COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 09

Combinational Circuit

By- Chandan Gupta Sir

Comparator CKt

MUX

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

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

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

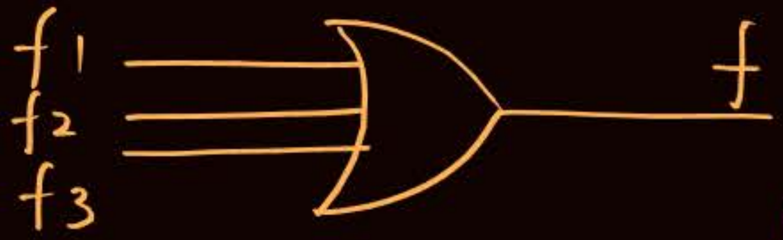
$$= \bar{A} + A$$

$$= 1$$

Q. $f_1(A,B,C) = \Sigma(2,6,7)$

$f_2(A,B,C) = \pi(4,5,6,7) = \Sigma(0,1,2,3)$

$f_3(A,B,C) = ?$



$f = (f_1 + f_2 + f_3) = \Sigma(0,1,2,3,4,5,6,7)$

If f is logic '1', then maximum number of possible maxterm in function f_3.

a. 8

b. 6

c. 2

d. 5

$f_4 = f_1 + f_2 = \Sigma(0,1,2,3,6,7)$

$f_3 = \underbrace{\Sigma(4,5)}_{\text{necessary}} + \underbrace{(0,1,2,3,6,7)}_{\text{any of them is optional}}$

$(f_3) = \Sigma(4,5)$ minimum SOP

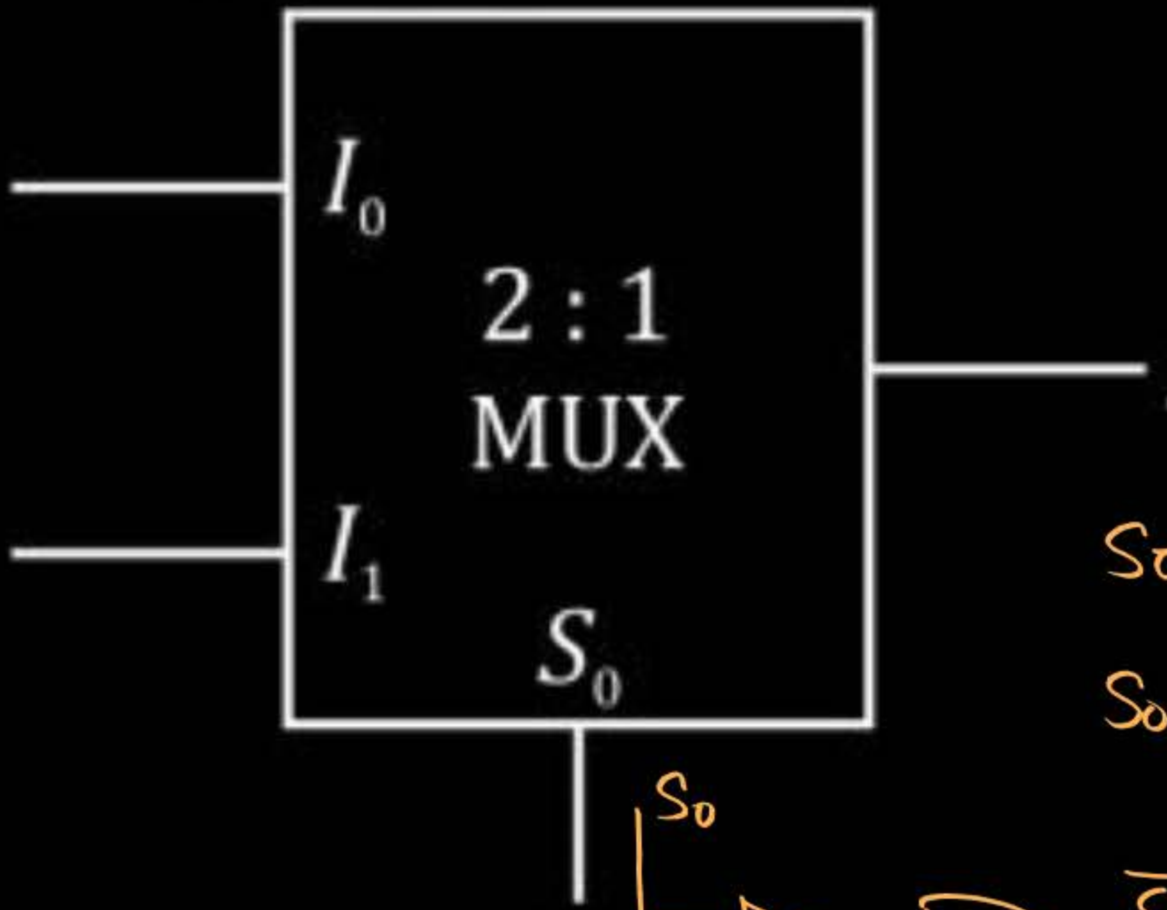
$f_3 = \pi(0,1,2,3,6,7) \rightarrow$ max^m maxterm

[MUX]

- What is MUX ?

It is a combinational ckt having many i/p lines and one output line & on the basis of select line one of the i/p line is transferred to the o/p line.

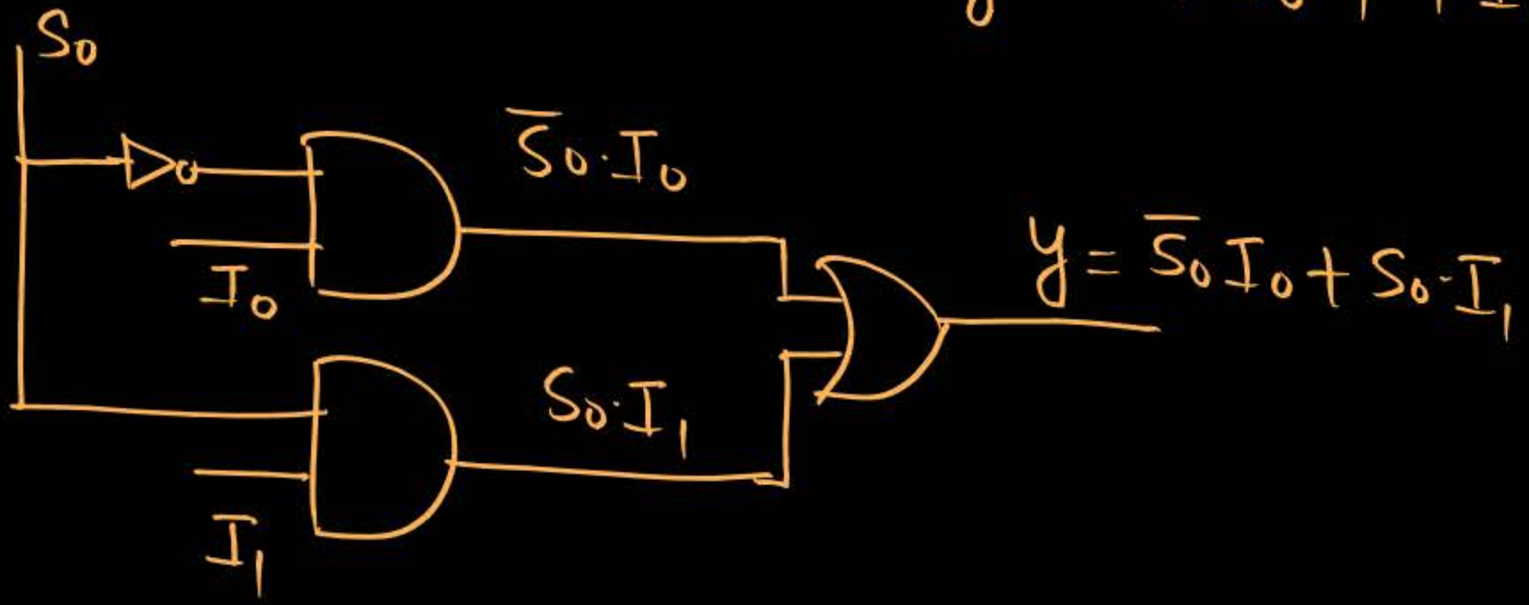
- 2 : 1 MUX



$$y = \overline{S_0}\cdot I_0 + S_0\cdot I_1$$

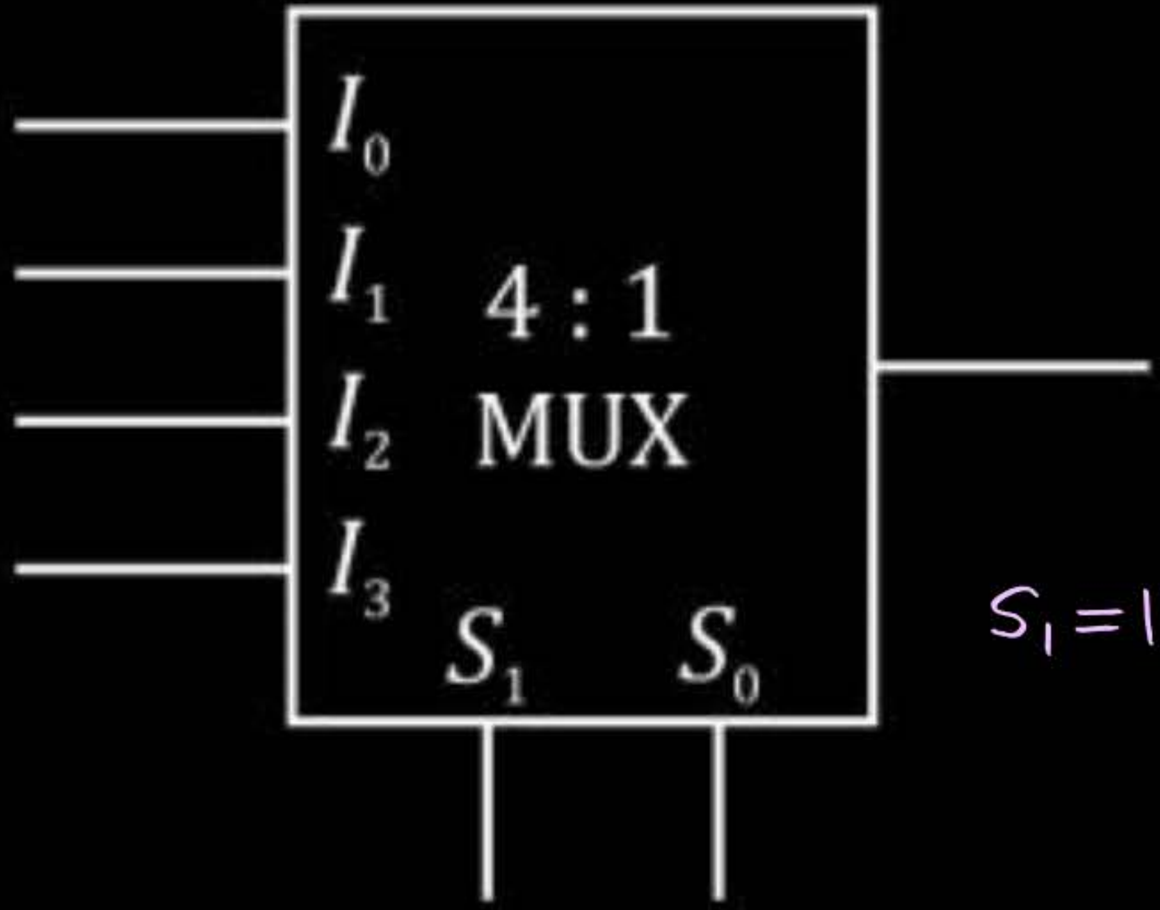
$$S_0 = 0 \Rightarrow y = 1\cdot I_0 + 0\cdot I_1 = I_0$$

$$S_0 = 1 \Rightarrow y = \overline{1}\cdot I_0 + 1\cdot I_1 = I_1$$



$N \longrightarrow 2^N$

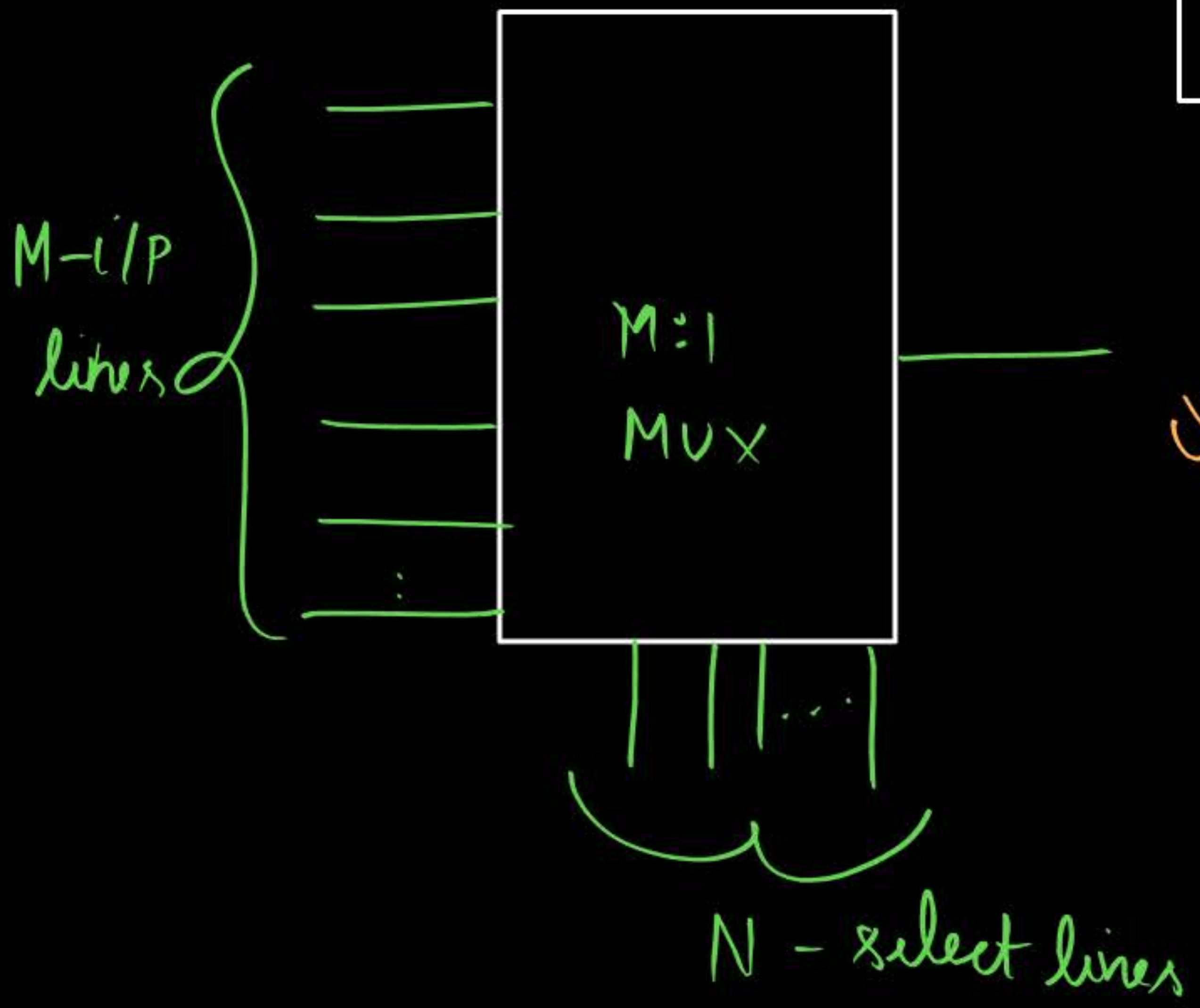
- 4 : 1 MUX



$$y = \bar{S}_1\bar{S}_0 \cdot I_0 + \bar{S}_1 S_0 \cdot I_1 + S_1\bar{S}_0 \cdot I_2 + S_1 S_0 \cdot I_3$$

$S_1 = 1,\ S_0 = 0,\quad y = 0 + 0 + I_2 + 0 = I_2$

- Relation between number of input lines M and number of select lines N :



$$\boxed{2^N \geqslant M}$$

$$\log_2 2^N \geqslant \log_2 M$$

$$\boxed{N \geqslant \log_2 M}$$

Higher order MUX using lower order MUX

- $4:1 \xrightarrow{\text{Using } 2:1 \text{ MUX}}$ $\frac{4}{2}+\frac{2}{2}=3=2^2-1$

  $2^2:1$

- $8:1$ MUX $\xrightarrow{\text{Using } 2:1 \text{ MUX}}$ $4+2+1=7=2^3-1$

  $2^3:1$

- $16:1$ MUX $\xrightarrow{\text{Using } 2:1 \text{ MUX}}$ $8+4+2+1=15=(2^4-1)$

  $2^4:1$

- $2^n:1$ MUX $\xrightarrow{\text{Using } 2:1 \text{ MUX}}$ (2^n-1)

Implement 8 : 1 MUX using 2 : 1 MUX and design the complete circuit.

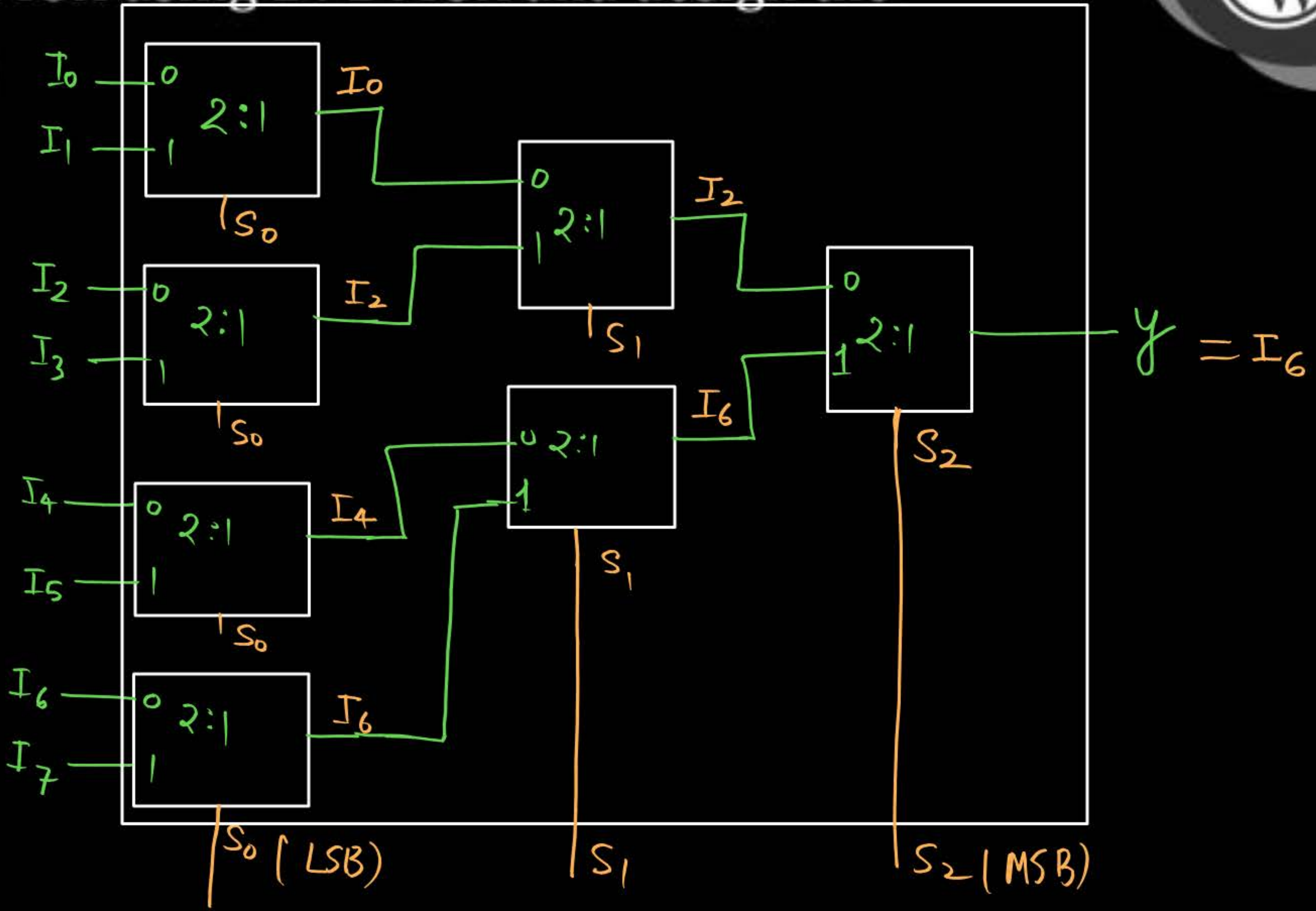
$8:1$

$\rightarrow$ 8 i/p lines – $(I_0 - I_7)$

$\rightarrow S_2, S_1, S_0$

$8:1 \xrightarrow{2:1} \underline{4+2+1}$

$S_2 S_1 S_0 = 110$



- $16:1$ MUX $\xrightarrow{\text{Using } 4:1 \text{ MUX}}$ $4+1$
- $64:1$ MUX $\xrightarrow{\text{Using } 4:1 \text{ MUX}}$ $16+4+1$
- $64:1$ MUX $\xrightarrow{\text{Using } 8:1 \text{ MUX}}$ $8+1$
- $256:1$ MUX $\xrightarrow{\text{Using } 16:1 \text{ MUX}}$ $16+1$

$32:1 \xrightarrow{4:1} (8+2)$ 4:1 MUX $+ 1(2:1)$ MUX $=$ 11 (4:1) MUX

but 1 (4:1) MUX will be used as (2:1) MUX

$128:1 \xrightarrow{8:1} (16+2)$ 8:1 MUX $+ 1(2:1)$ MUX $\longrightarrow$ 19 (8:1) MUX

but 1 (8:1) MUX will be used as (2:1) MUX

$256:1 \xrightarrow{8:1} (32+4)$ 8:1 MUX $+ 1(4:1)$ MUX

36 (8:1) $+$ 1 (8:1) MUX is used as (4:1) MUX

37 (8:1) MUX

$32:1 \xrightarrow{4:1}$

→ 32 - i/p → lines

→ S_4, S_3, S_2, S_1, S_0

$$\boxed{\underbrace{8+2}_{\substack{4:1 \\ \text{MUX}}} + 1(2:1)}$$

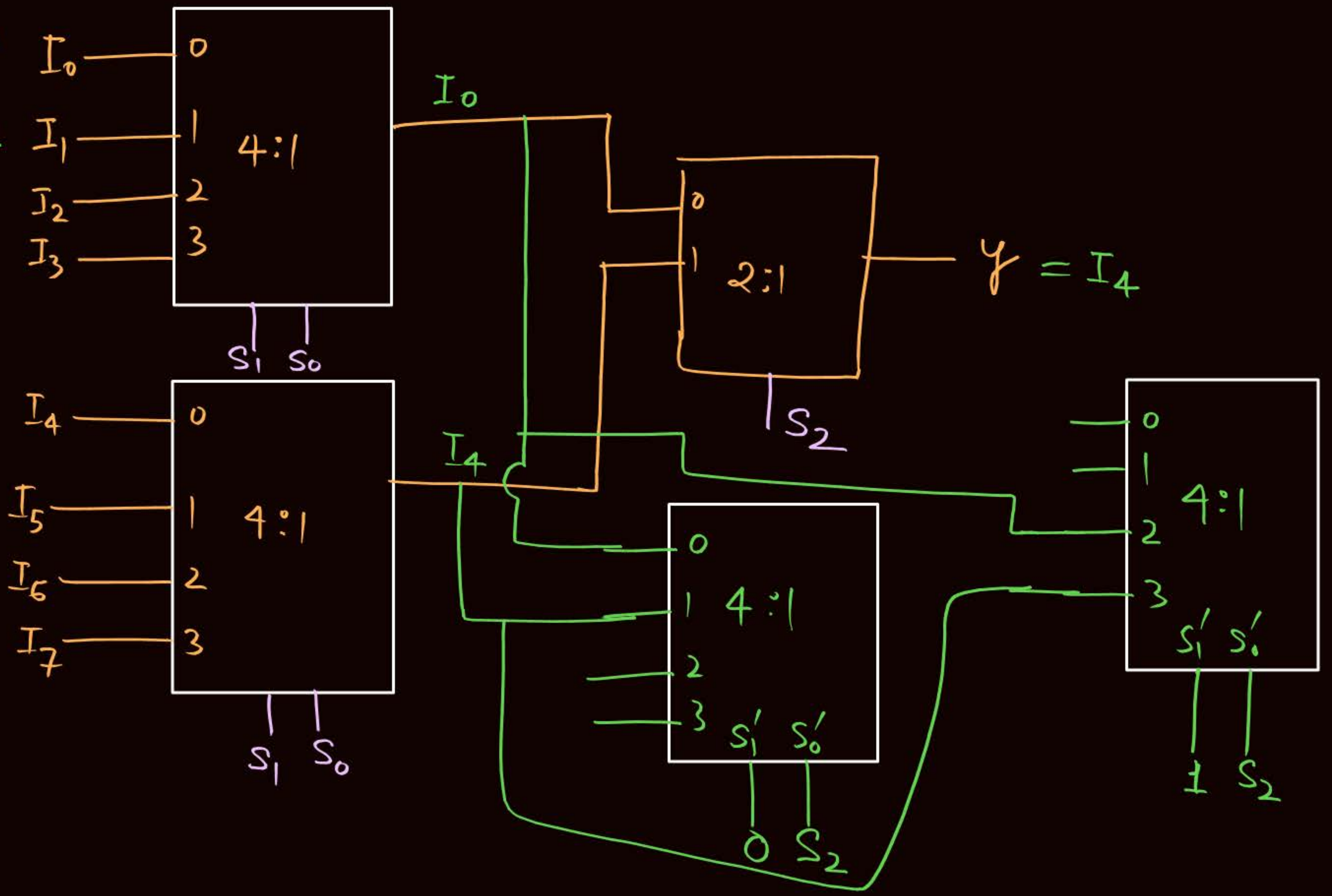
$10\,(4:1) + \underbrace{1\,(4:1)\text{ MUX}}_{\text{will be used as } 2:1 \text{ MUX.}}$

$8:1 \xrightarrow{4:1} \boxed{2(4:1)\text{MUX} + 1(2:1)\text{MUX}} \Rightarrow (2+1)\ 4:1\ \text{MUX}$ but the last 4:1 MUX will be used as 2:1 MUX

$8:1 \to I_0 - I_7$

$\to S_2, S_1, S_0$

$S_2 S_1 S_0 = 100$



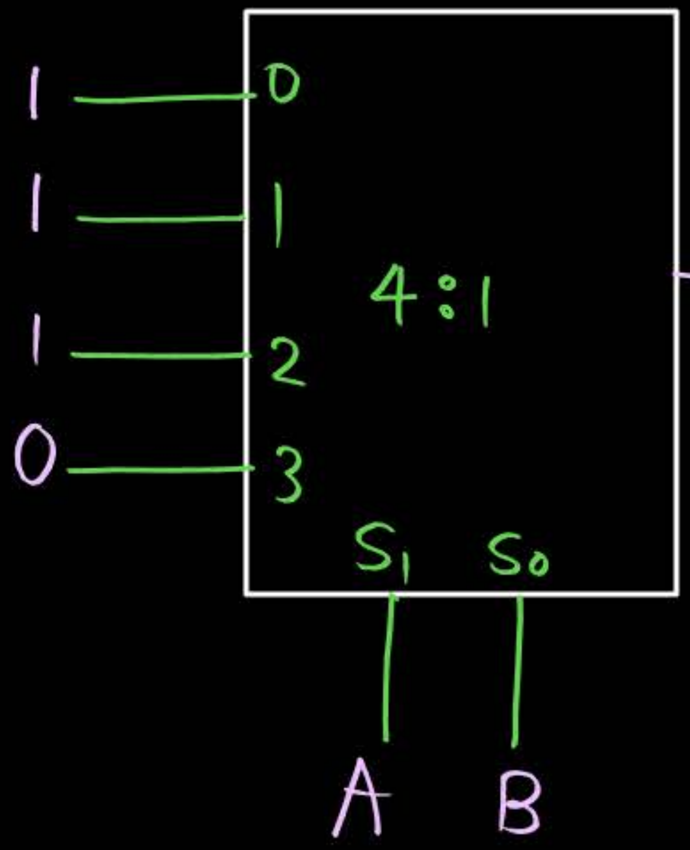
Implementation of Boolean function using MUX

Q. $f(A, B) = \Sigma(0, 1, 2) \rightarrow$ implement this logical function $= \bar{A}\bar{B} + \bar{A}B + A\bar{B}$

(i) using 4 : 1 MUX

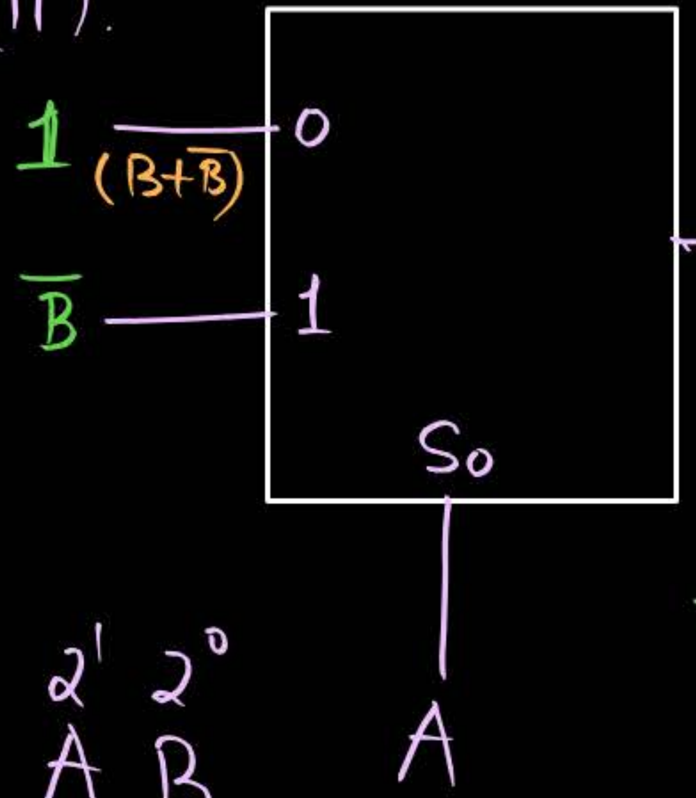
(ii) using 2 : 1 MUX

(i).



$\bar{A}\bar{B}\cdot 1 + \bar{A}B\cdot 1$
$+ A\bar{B}\cdot 1$
$+ AB\cdot 0$

(ii).



$\bar{A}\cdot 1$
$+ A\cdot\bar{B}$
$= (\bar{A}+\bar{B})$
$= \overline{A\cdot B}$

	I_0	I_1
$\bar{B}$	0	2
B	1	3
	1	$\bar{B}$

2^1	2^0
A	B
0	0
0	1
1	0
1	1

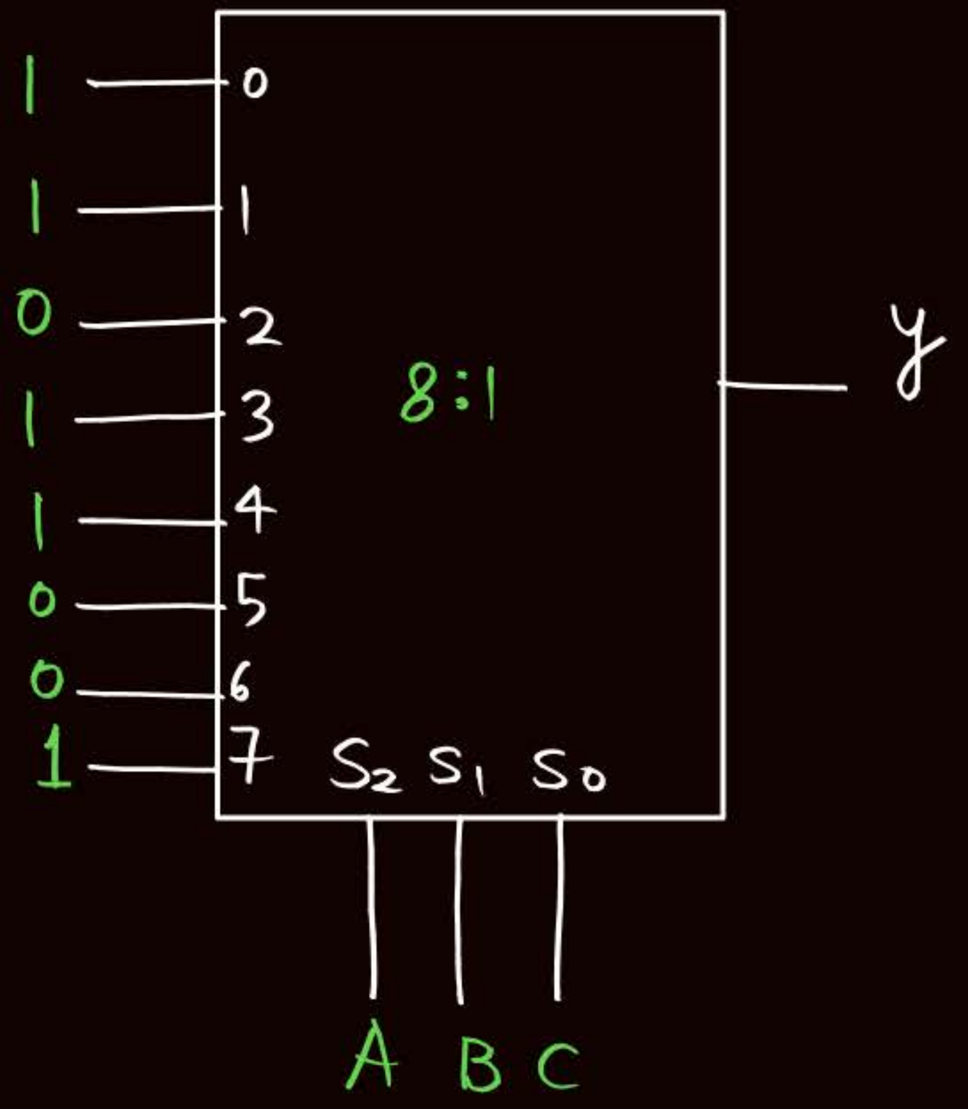
$f(A,B) = \bar{A}\bar{B} + \bar{A}B + A\bar{B}$

$f(0,B) = \bar{B} + B + 0 = 1 \rightarrow I_0 = 1$

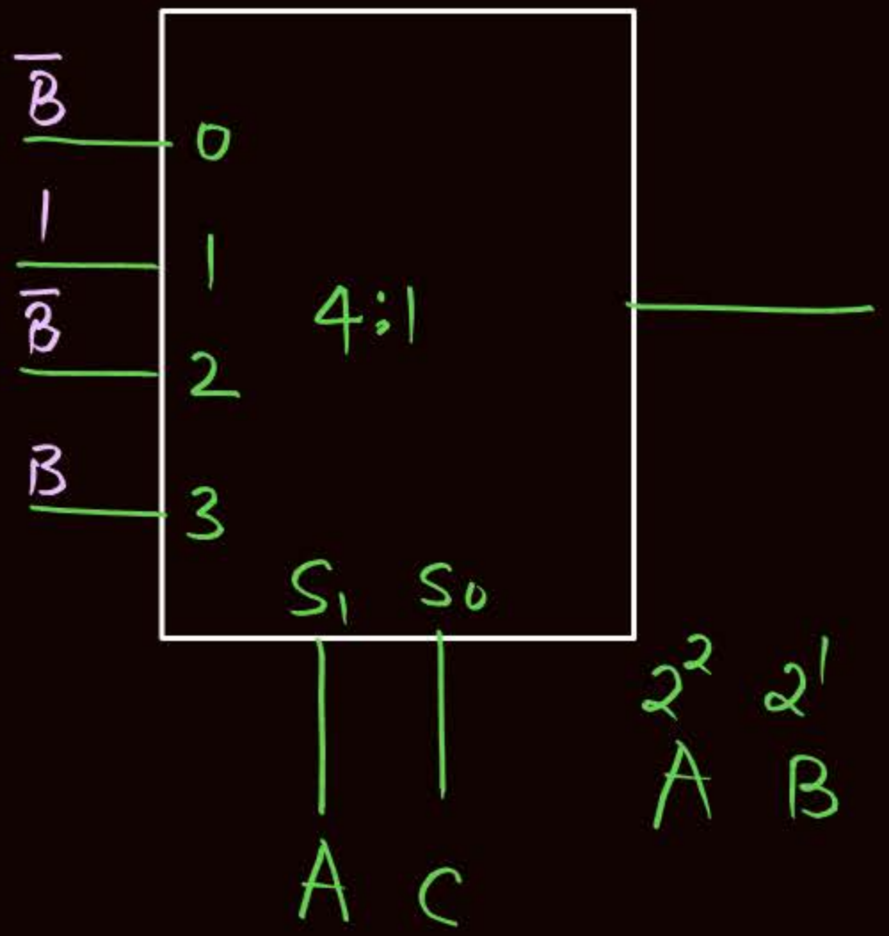
$f(1,B) = \bar{B}, \; I_1 = \bar{B}$

Q. $f(A,B,C) = \Sigma(0,1,3,4,7)$

(i) using 8:1 MUX
(ii) using 4:1 MUX

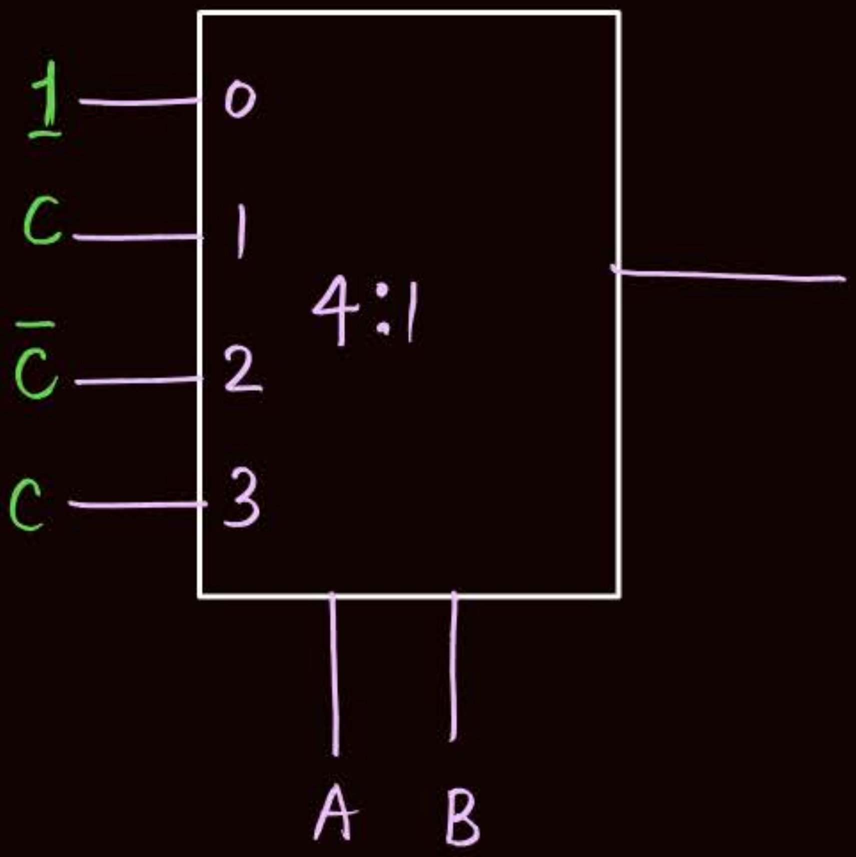


(ii) 4:1

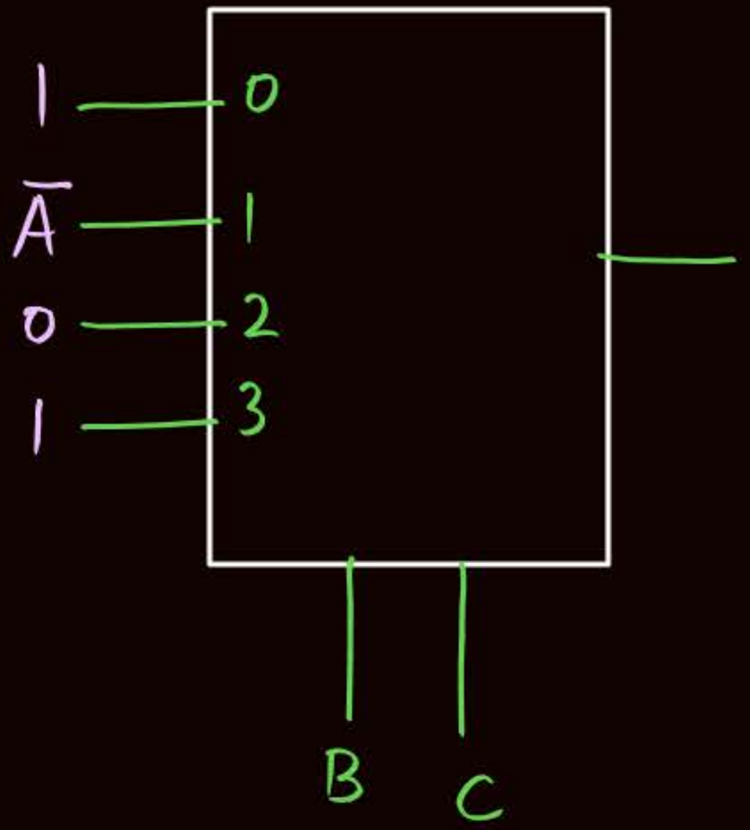


2^2 2^1 2^0
A B C

		I_0	I_1	I_2	I_3
0	$\overline{B}$	0	1	4	5
1	B	2	3	6	7
		$\overline{B}$	1	$\overline{B}$	B



	I_0	I_1	I_2	I_3
0 $\bar{C}$	0	2	4	6
1 C	1	3	5	7
	1	C	$\bar{C}$	C



	I_0	I_1	I_2	I_3
0 $\bar{A}$	0	1	2	3
1 A	4	5	6	7
	1	$\bar{A}$	0	1

$$f(A,B,C) = \sum(0,1,3,4,7)$$

$$f(A,0,0) = \sum(0,4) = \bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C}$$

$$= \bar{A} + A = 1 \rightarrow I_0 = 1$$

$$f(A,0,1) = \sum 1$$

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

$$= \bar{A}\,1\cdot 1 = \bar{A} \rightarrow I_1 = \bar{A}$$

$$f(A,1,0) = 0, \quad I_2 = 0,$$

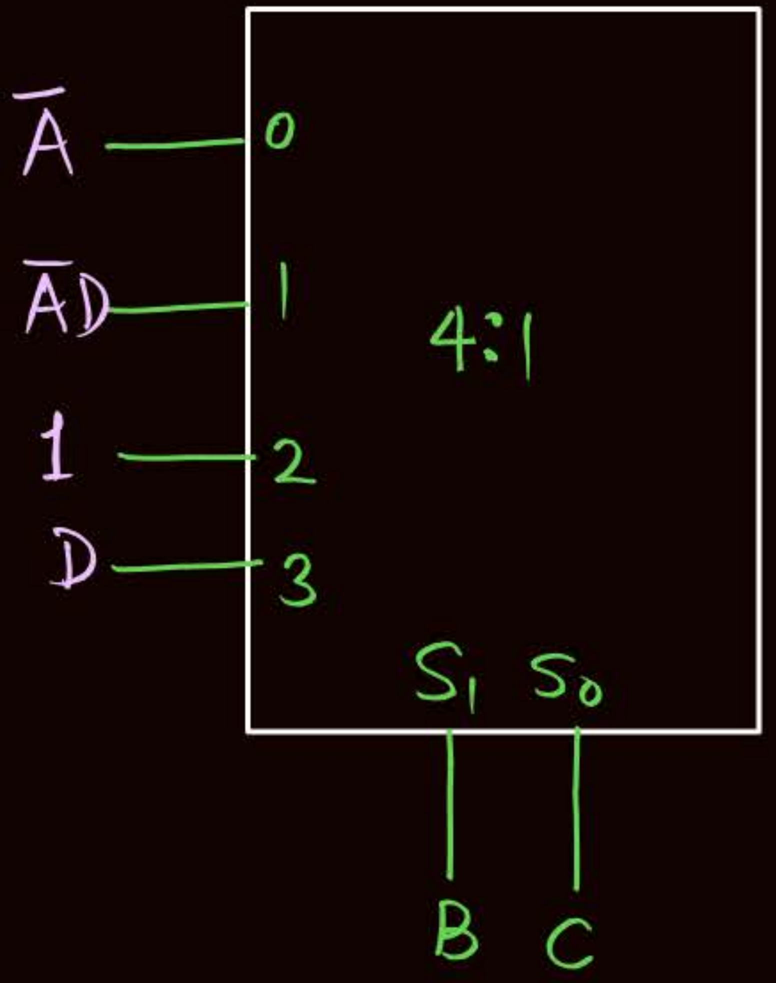
$$f(A,1,1) = \sum(3,7)$$

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

$$I_3 = 1$$

Q. $f(A,B,C,D) = (\bar{A}+B)(\bar{C}+D) = \Sigma$

using 4:1 MUX.



		I_0	I_1	I_2	I_3
00	$\bar{A}\bar{D}$	0	2	4	6
01	$\bar{A}D$	1	3	5	7
10	$A\bar{D}$	8	10	12	14
11	AD	9	11	13	15
		$\bar{A}D + A\bar{D}$			

A	B	C	D
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0

$f(A,0,0,D) = \bar{A} \longrightarrow I_0 = \bar{A}$

$f(A,0,1,D) = \bar{A}D \longrightarrow I_1 = \bar{A}D$

$f(A,1,0,D) = 1$

$I_2 = 1$

$f(A,1,1,D) = D$

$I_3 = D$

Q. $f(A, B, C) = \Sigma(0, 1, 2, 3, 4, 7)$ $\boxed{\text{H.W}}$

(i) implement it using 8 : 1 MUX

(ii) implement it using 4 : 1 MUX

→ AB as select line

→ BC as select line

→ AC as select line

2 Minute Summary

→ MUX

Thank you

GW

Soldiers !