CS & IT ENGINEERING

DIGITAL LOGIC

Combinational Circuit

Lecture No. 2

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01 MULTIPLEXER

02 QUESTION PRACTICE

03 DISCUSSION

✓ One bit comparator

- ✓ $X\,(A>B) = A\bar{B}$
- ✓ $Y\,(A<B) = \bar{A}B$

$Z\,(A=B) = A \odot B$

COMPARATOR

Q. Design a two-Bit comparator?

Step 1.

COMPARATOR

Step 2. Truth table

A_1	A_0	B_1	B_0	x	y
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		

COMPARATOR

Step 4. Minimization

$X(A>B) = A_1\bar{B}_1 + A_0\bar{B}_1\bar{B}_0 + A_1A_0\bar{B}_0$

For X

$$X = A_1\bar{B}_1 + [A_1 + \bar{B}_1]\,A_0\bar{B}_0$$ ✓

→ minimized Expression

$X(A>B) = A_1\bar{B}_1 + \bar{A}_1A_0\bar{B}_1\bar{B}_0 + A_1A_0B_1\bar{B}_0$

$= A_1\bar{B}_1 + [\bar{A}_1\bar{B}_1 + A_1B_1]\,A_0\bar{B}_0$

$$X = A_1\bar{B}_1 + (A_1 \odot B_1)\cdot A_0\bar{B}_0$$

→ semiminimized Expression.

$Y(A<B) = \bar{A}_1B_1 + \bar{A}_1\bar{A}_0B_0 + \bar{A}_0B_1B_0$

$$Y = \bar{A}_1B_1 + [\bar{A}_1 + B_1]\,\bar{A}_0B_0$$ ✓

For Y

$Y = \bar{A}_1B_1 + \bar{A}_1\bar{A}_0\bar{B}_1B_0 + A_1\bar{A}_0B_1B_0$

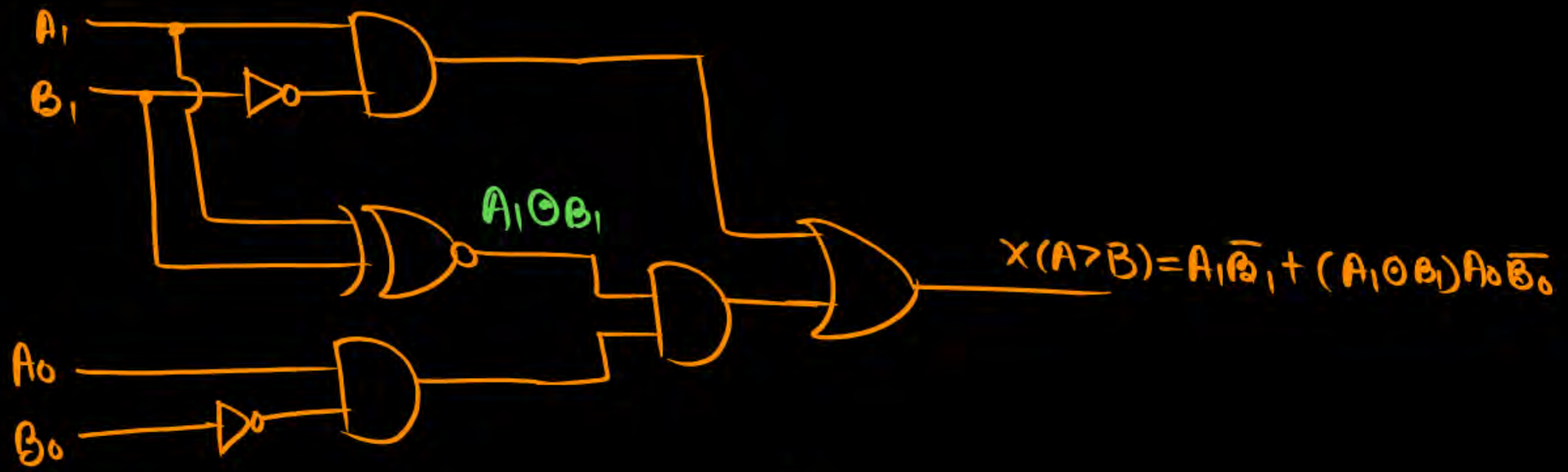
$$Y = \bar{A}_1B_1 + [A_1 \odot B_1]\cdot\bar{A}_0B_0$$

COMPARATOR

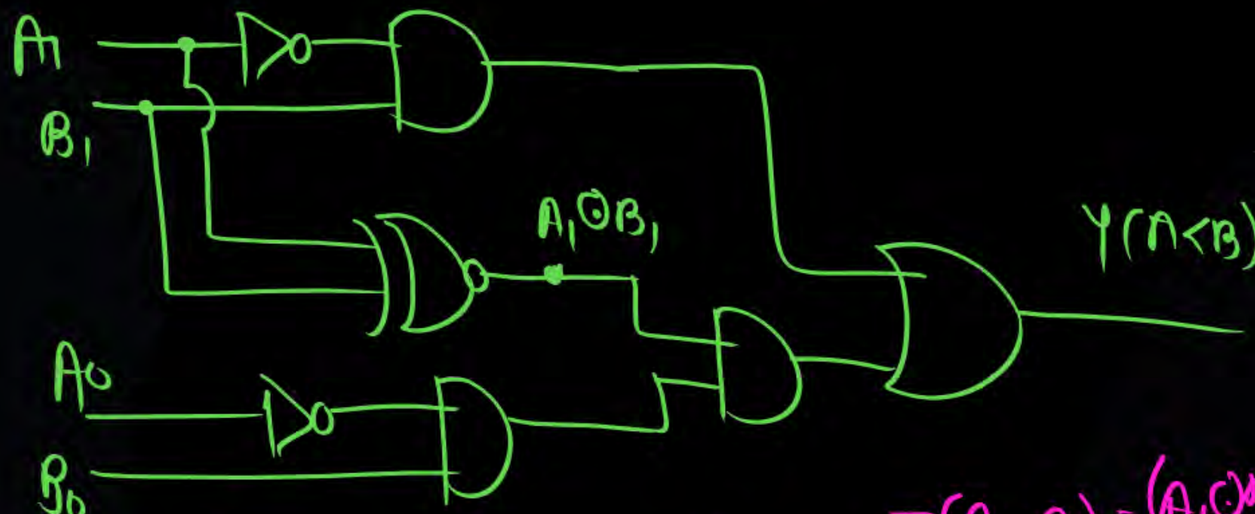
Step 4. Minimization

For Z = $(A_1 \odot B_1) \cdot (A_0 \odot B_0)$

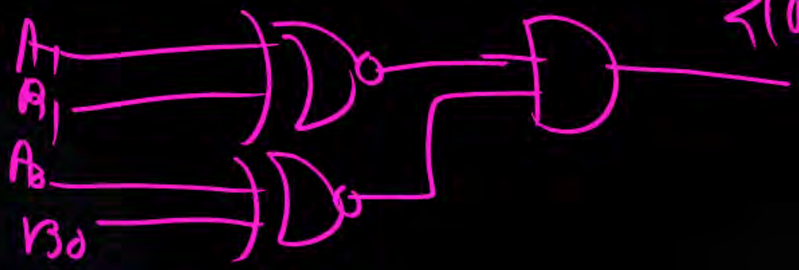
Step5 :→



$X(A>B) = A_1\bar{B}_1 + (A_1 \odot B_1)A_0\bar{B}_0$

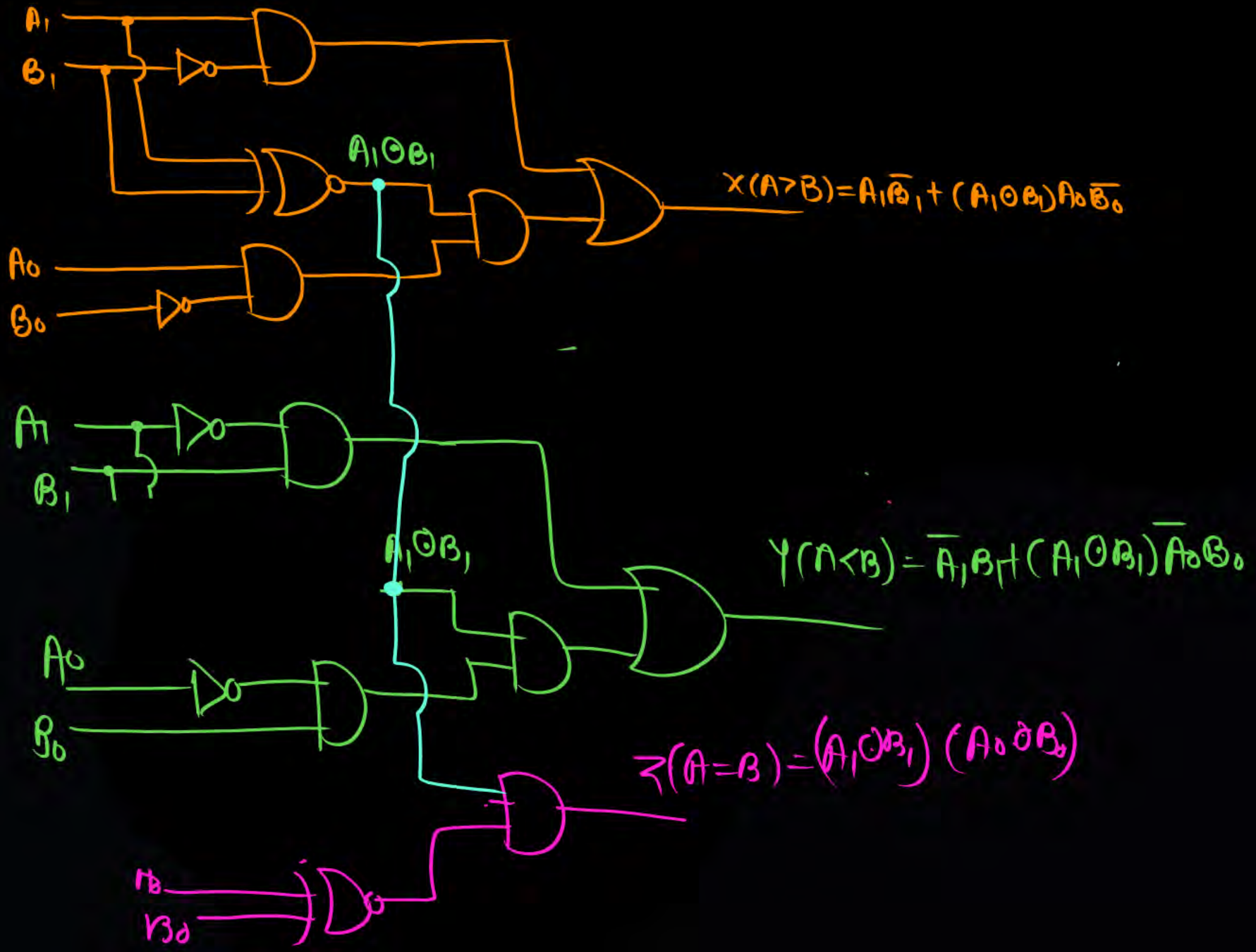


$Y(A<B) = \bar{A}_1B_1 + (A_1 \odot B_1)\bar{A}_0B_0$



$Z(A=B) = (A_1 \odot B_1)(A_0 \odot B_0)$

Step5 :→


A1
B1
A1⊙B1
A0
B0
X(A>B)=A1B̄1+(A1⊙B1)A0B̄0
A1
B1
A1⊙B1
Y(A<B)=Ā1B1+(A1⊙B1)Ā0B0
A0
B0
Z(A=B)=(A1⊙B1)(A0⊙B0)

COMPARATOR

FOR ONE BIT COMPARATOR

Total condition = 4

Equal condition = 2

Unequal condition = 2

Greater = Less condition = 1

COMPARATOR

FOR TWO BIT COMPARATOR

Total condition = 16

Equal condition = 4

Unequal condition = 12

Greater = Less condition = 6

COMPARATOR

FOR THREE BIT COMPARATOR

Total condition = 64

Equal condition = 8

Unequal condition = 56

Greater = Less condition = 28

COMPARATOR

'n' BIT COMPARATOR

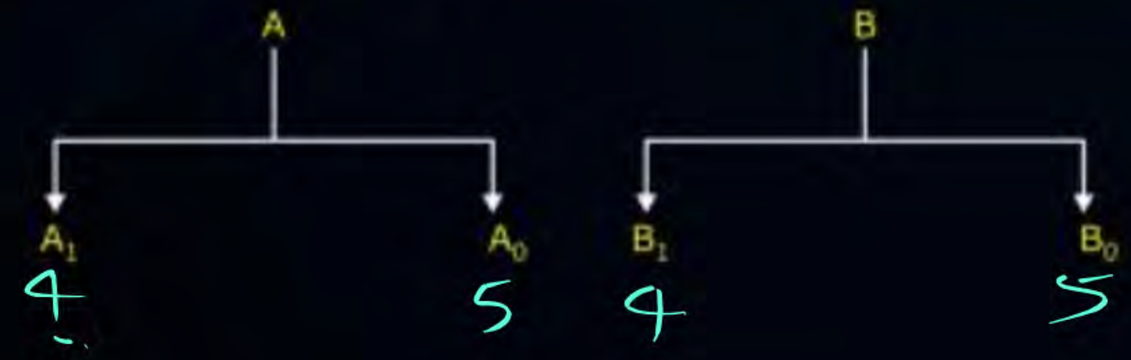
Total condition = 2^{2n}

Equal condition = 2^n ✓

Unequal condition = $2^{2n} - 2^n$

Greater = Less condition = $(2^{2n} - 2^n)/2$

SHORT TRICK TO USE SEMI MINIMIZED EXPRESSION



$$X(A>B) = A_1\bar{B}_1 + (A_1 \odot B_1)A_0\bar{B}_0$$

$$Y(A<B) = \bar{A}_1 B_1 + (A_1 \odot B_1)\bar{A}_0 B_0$$

$$Z(A=B) = (A_1 \odot B_1)\cdot(A_0 \odot B_0)$$

"3 bit comparator"

✓ $X(A>B) = A_2\bar{B}_2 + (A_2 \odot B_2)A_1\bar{B}_1 + (A_2 \odot B_2)\cdot(A_1 \odot B_1)A_0\bar{B}_0$

✓ $Y(A<B) = \bar{A}_2B_2 + (A_2 \odot B_2)\bar{A}_1B_1 + (A_2 \odot B_2)\cdot(A_1 \odot B_1)\bar{A}_0B_0$

✓ $Z(A=B) = (A_2 \odot B_2)(A_1 \odot B_1)(A_0 \odot B_0)$

Multiplexer

FM → Frequency Modulation

Shreya

94.3 My FM

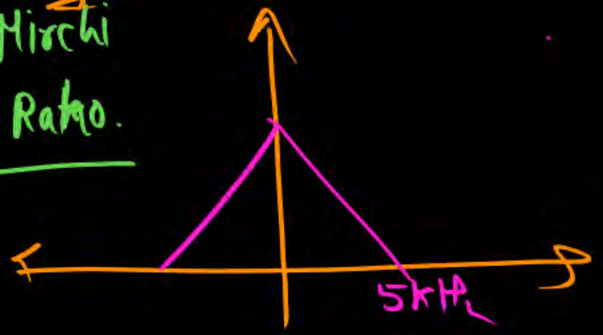
Jio Sil se.

Voice → 300Hz – 3.5KHz

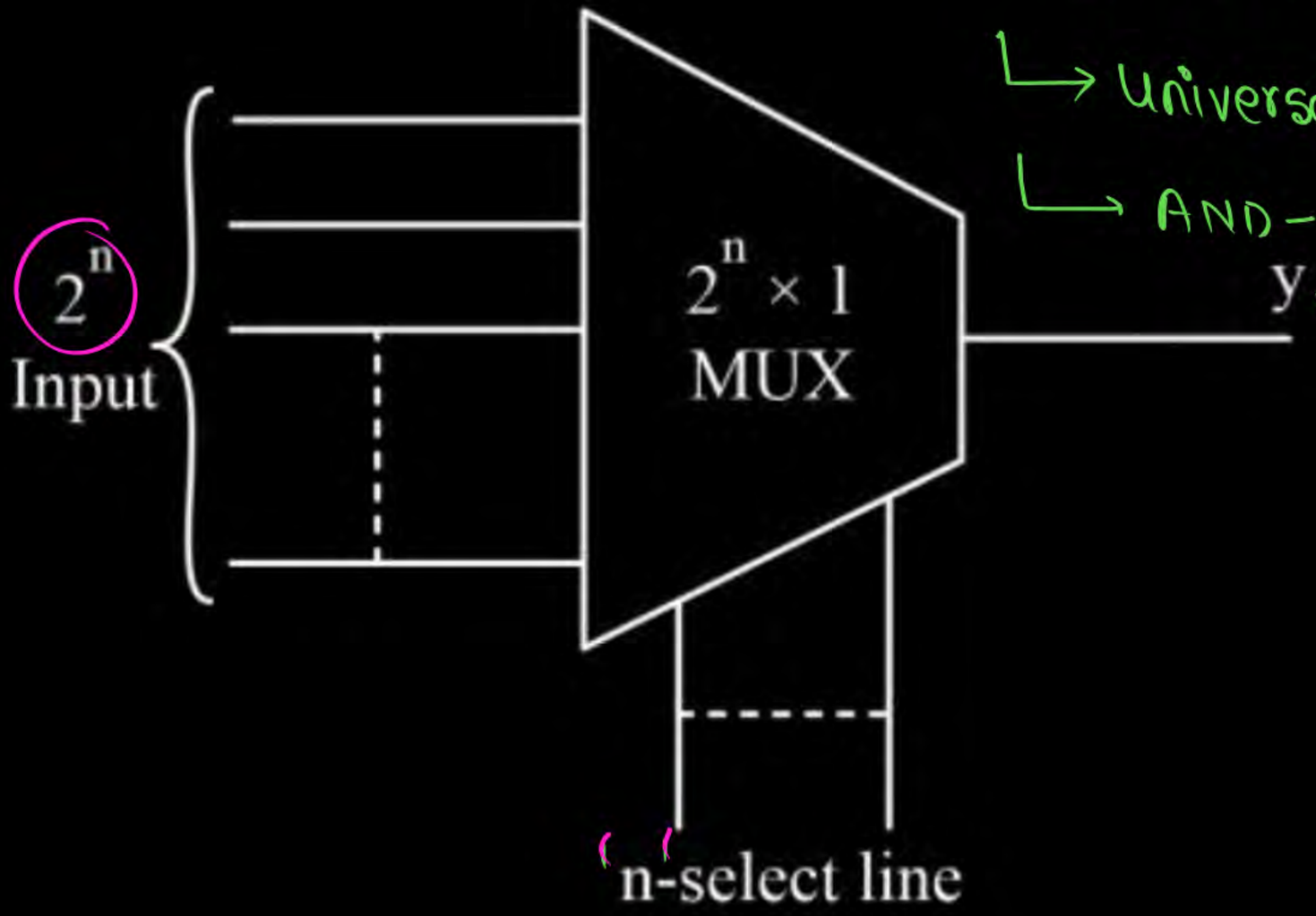
Arjeet

MHz 98.7 Radio Mirchi

bajate Raho.



MULTIPLEXER



↳ 2^n to One converter

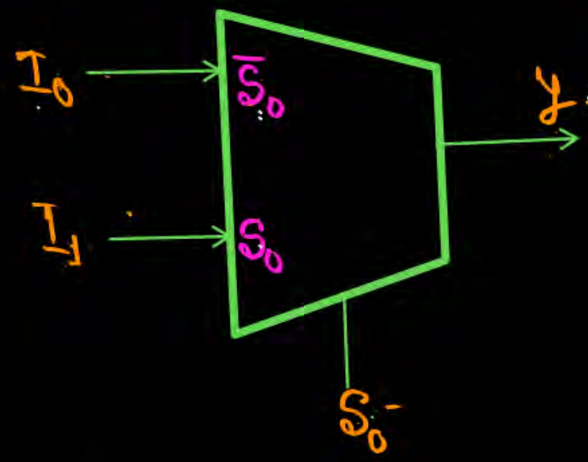
↳ Universal Logic

↳ AND-OR Logic

Multiplexer

Design a 2 × 1 MUX

Step 1 :→



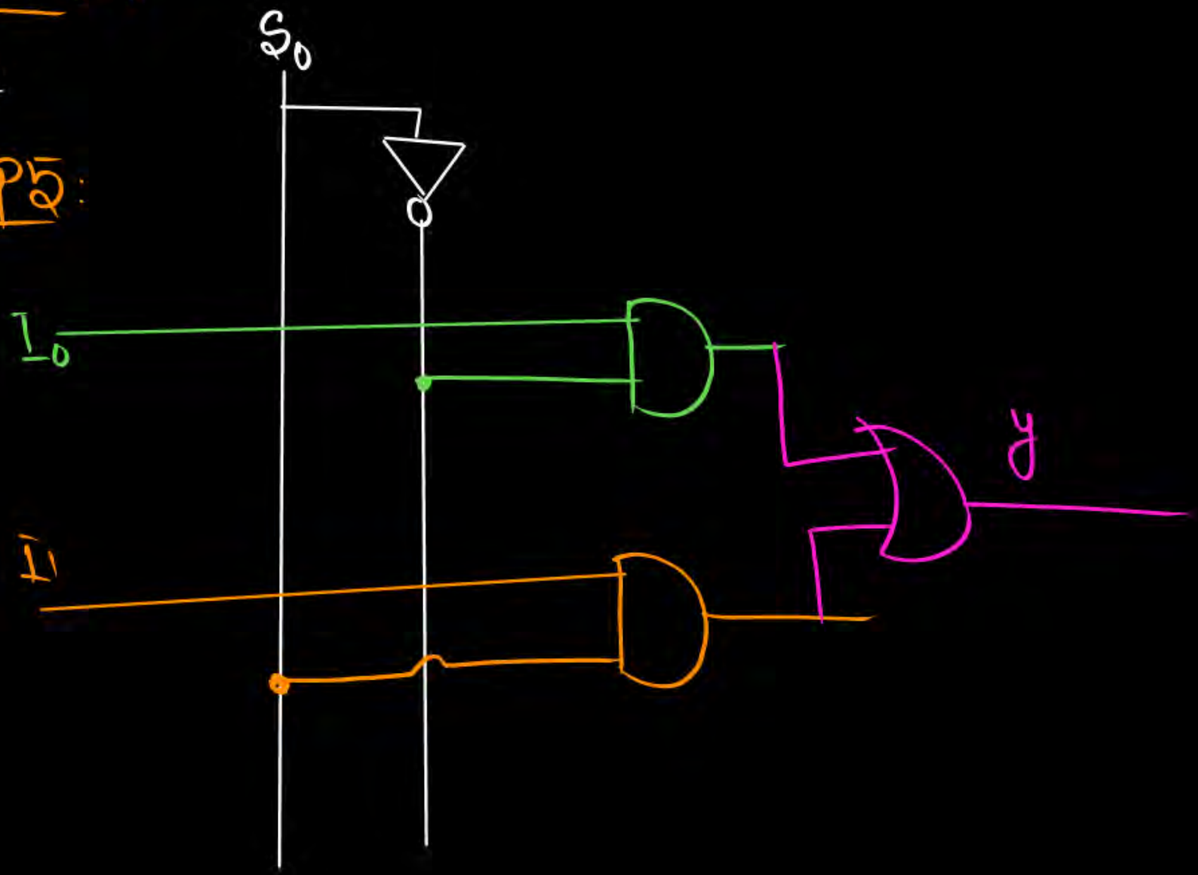
Step 2 :

S_0	y
0	I_0
1	I_1

Step 3 :→ $y = \bar{S}_0 I_0 + S_0 I_1$

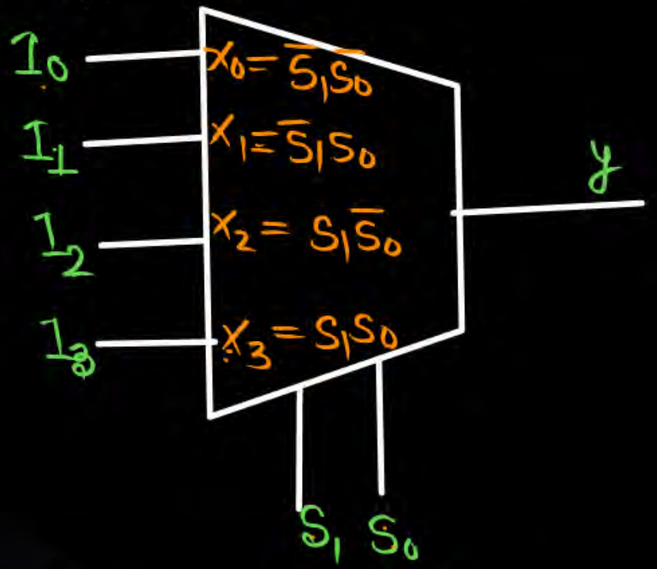
Step 4 :→

Step 5 :



Question → Design a 4×1 MUX ?

Step 1 :→



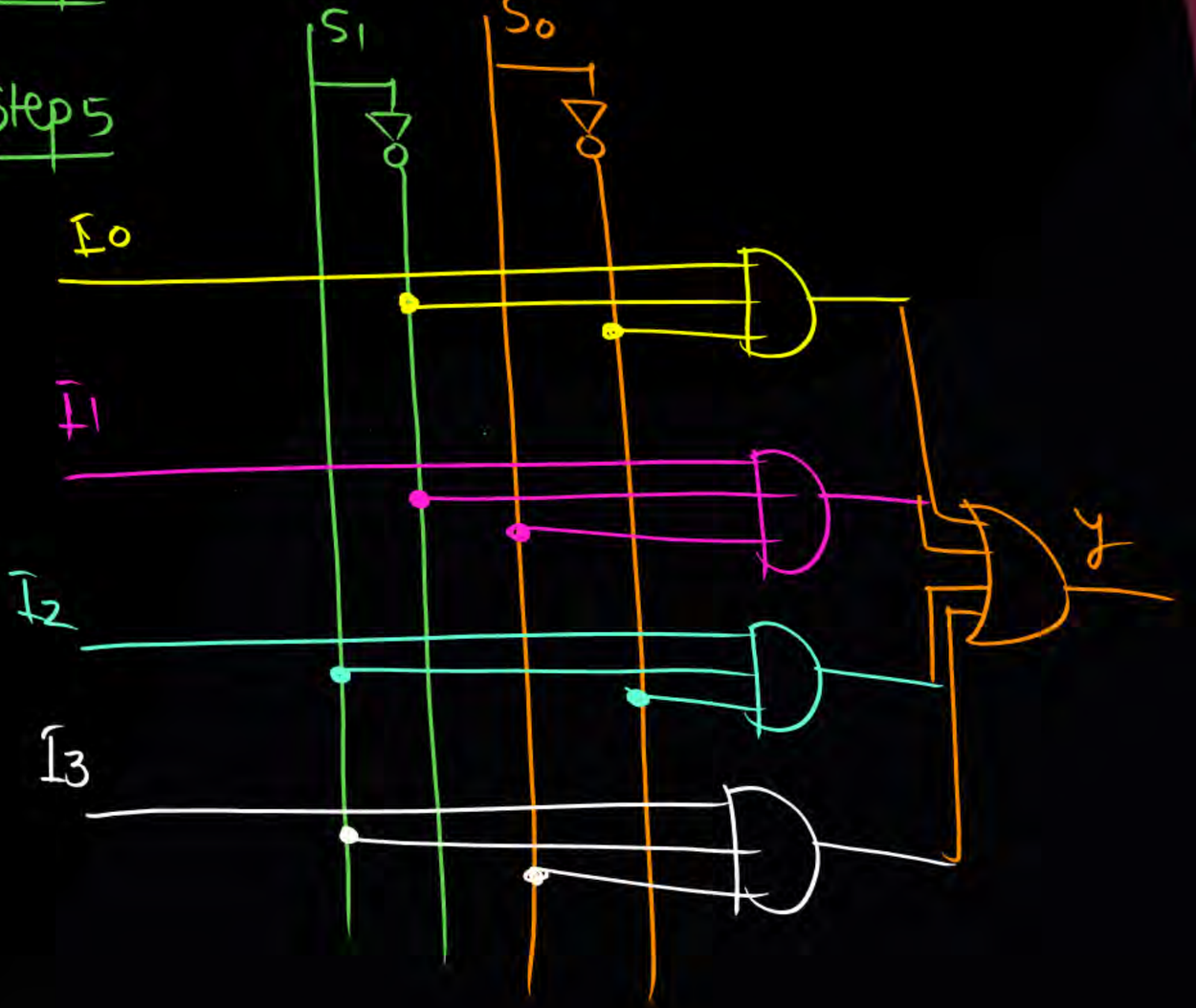
Step 2.

S_1	S_0	y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

Step 3 :→ $y = \bar{S}_1\bar{S}_0 I_0 + \bar{S}_1 S_0 I_1 + S_1\bar{S}_0 I_2 + S_1 S_0 I_3$

Step 4 :

Step 5

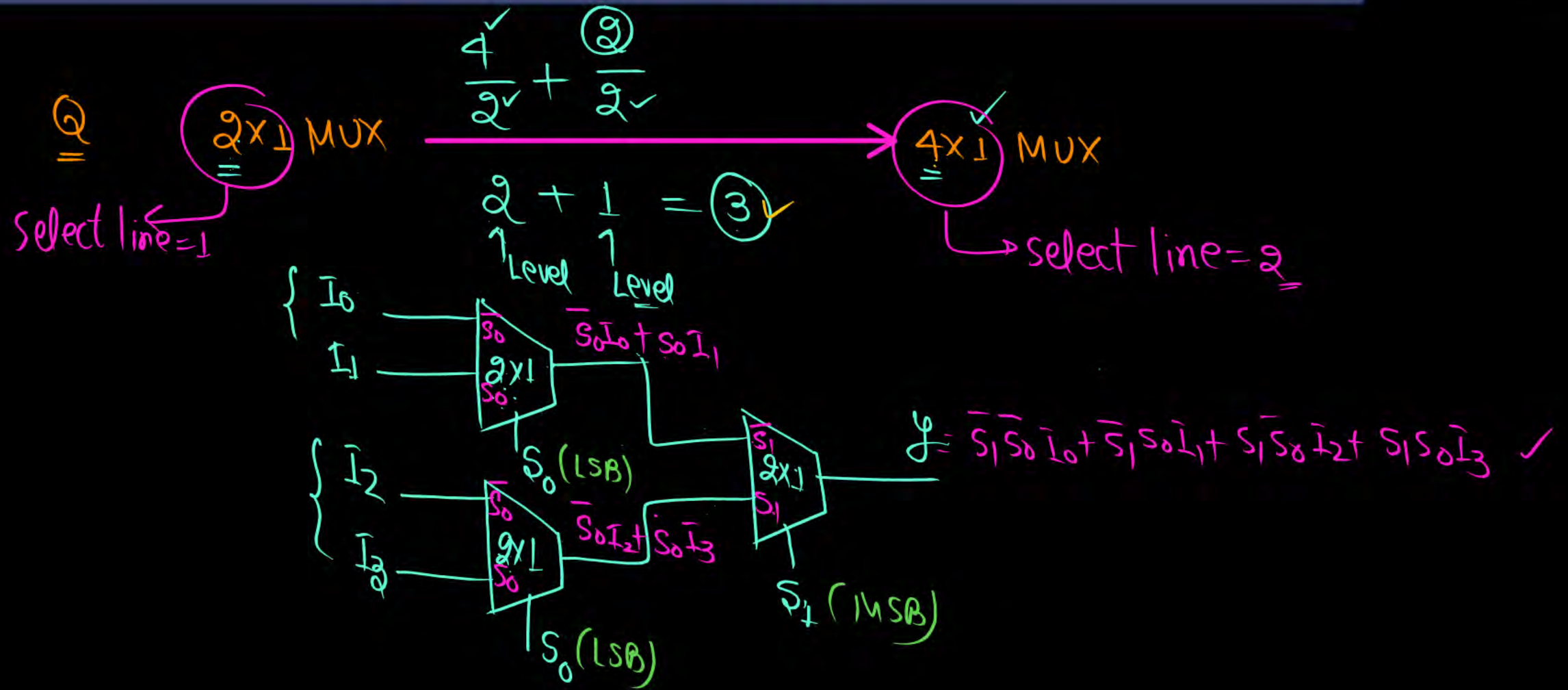


HW

Q. Design a 8×1 MUX

Q Design a 16×1 MUX.

Type 1. Designing of Higher order Mux By using Lower Order Mux



Q 2x1 MUX $\xrightarrow{\frac{8}{2}+\frac{4}{2}+\frac{2}{2}}$ 8x1 MUX

$4+2+1=7$

Ans

Q 2x1 MUX $\xrightarrow{\frac{64}{2}+\frac{32}{2}+\frac{16}{2}+\frac{8}{2}+\frac{4}{2}+\frac{2}{2}}$ 64x1 MUX

$32+16+8+4+2+1=63$

Q 2x1 MUX $\xrightarrow{255}$ 256x1 MUX

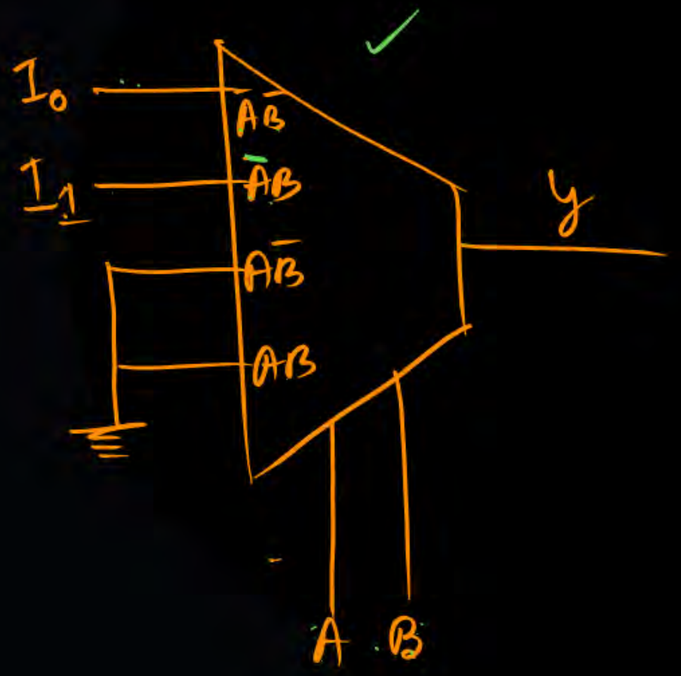
Q 2x1 MUX $\xrightarrow{2^n-1}$ 2^nx1 MUX

Q 4×1 MUX $\xrightarrow{\frac{16}{4}+\frac{4}{4}}$ 16×1 MUX

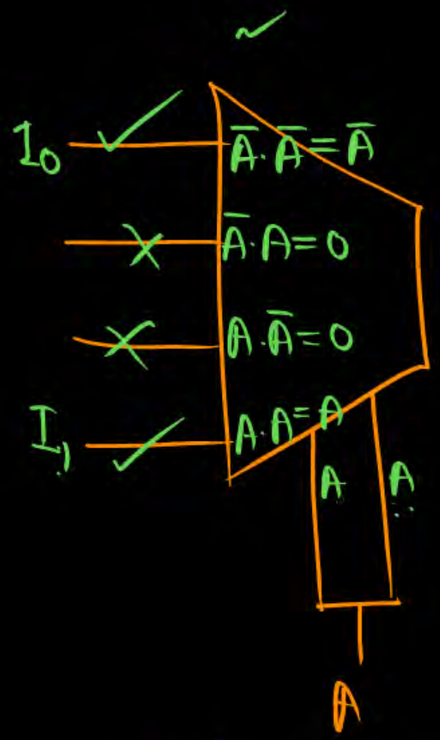
$4+1=5$ Ans

Q 4×1 MUX $\xrightarrow{\frac{64}{4}+\frac{16}{4}+\frac{4}{4}}$ 64×1 MUX

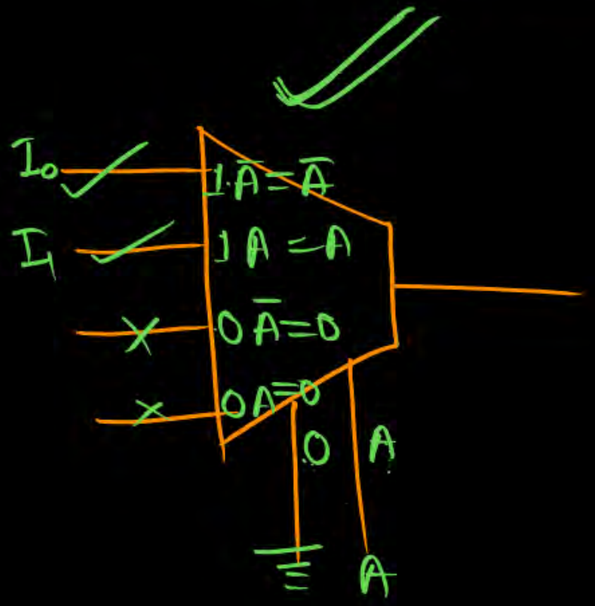
$16+4+1=21$



Select line = 2



Select Variable = 1



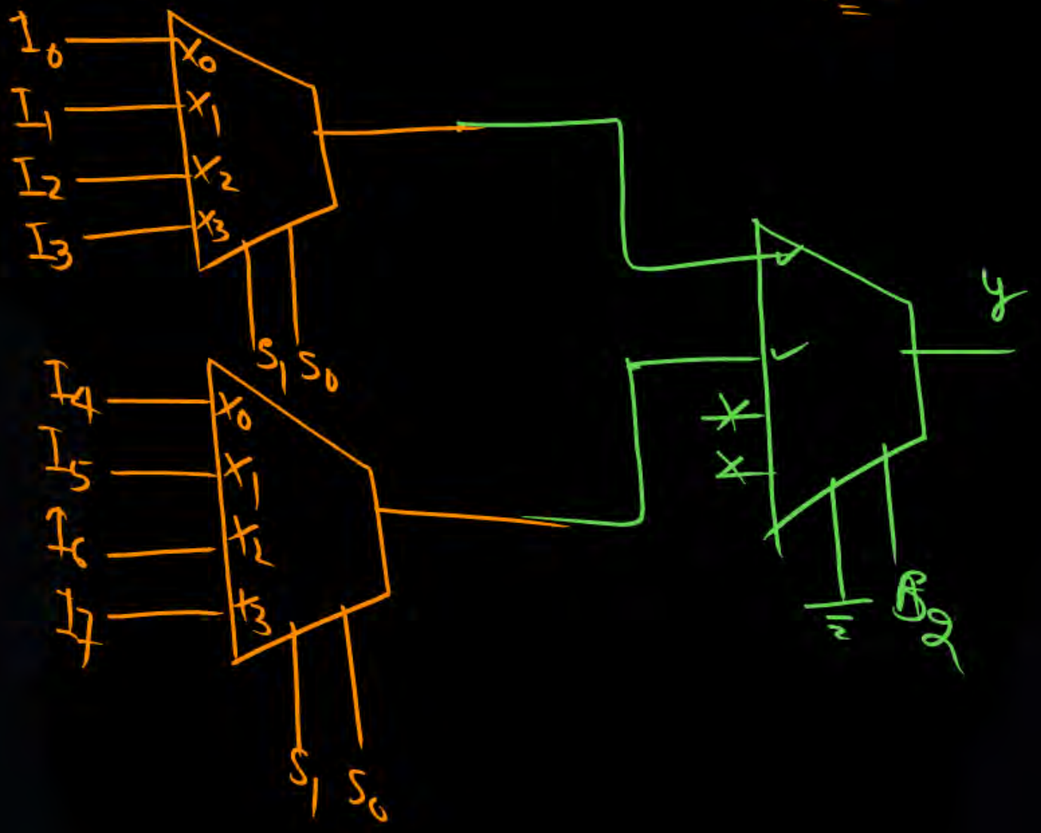
Select Variable = 1

Q = 4x1 MUX $\xrightarrow{\frac{8}{4} + \frac{2}{4}}$ 8x1 MUX.

$2 + 1 = 3$

Ans = 3

Select line = 3



MULTIPLEXER

Design 64 × 1 MUX using 8 × 1 MUX.

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

Ans

$4\times1\ MUX \xrightarrow[8+2+1=11]{\frac{32}{4}+\frac{8}{4}+\frac{2}{4}} 32\times1\ MUX$

16X1 MUX $\xrightarrow[16+1=17]{\frac{256}{16}+\frac{16}{16}}$ 256X1 MUX

Ans


THANK YOU GW
SOLDIERS !