COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 13

Combinational Circuit

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Question Discussion

Decoder

Encoder

[Decoder]

- What is Decoder ?

- It is a combinational ckt having many inputs and many o/ps

- It is basically used to convert binary into other codes.
  - eg. binary to octal
  - eg. binary to hexadecimal

- Its order is $n : 2^n$

$0 \cdot X = 0$

$X \cdot X = X$

$X + X = X$

$1 + X = 1$

$1 \cdot X = X$

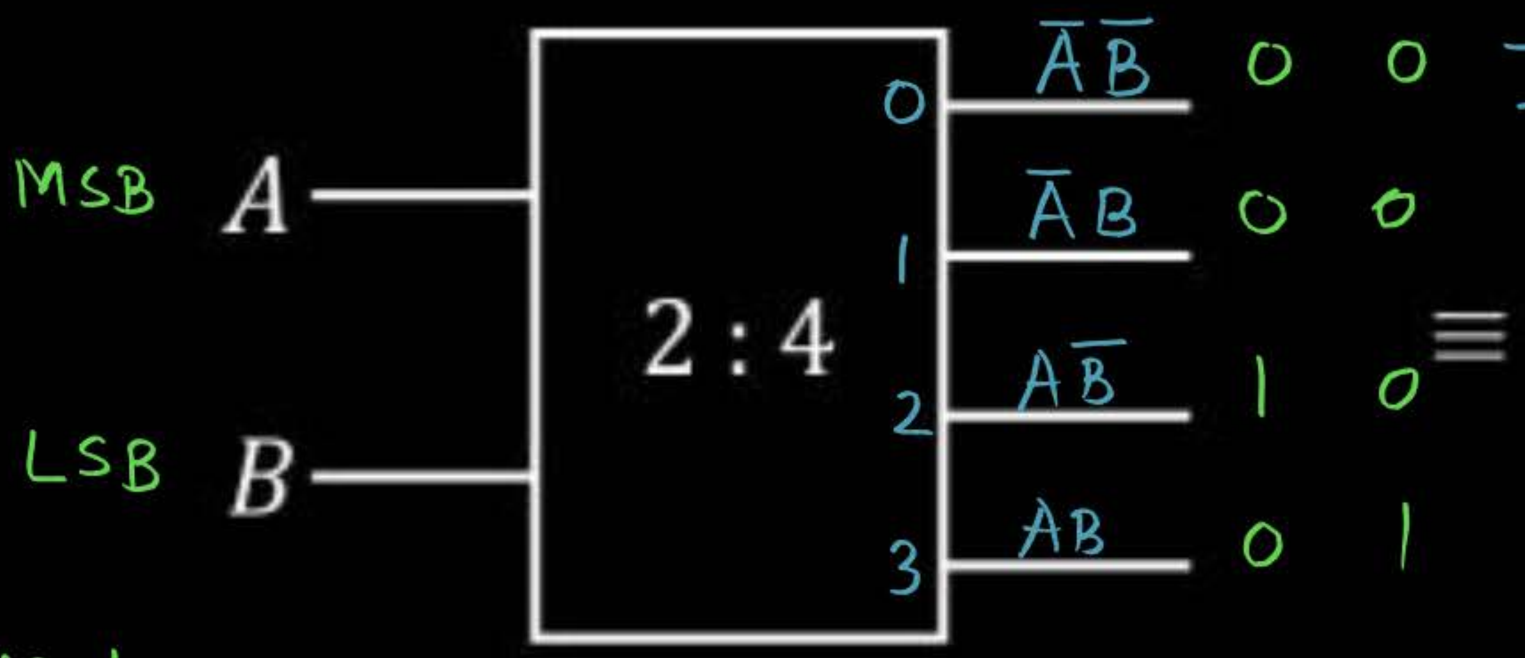
$1 \oplus X = \bar{X}$

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

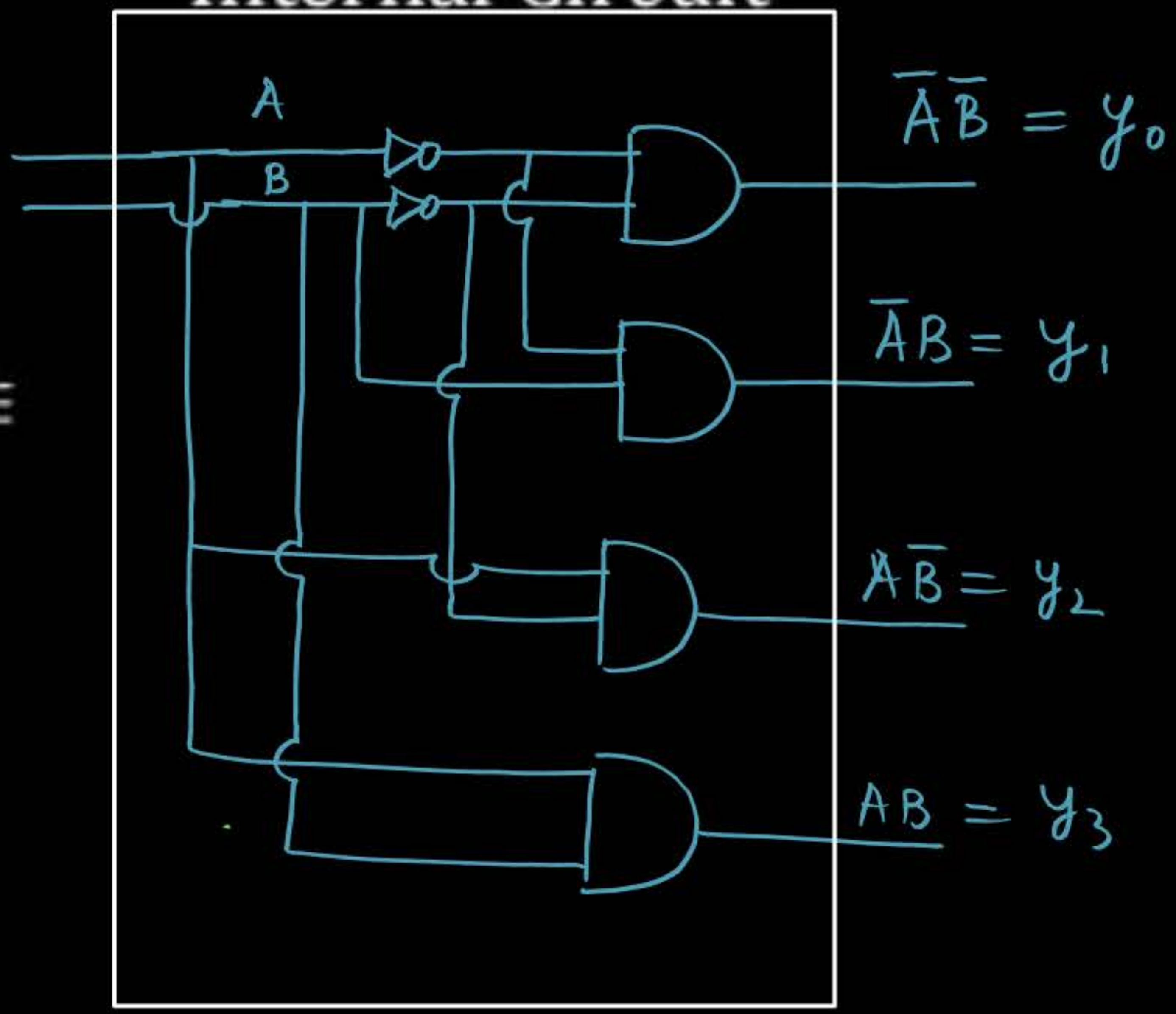
$\overline{0 \cdot X} = 1$

$\bar{\bar{X}} = X$

- 2 : 4 Decoder



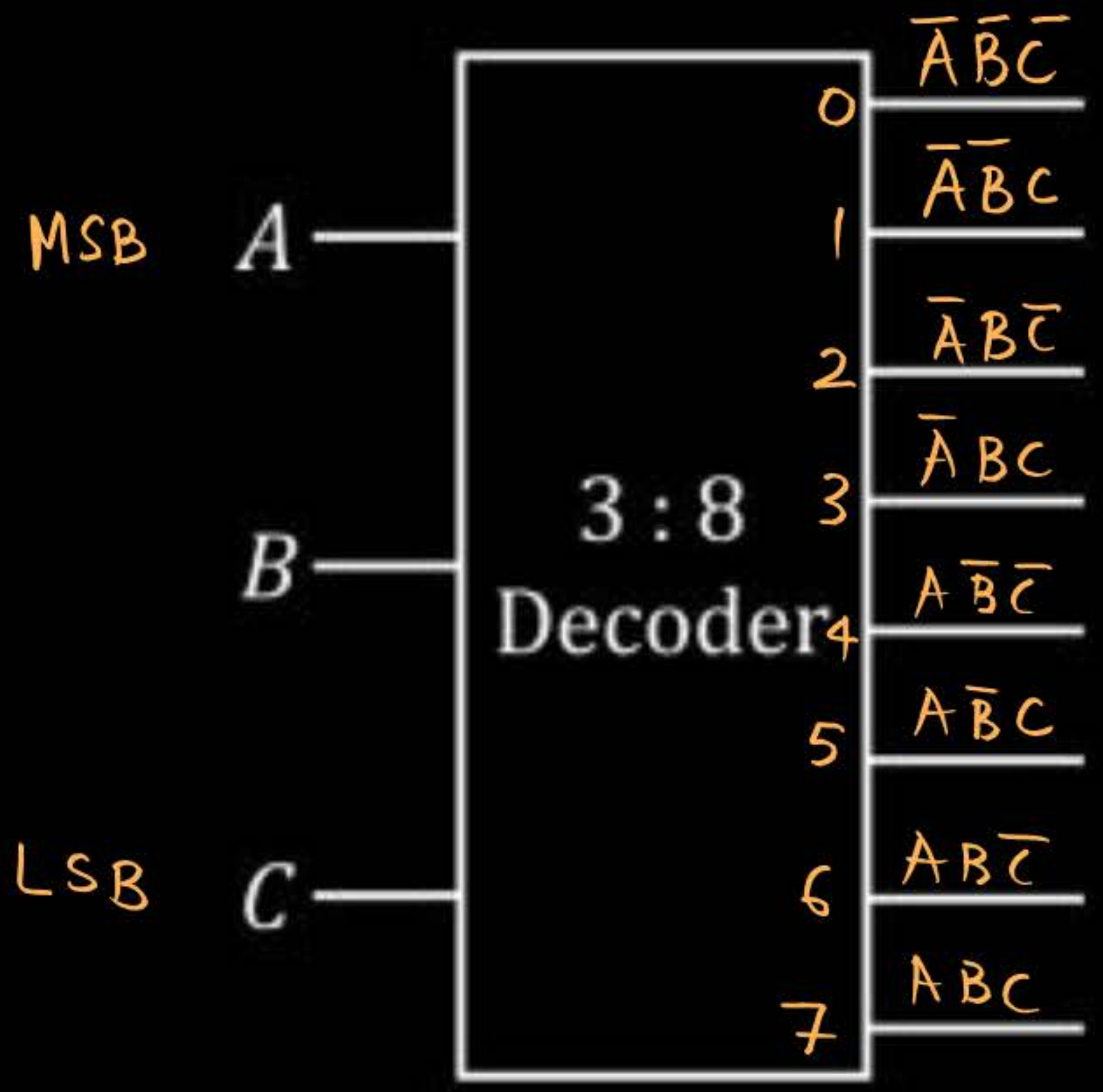
Internal Circuit



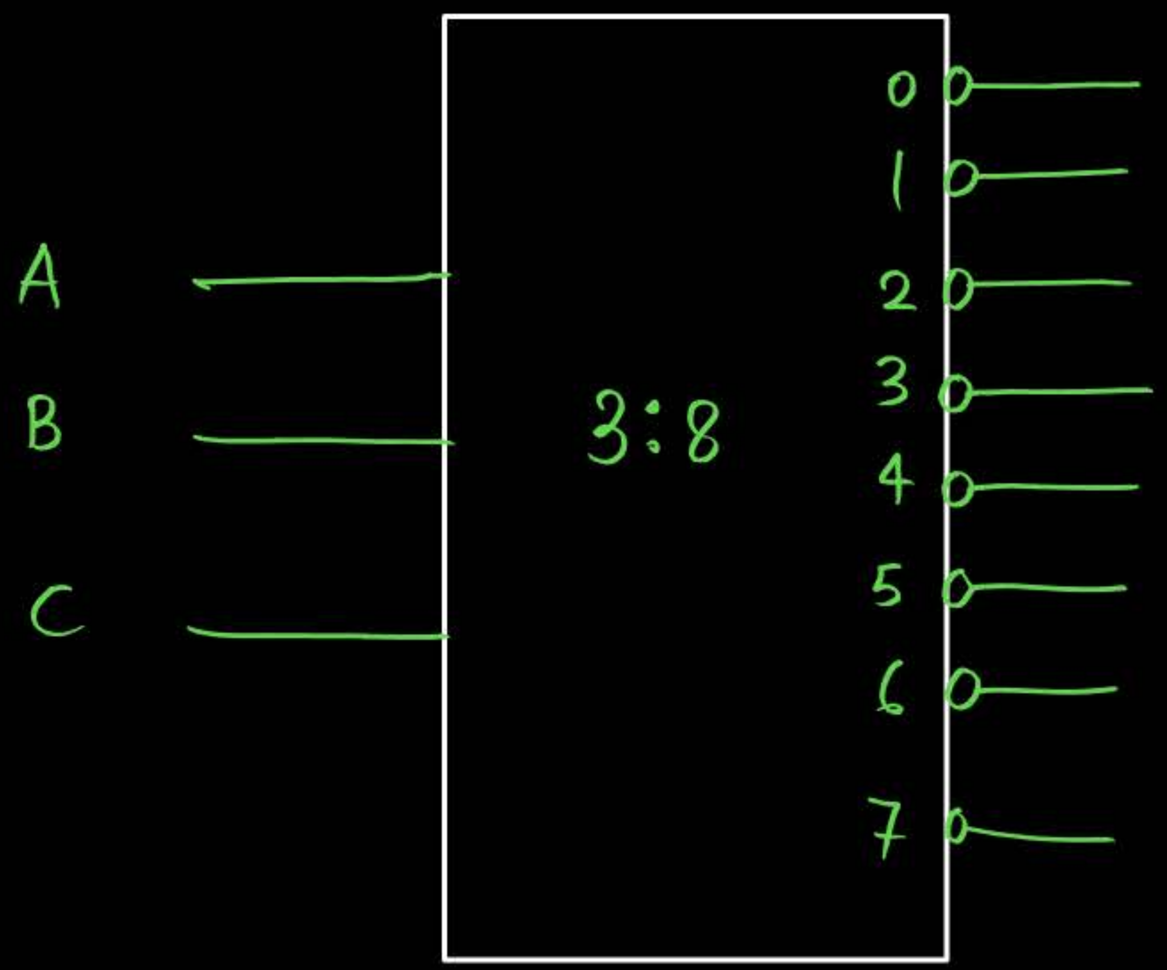
AB=1 0

AB=11

- 3 : 8 Decoder



MSB
A
B
LSB
C
3 : 8
Decoder
0
1
2
3
4
5
6
7
$\bar{A}\bar{B}\bar{C}$
$\bar{A}\bar{B}C$
$\bar{A}B\bar{C}$
$\bar{A}BC$
$A\bar{B}\bar{C}$
$A\bar{B}C$
$AB\bar{C}$
ABC



Low enable decoder

- Imp point regarding functionality of decoder :

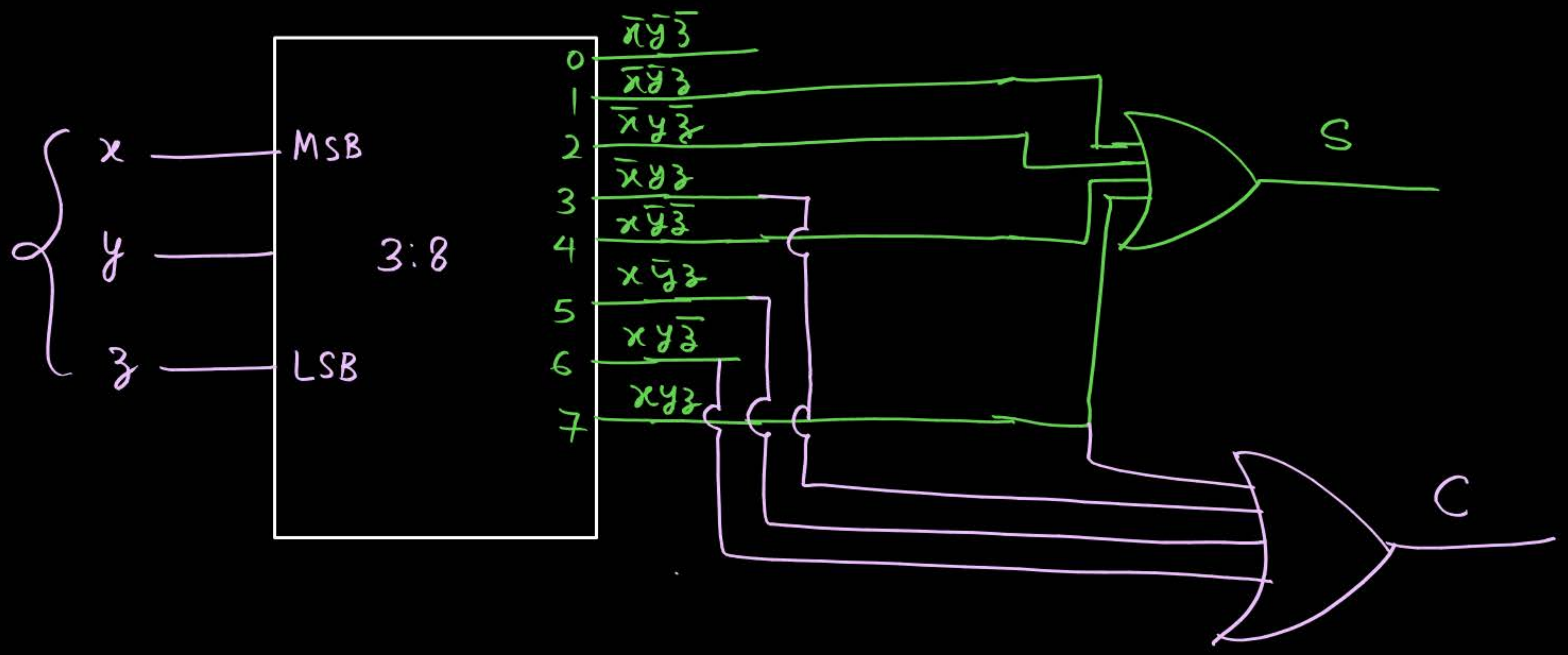
- Whenever we apply a particular input combination on i/p side then corresponding o/p line will go at logic '1' and at the same time other o/p lines will be at '0'.

Full adder implementation using Decoder + OR gate

- Full adder using 3 : 8 decoder + OR gate :

$S(x,y,z) = x \oplus y \oplus z = \sum(1,2,4,7) = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xyz$

$C(x,y,z) = \underline{xy} + \underline{yz} + \underline{zx} = xy + (x \oplus y)z = \sum(3,5,6,7)$



H.W.

Q. Implement F.S. using 3:8 decoder & OR gate.

Q. Implement H.A & H.S using 2:4 decoder & OR gate.

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

implement the given function using a decoder and OR.

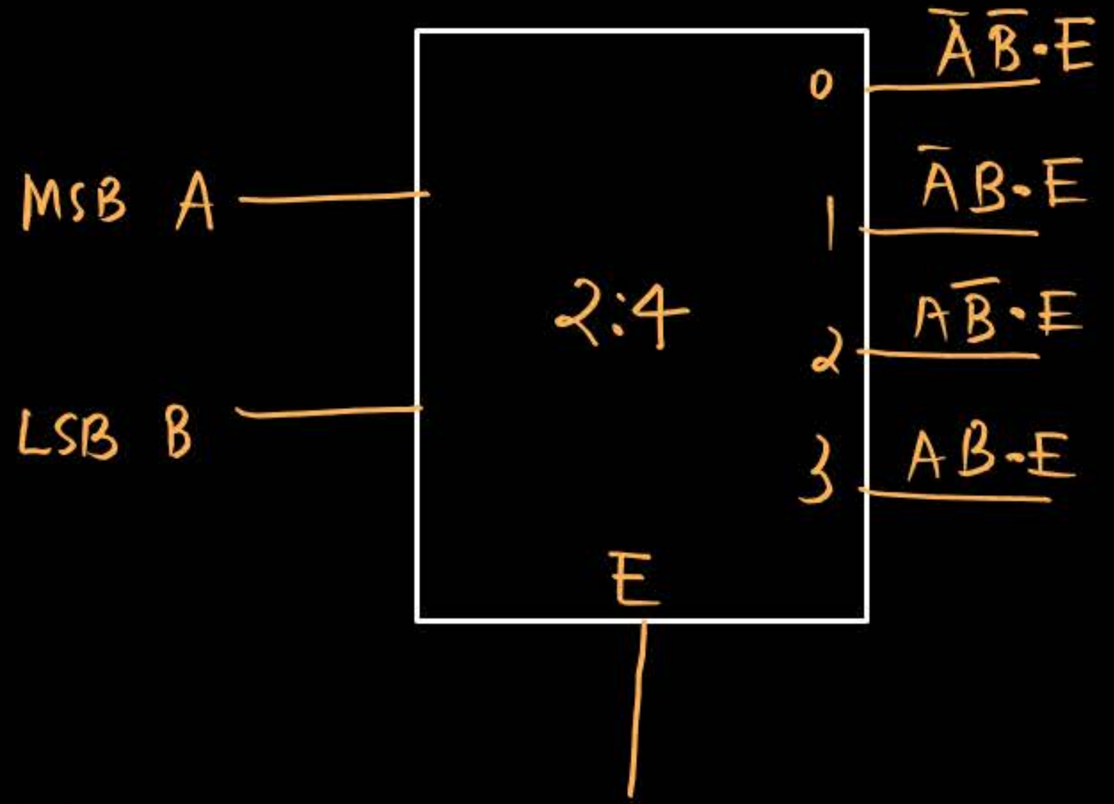
- Imp point regarding implementation of logical function using decoder :

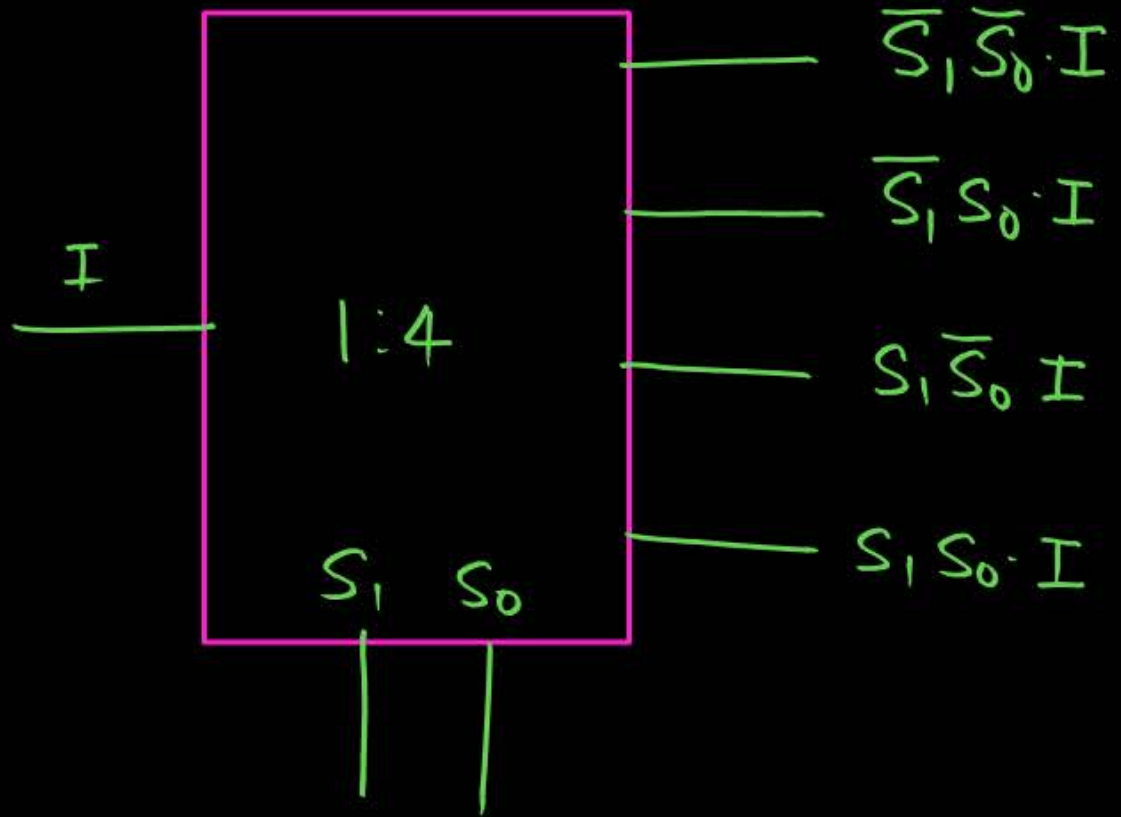
Whenever we need implement any boolean function using decoder & OR gate, then function must always be expressed in standard SOP form.

No. of i/p lines in decoder is equal to no of Variables in boolean function.

Comparison of DeMUX and Decoder circuit

- How their internal circuits are same ?





$\Rightarrow$ Decoder with enable pin (E) has same internal circuitry as of the DeMUX of same order

[Encoder]

- What is encoder ?

$\boxed{\text{It is a combinational CKt having many i/Ps and many o/Ps.}}$

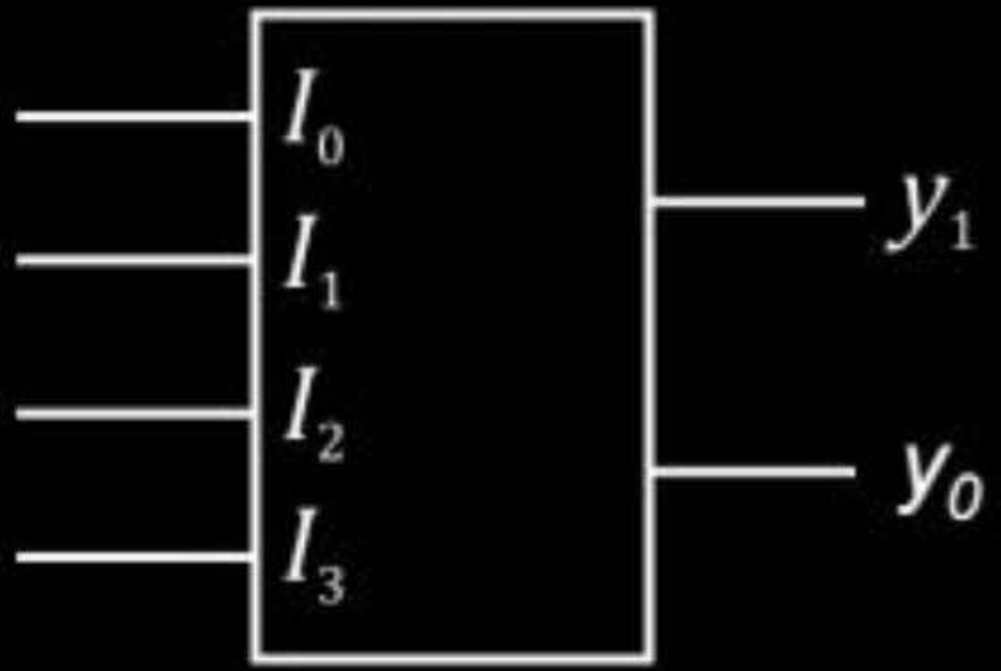
$\boxed{\text{It is basically used to convert other codes into binary.}}$

→ eg. Octal to binary

eg. Hexadecimal to binary.

$\boxed{\text{Its order is } (2^n : n)}$

- 4 : 2 Encoder :



$y_1(I_0, I_1, I_2, I_3) = \Sigma(1,2) + d\Sigma(0,3,5,6,7,9,10,11,14,15)$

$y_0(I_0, I_1, I_2, I_3) = \Sigma(1,4) + d\Sigma(0,3,5,6,7,9,12,13,14,15)$

$$\boxed{\begin{aligned} y_1 &= I_2 + I_3 \\ y_0 &= I_1 + I_3 \end{aligned}}$$

Truth Table :

	I_0	I_1	I_2	I_3	y_1	y_0
8	1	0	0	0	0	0
4	0	1	0	0	0	1
2	0	0	1	0	1	0
1	0	0	0	1	1	1

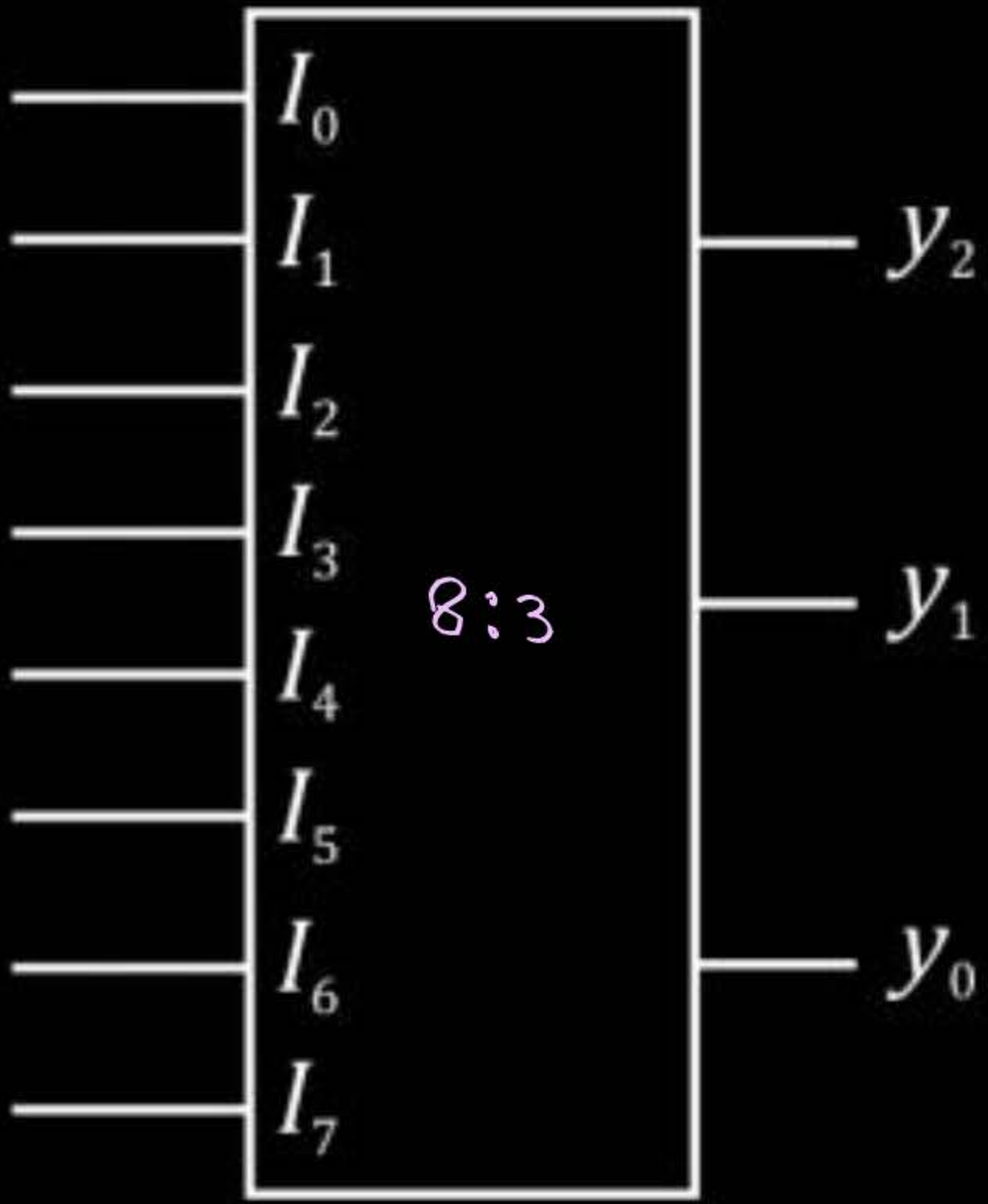
y_1	$\bar{I}_2\bar{I}_3$	$\bar{I}_2 I_3$	$I_2 I_3$	$I_2\bar{I}_3$
$\bar{I}_0\bar{I}_1$	X	1	X	1
$\bar{I}_0 I_1$	.	X	X	X
$I_0 I_1$	X	X	X	X
$I_0\bar{I}_1$	.	X	X	X

$$\boxed{y_1 = I_2 + I_3}$$

y_0	$\bar{I}_2\bar{I}_3$	$\bar{I}_2 I_3$	$I_2 I_3$	$I_2\bar{I}_3$
$\bar{I}_0\bar{I}_1$	X	1	X	.
$\bar{I}_0 I_1$	1	X	X	X
$I_0 I_1$	X	X	X	X
$I_0\bar{I}_1$	.	X	X	X

$$\boxed{y_0 = I_1 + I_3}$$

- 8 : 3 Encoder :



Truth Table :

I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7	y_2	y_1	y_0
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

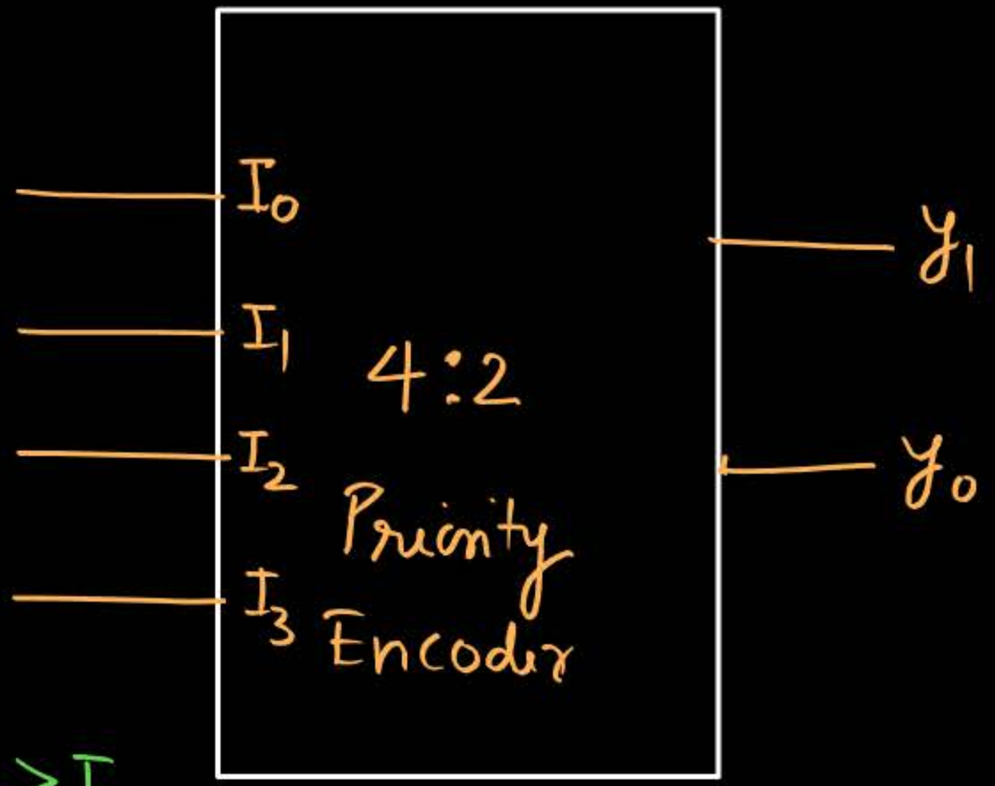
$$y_2 = I_4 + I_5 + I_6 + I_7$$

$$y_1 = I_2 + I_3 + I_6 + I_7$$

$$y_0 = I_1 + I_3 + I_5 + I_7$$

Priority Encoder:

11	00
10	01
01	10
00	11



$I_3 > I_2 > I_1 > I_0$

I_3	I_2	I_1	I_0		y_1	y_0	y_1'	y_0'
0	0	0	0	→	×	×	×	×
0	0	0	1	→	0	0	1	1
0	0	1	0	→	0	1	1	0
0	0	1	1	→	0	1	1	0
0	1	0	0	→	1	0	0	1
0	1	0	1	→	1	0	0	1
0	1	1	0	→	1	0	0	1
0	1	1	1	→	1	0	0	1
1	0	0	0	→	1	1	0	0
1	0	0	1	→	1	1	0	0
1	0	1	0	→	1	1	0	0
1	0	1	1	→	1	1	0	0
1	1	0	0	→	1	1	0	0
1	1	0	1	→	1	1	0	0
1	1	1	0	→	1	1	0	0
1	1	1	1	→	1	1	0	0

$$y_1(I_3, I_2, I_1, I_0) = \sum(4,5,6,7,8,9,10,11,12,13,14,15) + d\sum 0$$

$$y_0(I_3, I_2, I_1, I_0) = \sum(2,3,8,9,10,11,12,13,14,15) + d\sum 0$$

	$\bar{I}_1\bar{I}_0$	$\bar{I}_1 I_0$	$I_1 I_0$	$I_1\bar{I}_0$
$\bar{I}_3\bar{I}_2$	X			
$\bar{I}_3 I_2$	1	1	1	1
$I_3 I_2$	1	1	1	1
$I_3\bar{I}_2$	1	1	1	1

$$\boxed{y_1 = I_2 + I_3}$$

	$\bar{I}_1\bar{I}_0$	$\bar{I}_1 I_0$	$I_1 I_0$	$I_1\bar{I}_0$
$\bar{I}_3\bar{I}_2$	X		1	1
$\bar{I}_3 I_2$				
$I_3 I_2$	1	1	1	1
$I_3\bar{I}_2$	1	1	1	1

$$\boxed{y_0 = I_3 + \bar{I}_2 I_1}$$

$$y_1'(I_3, I_2, I_1, I_0) = \sum(1,2,3) + d\sum(0)$$

$$y_0'(I_3, I_2, I_1, I_0) = \sum(1,4,5,6,7) + d\sum(0)$$

y_1

	$\bar{I}_1\bar{I}_0$	$\bar{I}_1 I_0$	$I_1 I_0$	$I_1\bar{I}_0$
$\bar{I}_3\bar{I}_2$	X	1	1	1
$\bar{I}_3 I_2$				
$I_3 I_2$				
$I_3\bar{I}_2$				

$$y_1 = \bar{I}_3\bar{I}_2$$

y_0

	$\bar{I}_1\bar{I}_0$	$\bar{I}_1 I_0$	$I_1 I_0$	$I_1\bar{I}_0$
$\bar{I}_3\bar{I}_2$	X	1		
$\bar{I}_3 I_2$	1	1	1	1
$I_3 I_2$				
$I_3\bar{I}_2$				

$$y_0 = \bar{I}_3 I_2 + \bar{I}_3\bar{I}_1$$

Note: All 0's combination will never be possible in any Encoder → normal or priority Encoder.

2 Minute Summary

→ Decoder & Encoder

Thank you

GW Soldiers !