COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 07

Combinational Circuit

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K-Map & Comparator ckt

Comparator ckt cont.

MUX.

$A \rightarrow 2\text{ bit}$ $\quad B \rightarrow 2\text{ bit} \longrightarrow$ Total bits $= 4 \longrightarrow$ Total Comb. $= 2^4 = 16$ Comb.

A	B
0	0
1	1
2	2
3	3

$y_1(A>B)$

$N_1(A>B) = 0+1+2+3 = 6$

$N_2(A<B) = 0+1+2+3 = 6$

$N_3(A=B) = 4 = 2^2$

$(N_1+N_2+N_3) = 16$

$1+2+3+\cdots m = m(m+1)/2$

A $\quad$ B $\longrightarrow$ Total bits $= 2n \longrightarrow$ Total comb. $= 2^{2n}$

A	B
n-bit	n-bit
0	0
1	1
⋮	⋮
(2^n-1)	(2^n-1)

$$\boxed{\begin{aligned} &N_1(A>B) = N_2(A<B) = 0+1+2 \cdots + (2^n-1) \\ &N_3(A=B) = 2^n \end{aligned}}$$

✓ $N_1+N_2+N_3 = 2^{2n}$

A (2 bit) | B (3 bit) $\longrightarrow$ Total = 5 bits $\longrightarrow$ Total comb. $= 2^5 = 32$

A	B
0	0
1	1
2	2
3	3
	4
	5
	6
	7

$N_1 (A > B) = 0 + 1 + 2 + 3 = 6$

$N_2 (A < B) = 4 + 5 + 6 + 7 = 22$

$N_3 (A = B) = 4 = 2^2$

$(N_1 + N_2 + N_3) = 32.$

$A\,(n_1 \text{ bit})$ $B\,(n_2 \text{ bit}) \rightarrow (n_1+n_2)$ bits

Total comb. $= 2^{n_1+n_2}$

Case-I if $(n_1 < n_2)$

A	B
n_1 bit	n_2 bit
0	0
1	1
⋮	2
$(2^{n_1}-1)$	⋮
	$(2^{n_2}-1)$

$N_1(A>B)$
$= 0+1+\cdots(2^{n_1}-1)$

$N_3(A=B) = 2^{n_1}$

$N_2(A<B) = \text{Total comb} - (N_1+N_3)$

Case-II $\rightarrow$ if $(n_1 > n_2)$

$N_2(A<B) = 0+1+2+ \quad (2^{n_2}-1)$

$N_3(A=B) = 2^{n_2}$

$N_1(A>B) = \text{Total comb} - (N_2+N_3)$
$= 2^{n_1+n_2} - (N_2+N_3)$

Question

We have two number A and B both A and B are 2-bit numbers then in how many combination A > B.

(a) 5

(b) 6

(c) 7

(d) 8

$N_1(A>B) = 0+1+2+3 = 6$

Question

We have two 4-bit number A and B then number of combinations in which A < B ________

Number of combinations in which A = B ___16___.

$N_2(A<B) = 0+1+2+\cdots 15 = \frac{15(16)}{2} = 120$,

Total comb $= 2^{4+4} = 2^8$
$= 256$

$N_3(A=B) = 2^4 = 16$

- If y_1 represents logical o/p for $A>B$ then no. of terms in its POS expression will be ___136___.

$N_1(A>B) = 0+1+2+3 \cdots 15 = 120$

$y_1(A>B) \Rightarrow$ SOP terms $= 120$

POS terms $= 136$

$A \longrightarrow 3$ bit

$B \longrightarrow 6$ bit

No. of comb. where $B > A$ $\underline{\quad 476 \quad}$.

Total bits $= 9 \longrightarrow$ Total comb $= 2^9 = 512$

$$N_1(A > B) = 0 + 1 + 2 + \cdots 7 = \frac{7(8)}{2} = 28$$

$$N_3(A = B) = 2^3 = 8$$

$$N_2(A < B) = \text{Total comb.} - (N_1 + N_3)$$

$$= 512 - 28 - 8 = 476$$

- $A \longrightarrow 4$ bit

  $B \longrightarrow 7$ bit

$\longrightarrow$ Total comb. $= 2^{11} = 2048$ Comb.

$N_1 (A > B)$ $\underline{\quad 120 \quad}$.

$N_2 (A < B)$ $\underline{\quad 1912 \quad}$.

$N_1 (A > B) = 0 + 1 + 2 + 3 - \cdots 15 = 120$

$N_3 (A = B) = 2^4 = 16$

$N_2 (A < B) = 2048 - 120 - 16 = 1912$

- $A \longrightarrow 6$ bits

  $B \longrightarrow 2$ bits

  $N_1 (A > B)$ $\underline{246}$.

  $N_2 (A < B) = 0+1+2+3 = 6$

  $N_3 (A = B) = 2^2 = 4$

  $N_1 (A > B) = 2^8 - 6 - 4 = 246$

Question

Design a combinational circuit having 3-input and 1-output line. The output is high when majority of input lines are at logic '0'.

H.W.

Question

Design a combinational circuit where input is 3-bit input and output is square of input number.

H.W.

Question

Design a combinational circuit where input is BCD code and output is '1' when input is divisible by 2.

H.W.

Question

A logic circuit implements the Boolean function :

$$f(A,B,C) = A\bar{B} + \bar{A}\bar{B}\bar{C} = \Sigma(0,4,5) + d\,\Sigma(2,6)$$

$A\bar{B}$: 1 0 0, 1 0 1; $\bar{A}\bar{B}\bar{C}$: 0 0 0

It is found that the input combination B = 1 and C = 0 can never occur. Then the simplified output $f(A, B, C)$ will be

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

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

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

(d) None of these

A	B	C	
0	1	0	$\rightarrow 2$
1	1	0	$\rightarrow 6$

} don't care conditions

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	1			X
A	1	1		X

$= \bar{C} + A\bar{B}$ ✓

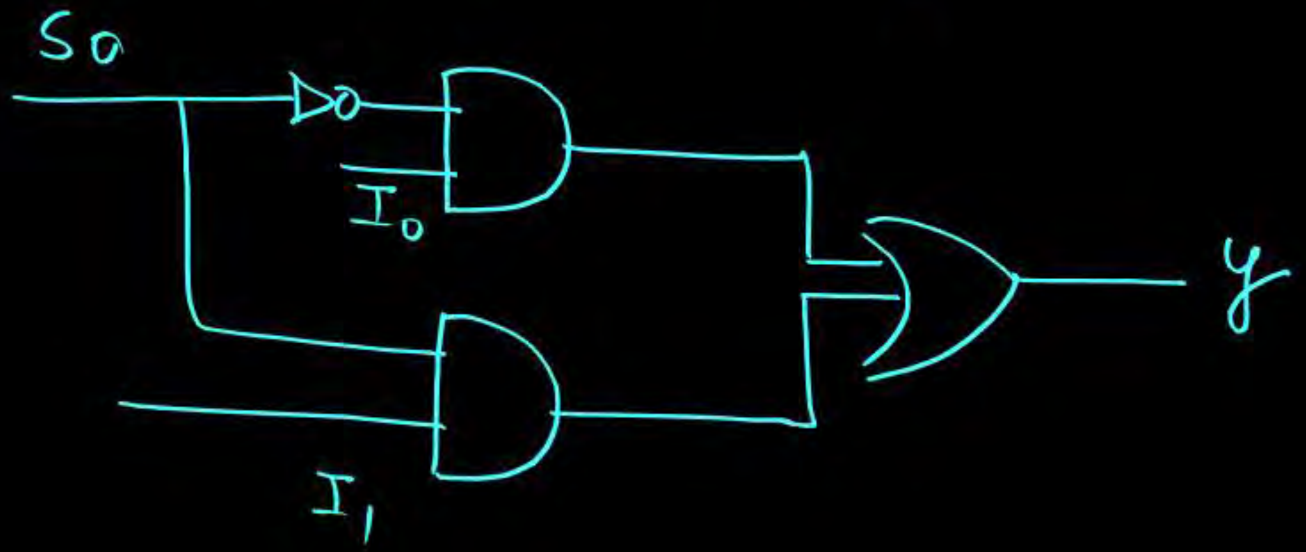
[MUX]

- What is MUX ?

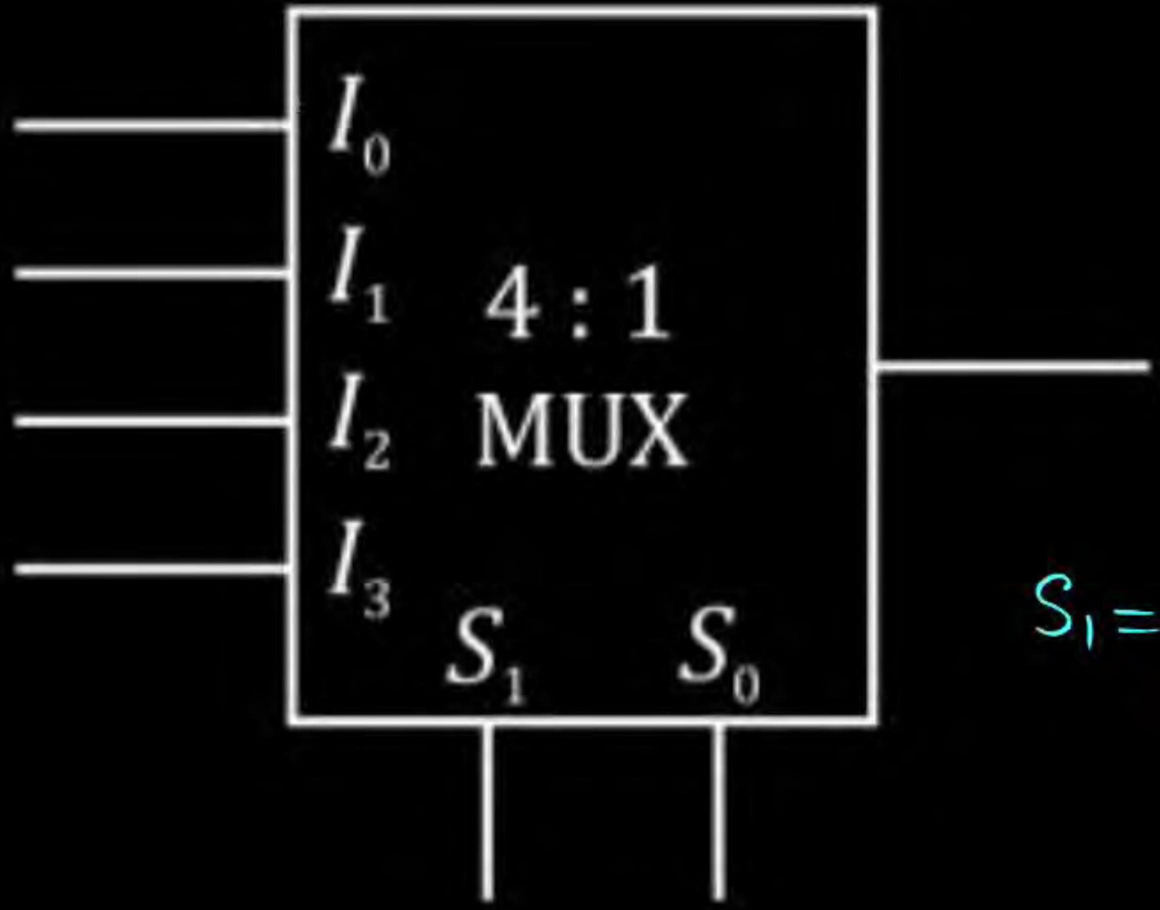
MUX is a comb. ckt having many i/ps and one o/p line and on the basis of select i/p line, one of the i/p line is transferred to the o/p line.

- 2 : 1 MUX

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



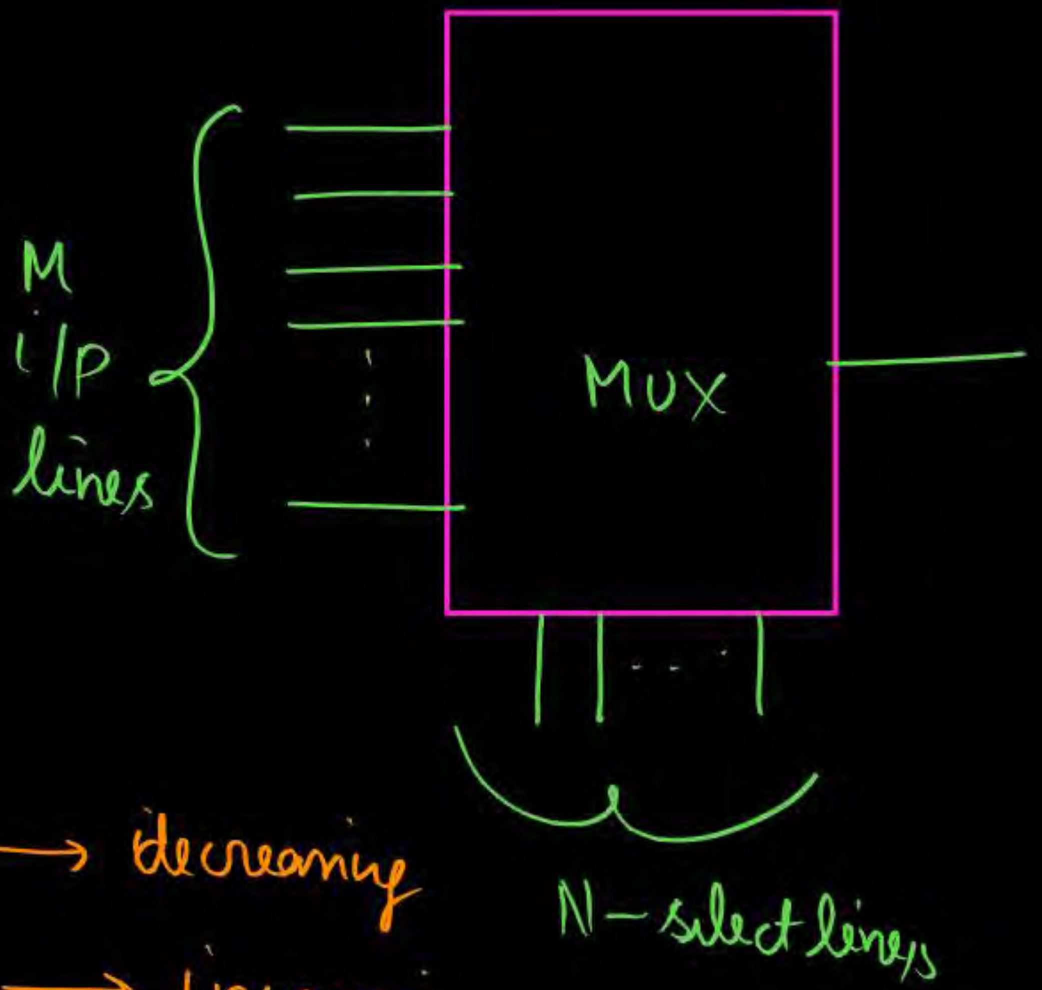
- 4 : 1 MUX



$$y = \bar{S_1}\cdot\bar{S_0}\cdot I_0 + \bar{S_1}S_0\cdot I_1 + S_1\bar{S_0}\cdot I_2 + S_1S_0\cdot I_3$$

$$S_1 = 1,\ S_0 = 0 \longrightarrow y = I_2$$

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



$\boxed{\log_a x}$

$x > 0$

$0 < a < 1 \longrightarrow$ decreasing

$a > 1 \longrightarrow$ increasing

For proper operation

$$2^N \geq M$$

$$\left(\log_2 2^N \geq \log_2 M\right)$$

$$\log_{0.5} 2^N \leq \log_{0.5} M$$

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

2 Minute Summary

→ Comparator CKt

→ MUX.

Thank you

GW Soldiers !