Computer Engineering Technology **Name:** Andy Zhang

Logic Gates **Date:** Feb 10 2023

Learning Goal Create a digital circuit from a boolean expression. Evaluate a digital circuit using a truth table. Simplify a digital circuit using boolean identities.

A logic gate is a physical device that performs boolean algebra on digital signals. They can be found inside integrated circuit (IC).

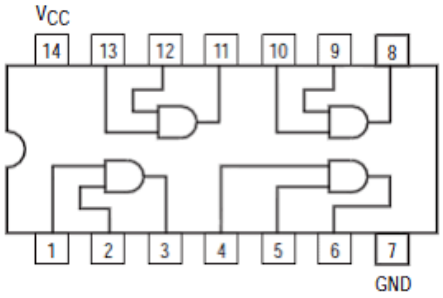
An integrated circuit is a circuit containing many (hundreds – millions) of components (resistors, capacitors, transistors and diodes) pre-packaged inside a small electronic chip.

The diagram shows an IC containing four AND gates.

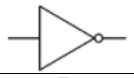
The pins are represented by the numbered squares.

VCC is connected to positive. GND is connected to negative.

The lines represent the connections between the pins and the gate.



NOT



$\bar{A}$

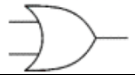
Input A	Output
1	0
0	1

AND
(Both on)

AB

Input A	Input B	Output
0	0	0
0	1	0
1	0	0
1	1	1

OR
(At least one on)

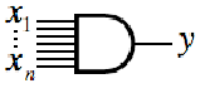


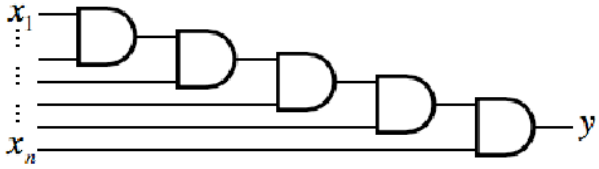
$A + B$

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	1

Multiple Inputs

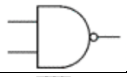
Multiple input gates can be made by joining multiple gates of the same type.





Every gate can be made using a combination of NOT, AND, OR.

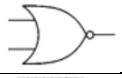
NAND
(Not And/At least one off)



$\overline{AB}$

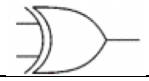
Input A	Input B	Output
0	0	1
0	1	1
1	0	1
1	1	0

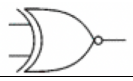
NOR
(Not Or/Neither are on/Both off)



$\overline{A + B}$

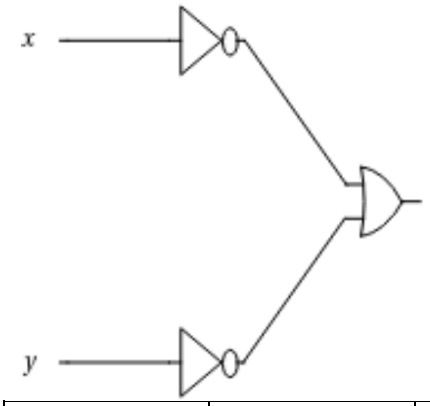
Input A	Input B	Output
0	0	1
0	1	0
1	0	0
1	1	0

XOR (Exactly one on/Inequality)		
		
$A \oplus B$		
Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	0

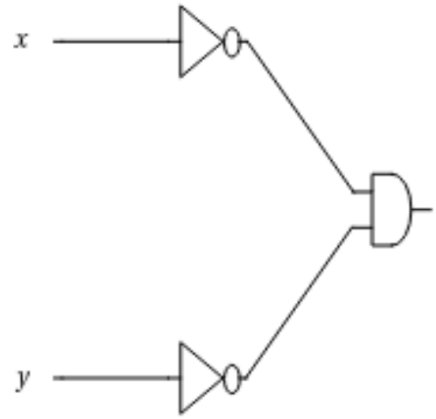
XNOR (Both on or both off/Equality)		
		
$A \odot B$		
Input A	Input B	Output
0	0	1
0	1	0
1	0	0
1	1	1

Reading Digital Circuits

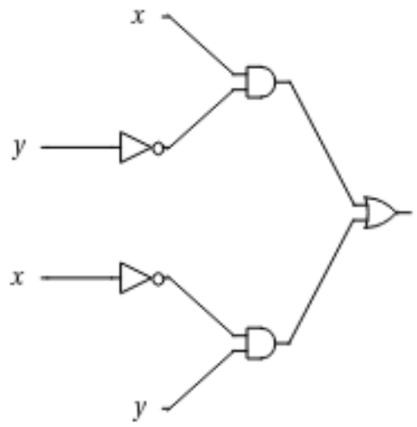
Digital circuits are made from combining logic gates. We can interpret digital circuits using a truth table.



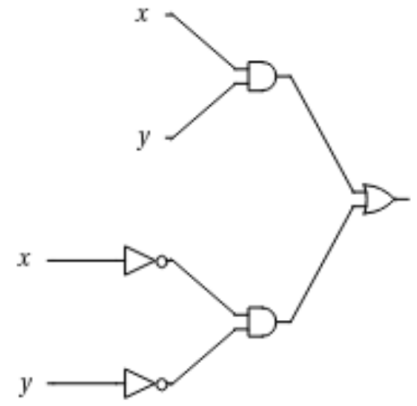
x	y	!x	!y	!x + !y
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0



x	y	!x	!y	(!x)(!y)
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0



x	y	!x	!y	x(!y)	(!x)y	x(!y) + (!x)y
0	0	1	1	0	0	0
0	1	1	0	0	1	1
1	0	0	1	1	0	1
1	1	0	0	0	0	0



x	y	!x	!y	xy	(!x)(!y)	xy + (!x)(!y)
0	0	1	1	0	1	1
0	1	1	0	0	0	0
1	0	0	1	0	0	0
1	1	0	0	1	0	1

Creating Circuits from a Boolean Expression

1. $AB + CD$	2. $(\bar{A}B)(\bar{C}\bar{D})$
3. $\bar{A}\bar{B} + AB$	4. $(A + B)(\bar{A} + \bar{B})$