COL215L: Digital Logic & System Design

Lecture 10: Binary Arithmetic

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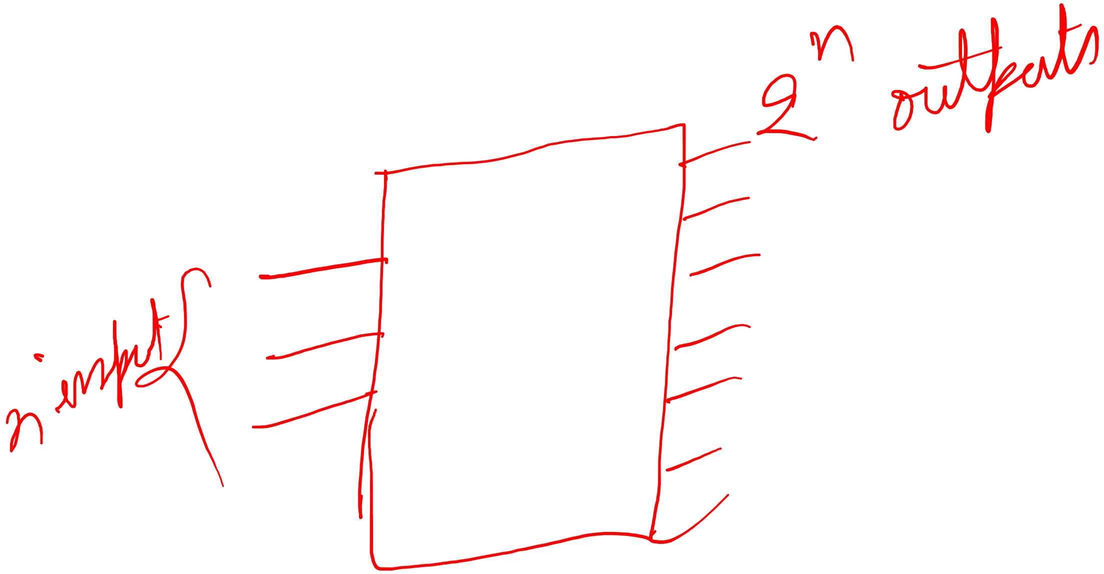
Decoder

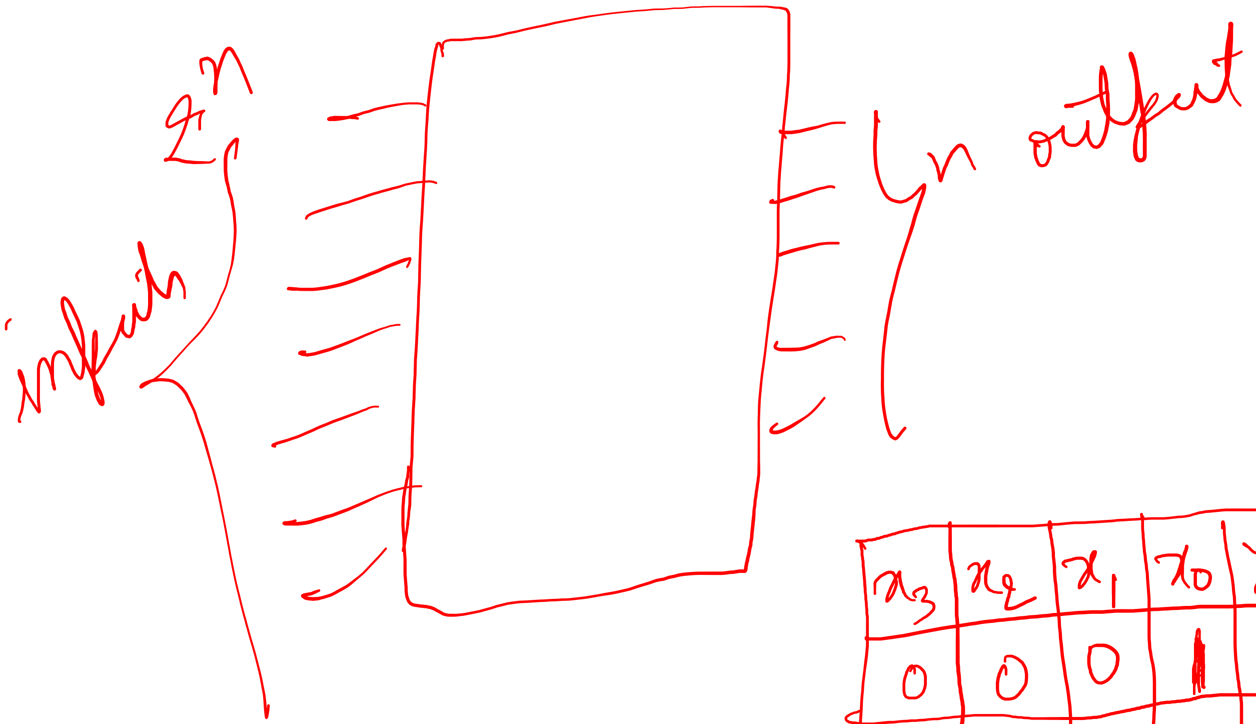
- n-2^n



Encoder

- 2^n-n

- $\boxed{\text{4-to-2 Encoder}}$



x_3	x_2	x_1	x_0	y_1	y_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1

$y_1 = (\quad)$

$y_0 = (\quad)$

Priority Encoder

- 2^n-n

- Inputs have priorities

4 inputs $x_3 > x_2 > x_1 > x_0$

$$z = (x_3 + x_2 + x_1 + x_0)$$

$$y_1 = (\quad)$$

$$y_0 = (\quad)$$

inputs | outputs

x_3	x_2	x_1	x_0	y_1	y_0	z
0	0	0	0	X	X	0
0	0	0	1	0	0	1
0	0	1	X	0	1	1
0	1	X	X	1	0	1
1	X	X	X	1	1	1

Half Adder

$(x), (y) \rightarrow (S)$ sum $\quad (C)$ carry

0	0	1	1
0	1	0	1
00	01	01	10

x	y	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$$S = x'y + xy'$$

$$C = xy$$

$$S = x \oplus y$$

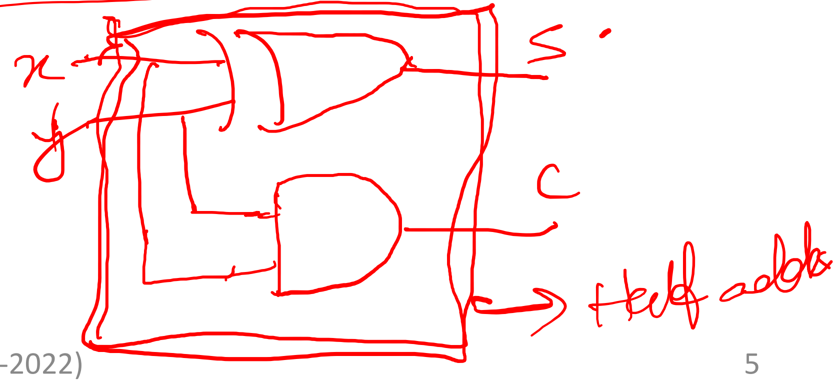
→ Unsigned integer

$\boxed{\text{Signed integer}}$

$$(X)_B = x_{n-1}\, x_{n-2} \cdots x_0$$

$$(X)_D = x_{n-1}\cdot 2^{n-1} + x_{n-2}\cdot 2^{n-2} \cdots + x_0 \cdot 2^0$$

$$(X)_D = 15 \rightarrow (X)_B = 1111$$



Full Adder

c_i	x_i	y_i	c_{i+1}	s_i
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

$$c_{i+1} = x_i y_i + x_i c_i + y_i c_i$$

$$s_i = x_i \oplus y_i \oplus c_i$$

$x_{n-1}\, x_{n-2} \cdots x_{i+1}\, x_i \cdots x_0$

$y_{n-1}\, y_{n-2} \cdots y_{i+1}\, y_i \cdots y_0$

$s_{n-1}\, s_{n-2} \cdots s_{i+1}\, s_i \cdots s_0$

$c_{n-2} \cdots c_{i+1}\, c_i \cdots c_0$