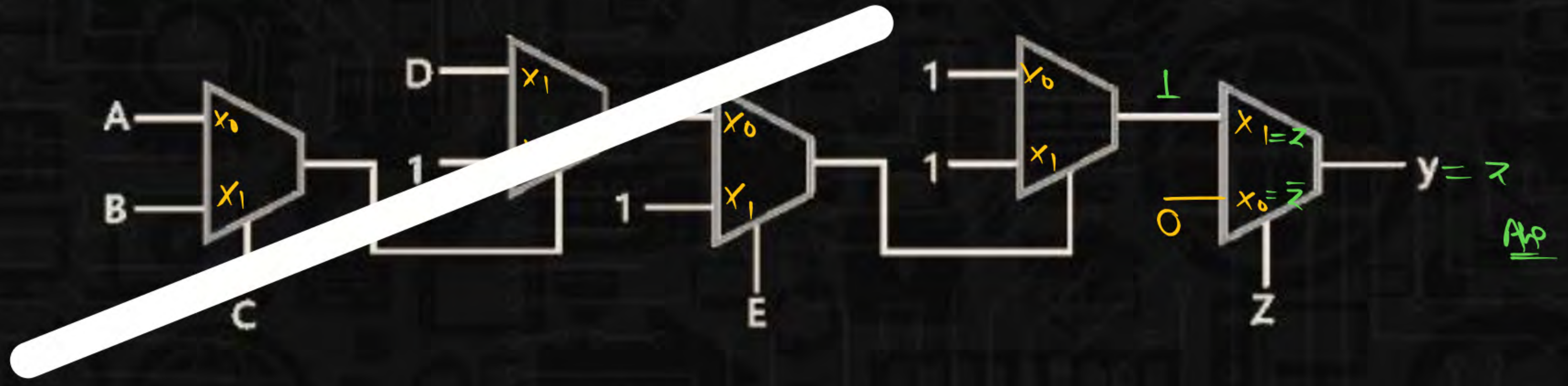
$= \bar{A} + A$

$= 1$

Ans

Type 4- Cascading

Q Find the output f.



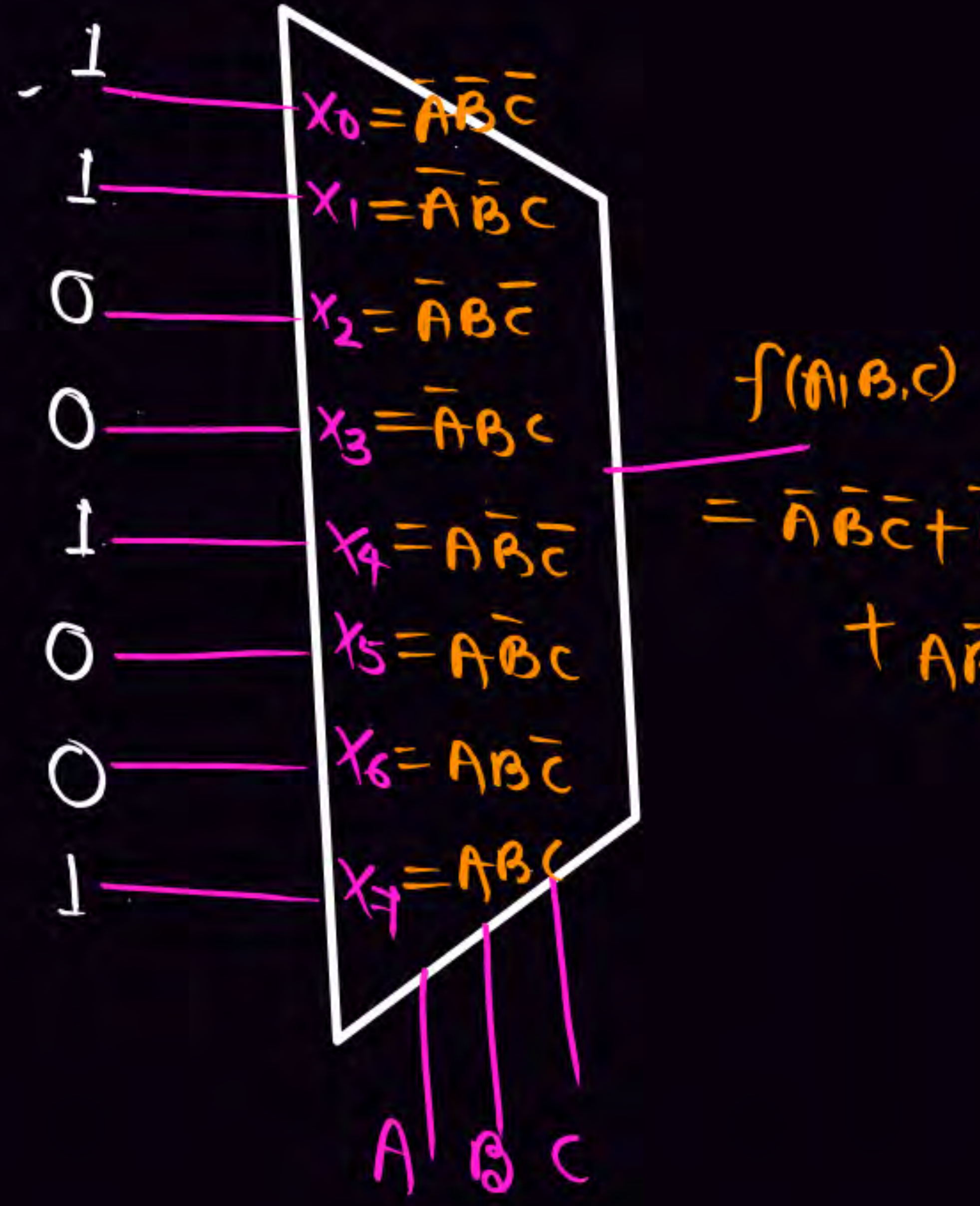
Type 5 :→ Implementation of function.

8X1 MUX

Ex. $f(A,B,C) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + ABC$

$= \Sigma m(0,1,4,7)$

case(1) By 8X1 MUX.



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


THANK YOU GW SOLDIERS !