Module 3

Logic

9/6/2023

1 Binary Codes

Binary Code is how information is represented with binary digits, mulitple exist.Codes provide further implementation methods of binary into a digital system.

Binary Coded Decimal is code to represent decimal in binary. Each digit is represented by its binary 4-bit equivalent.

Application include numeric LED displays. (BCD is translated digit by digit and the appropriate number is shown)

2 Logic

Logic math (`Boolean Algebra`) existed before digital computers. It explained logic, by the means of math, utilizing 2 values (*True or False*).

- As a transistor is a binary output, logic can be implemented
- Basic functions are `AND, OR, NOT`

- **AND** →All inputs mus tbe true for the expression too be true. $z = xy, z = x * y$ late
- **OR** →Any 1 input can be true for the expression to be true. $z = x + y$
- **NOT** →Reverse the expression/scoped output from true to false and vice versa. $z = x' = \bar{x}$

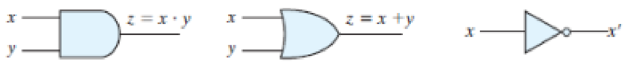
Truth Tables of Logical Operations

AND				OR				NOT	
x	y	$x \cdot y$		x	y	$x + y$		x	x'
0	0	0		0	0	0		0	1
0	1	0		0	1	1		1	0
1	0	0		1	0	1			
1	1	1		1	1	1			

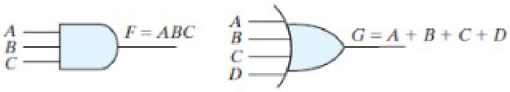
2.1 Logic gates

These functions are implemented with logic gates, Electronic device to implement Boolean function.

- These gatees have mulitple inputs and one output.
- They use specific symbols in their schematic representation



(a) Two-input AND gate (b) Two-input OR gate (c) NOT gate or inverter

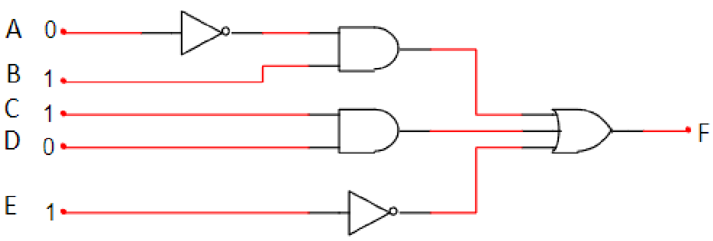


(a) Three-input AND gate (b) Four-input OR gate

Boolean Functions

Varibales are used to represent inputs and outputs. in a Boolean function, ANDs appear as a product and ORs appear as a sum. NOT is represented with a ' or a bar above the variable.

- In a Boolean function, ANDs appear as a product and ORs appear as a sum. NOT is represented with a ' or a bar above the variable



1. The output of the cicuit, F: 1
2. Circuit as a boolean expression: $F = \bar{A}B + CD + \bar{E}$

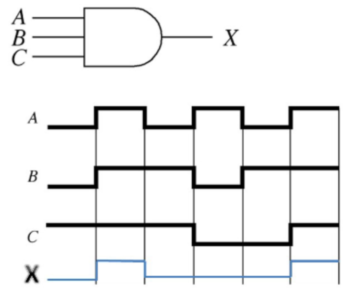
Cascading Logic Gates

Logic gates can be cascaded together to create more inputs, for physical logic gates only have a finite amount of inputs.

Timing DIagram

SHows inputs and outputs of a logic circuit over time. ouput of a logic circuit is assumed to change "instantly".

- Inputs are on the top, outputs are at the bottom, for the sake of readability.



Truth Tables

describes all of the possible input combinations to generate an output. can be developed from observing a schematic, and conversely, a schematic can be developed using a truth table.

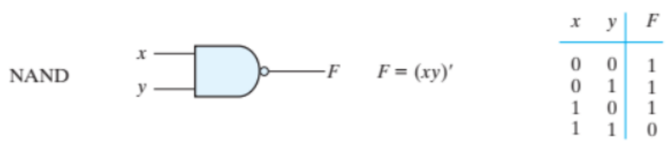
- Left hand side $\rightarrow$inputs from MSB to LSB
- Right hand side $\rightarrow$outputs from MSB to
- Number of rows $= 2^n$, where n is the number of inputs

3 Addional logic gates

NAND

$$F = (XY)' = NOT(X \ and \ Y)$$

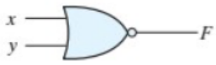
Universal Logic gate: Any gate can be made with NAND



NOR

$$F = (X + Y)' = NOT(X \ OR \ Y)$$

NOR



$F = (x + y)'$

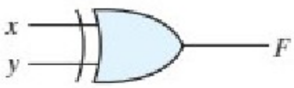
x	y	F
0	0	1
0	1	0
1	0	0
1	1	0

Exclusively OR (XOR)

$$F = X'Y + XY' \text{=x or y but not both}$$

$$F = X \oplus Y$$

Exclusive-OR (XOR)



$F = xy' + x'y$
$= x \oplus y$

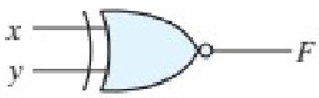
x	y	F
0	0	0
0	1	1
1	0	1
1	1	0

XNOR

***Negated xor gate**

$$F = XY + X'Y'$$

Exclusive-NOR



$F = xy + x'y'$
$= (x \oplus y)'$

x	y	F
0	0	1
0	1	0
1	0	0
1	1	1