

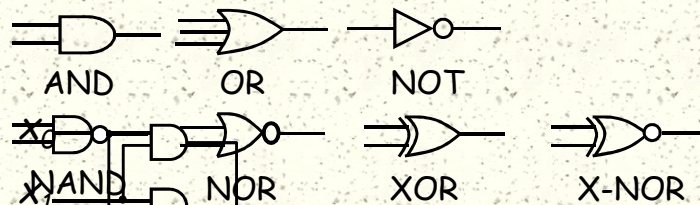
Digital System Implementation

- # The **implementation** of a system is how the system is constructed from simpler components.
- # Implementation building blocks
 - Basic logic gates
 - Universal gates
 - Technology library
 - Flip-flop (memory unit)
 - Intellectual property (IP)

Example: System Implementation

- # From Boolean expression to gate implementation

$$w(x_3, x_2, x_1, x_0) = x_1x_0 + x_2x_0 + x_3x_0 + x_2x_1$$



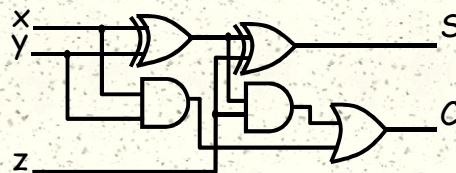
	x	y	NAND	NOR	XOR	XNOR
x_2	0	0	1	1	0	1
	0	1	1	0	1	0
x_3	1	0	1	0	1	0
	1	1	0	0	0	1

Example: System Implementation

- From Boolean expression to gate implementation

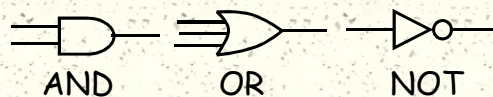
$$w(x_3, x_2, x_1, x_0) = x_1x_0 + x_2x_0 + x_3x_0 + x_2x_1$$

$$S(x, y, z) = x \oplus y \oplus z, C(x, y, z) = xy + z(x \oplus y)$$



Universal Gate

- A gate or a set of gates is called universal if it can implement all digital systems (all Boolean functions).
- Standard universal gate:



- A gate is universal if it can implement the standard universal gates {AND, OR, NOT}.

More on Universal Gate

Define a 3-input gate $f(x,y,z) = x'yz + xy' + y'z$, show that f is universal.

[Proof:]

NOT: $f(x,1,1)$

OR: $f(x,0,y)$

AND: $f(x, f(y,1,1), 0)$

