

# Performing Arithmetic&Logic Operations on Quantum Computer

Ali Hakim Taşkiran  
Department of Electrical&Electronics Engineering

# What is Logic?

***“The science of thinking about or explaining the reason for something using formal methods.”[1]***

**Logic enables us to relate and link statements.**

# Statement

***“Something that you say or write that gives information or an opinion.”[1]***

**“Ankara is capital of Turkey”(True)**

**“Books are printed on paper”(True)**

**“Inconsistent behaviour is consistent”(False)**

# Role of Statements in Logic

Reality may be unreal **and** it may .

# Logic Gate

## Logic Gate Symbols



OR



NOR



AND



NAND



XOR



XNOR



Buffer



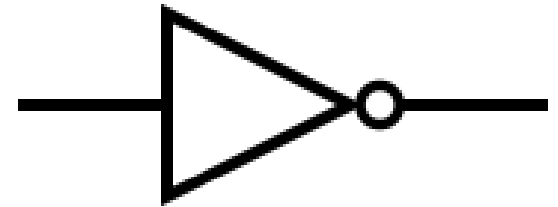
NOT

# NOT

*“used to give the following word or phrase a negative meaning”[1]*

I did **not** buy **apple**

A	A'
1	0
0	1



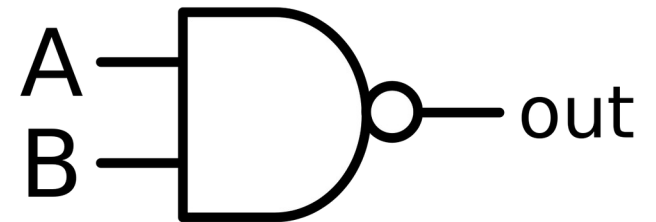
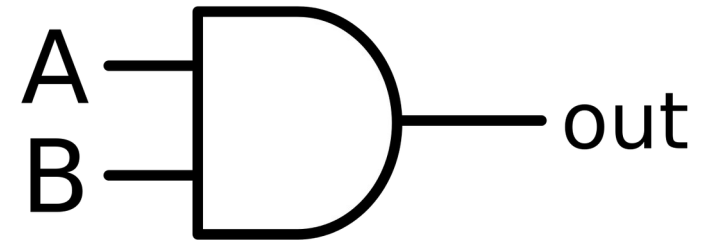
# AND

*“Used to connect words or parts of sentences”[1]*

I bought **apple**and**banana** from market

\*Both of them

A	B	A&B
1	1	1
1	0	0
0	1	0
0	0	0

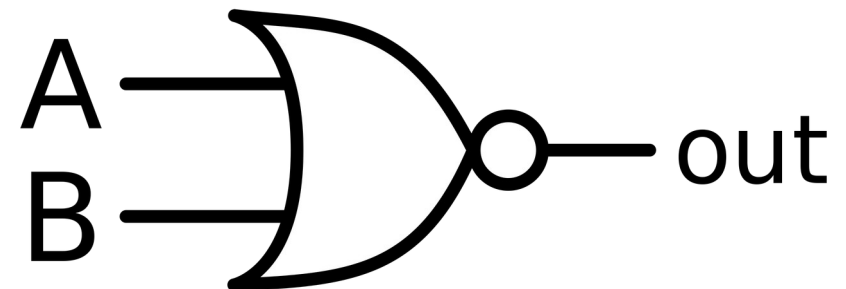
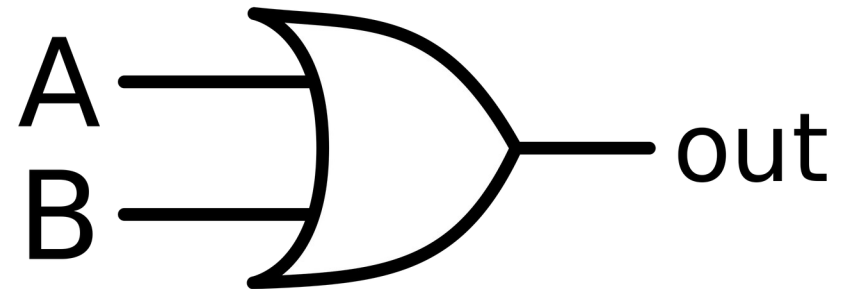


# OR

*“Used to introduce another possibility”[1]*

I bought **apple\_or\_banana** from market

A	B	A    B
1	1	1
1	0	1
0	1	1
0	0	0





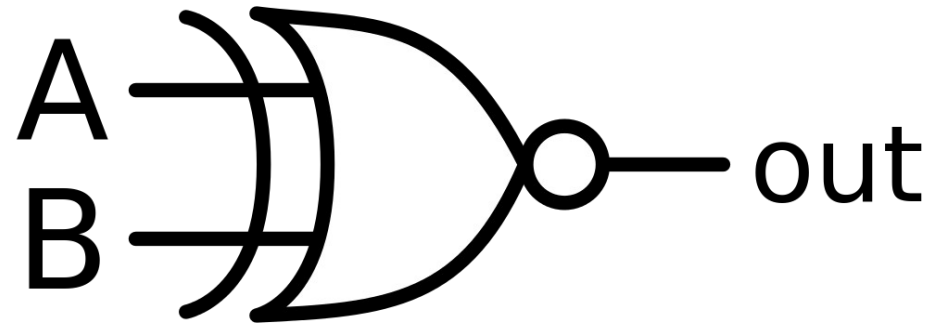
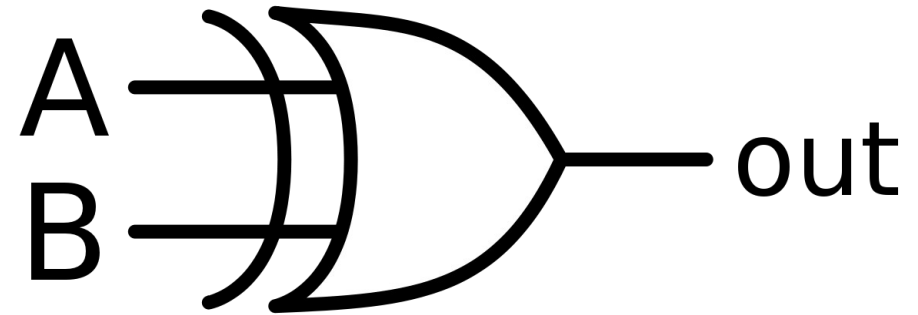
# XOR(Either)

*“One or the other of two; it does not matter which”[1]*

I bought **either apple or banana** from market

\*Not both and not none of them

A	B	$A \oplus B$
1	1	0
1	0	1
0	1	1
0	0	0

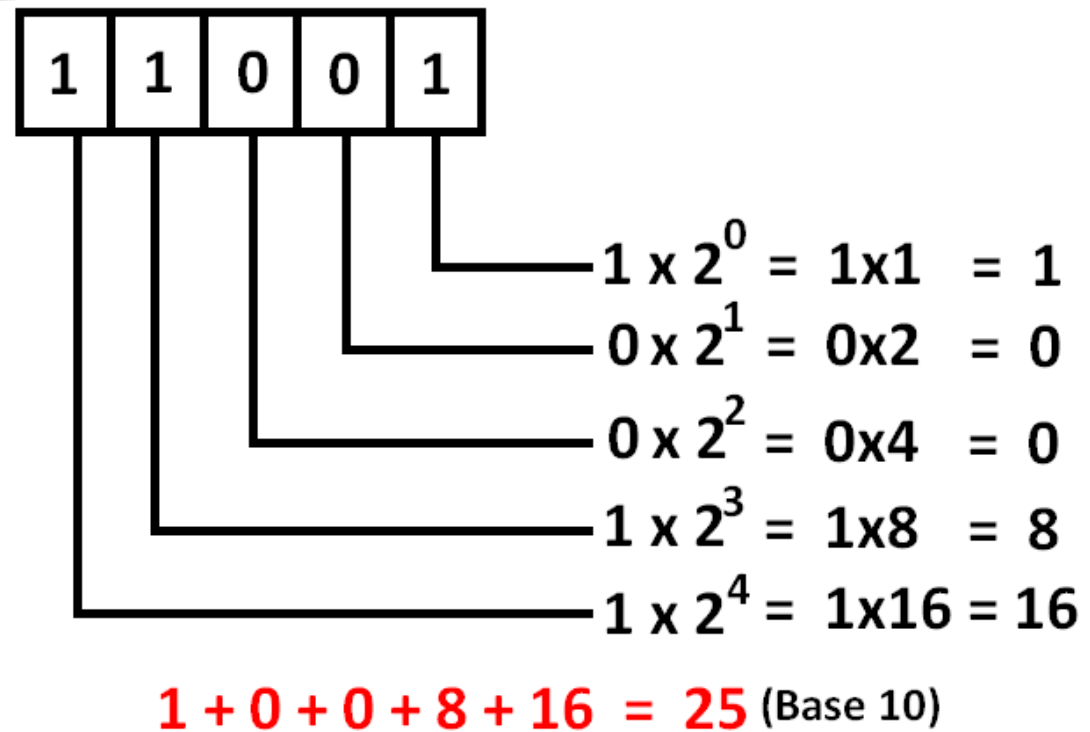


# What Is Arithmetic?

***“The type of mathematics that deals with the adding, multiplying, etc. of numbers.”[1]***

# Expressing Numbers in Binary

2	4215	
2	2107	— 1 ← LSB
2	1053	— 1
2	526	— 1
2	263	— 0
2	131	— 1
2	65	— 1
2	32	— 1
2	16	— 0
2	8	— 0
2	4	— 0
2	2	— 0
2	1	— 0
	0	— 1 ← MSB



# Addition

$$\begin{array}{r} 111 \\ + 101 \\ \hline \end{array}$$

# Addition

$$\begin{array}{r} 111 \\ + 101 \\ \hline \end{array}$$

↓

$$10$$

# Addition

$$\begin{array}{r} 1 \\ 111 \\ + 101 \\ \hline \end{array}$$

0

↓

10

# Addition

$$\begin{array}{r} 1 \\ 111 \\ + 101 \\ \hline \end{array}$$

↓ 00

$$\begin{array}{r} 11 \end{array}$$

# Addition

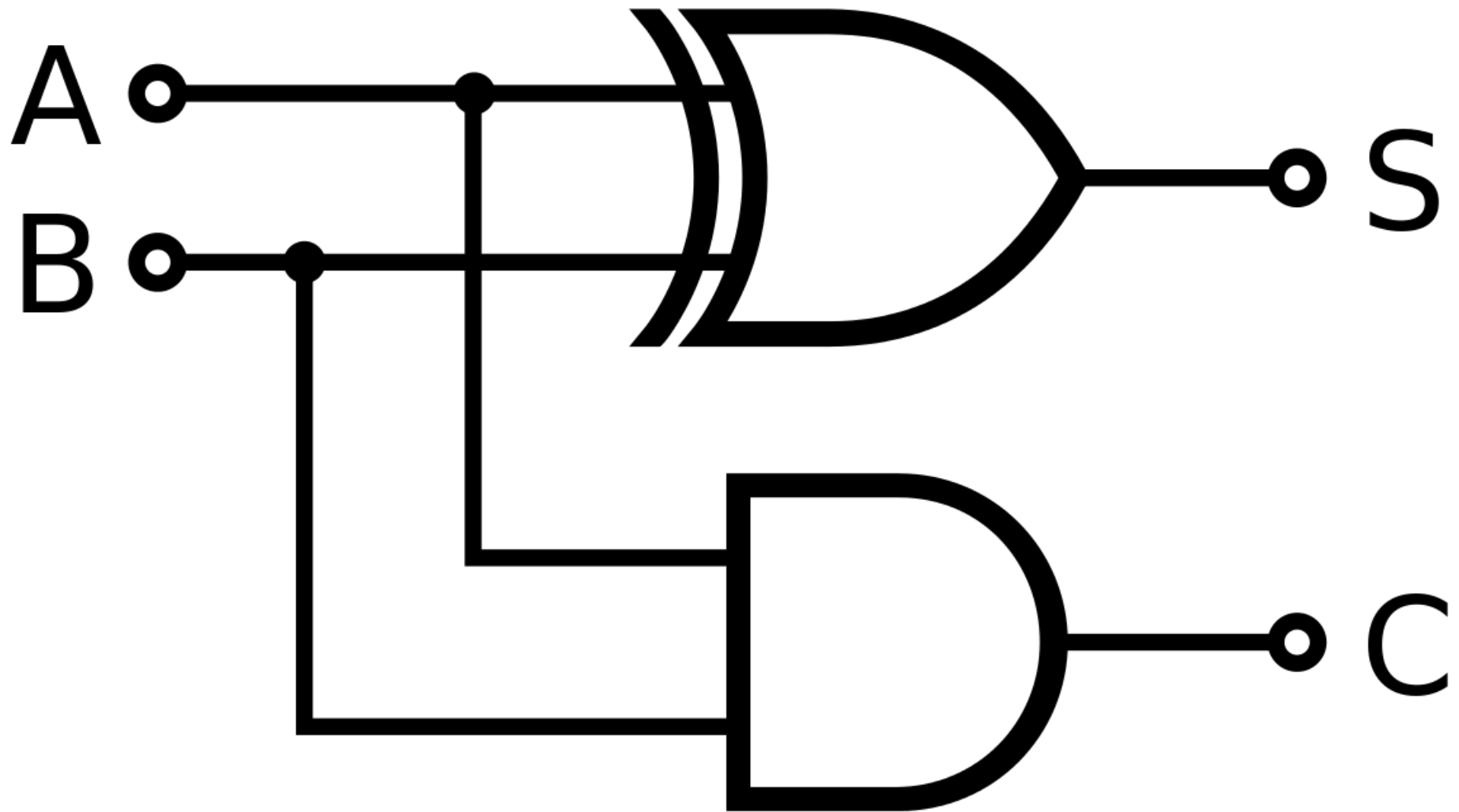
$$\begin{array}{r} 111 \\ + 101 \\ \hline 1100 \end{array}$$



# Addition

A	B	Carry	Sum
1	1	1	0
1	0	0	1
0	1	0	1
0	0	0	0

# Half Adder



# What If We Add Carry?

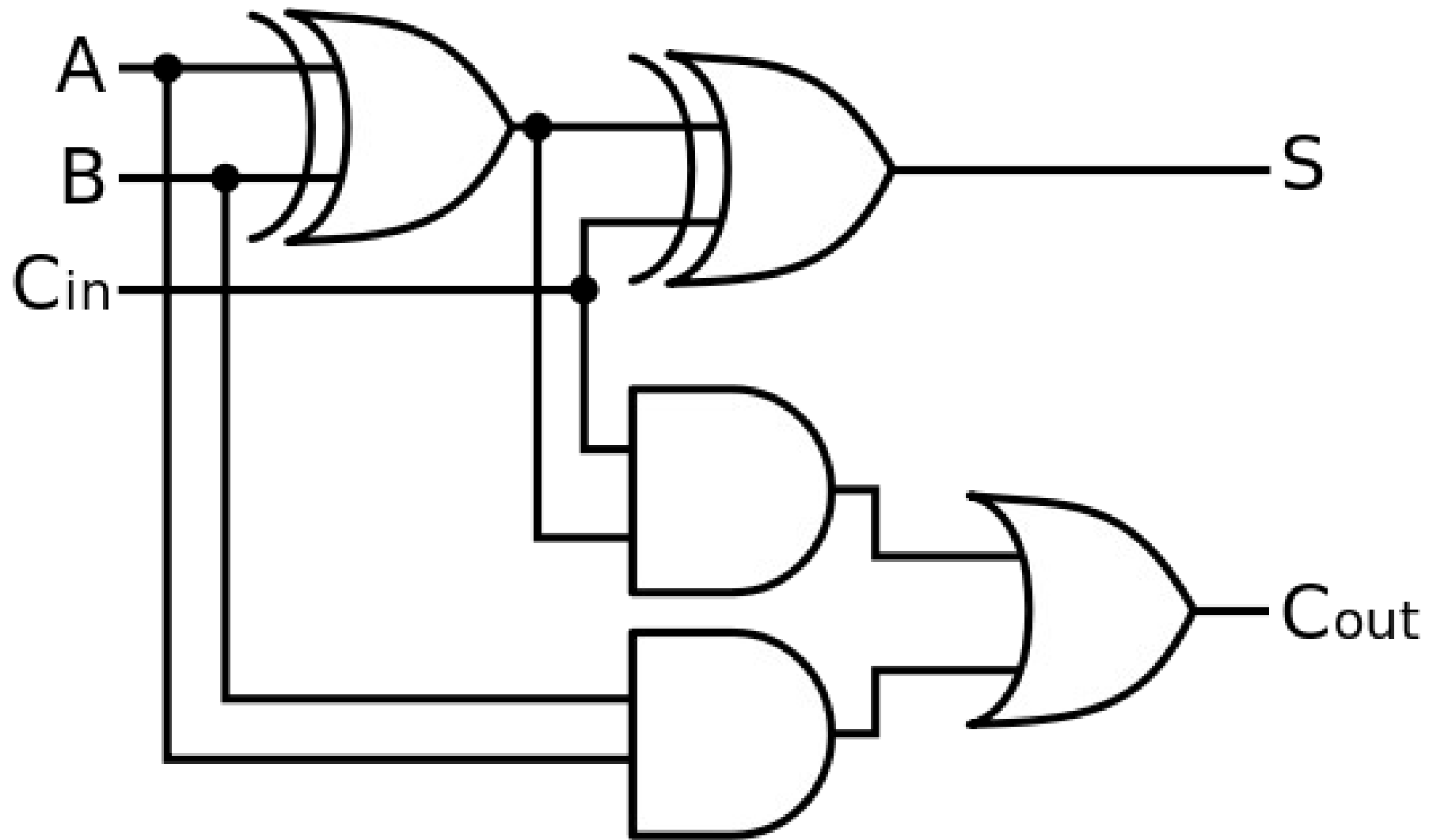
**We will no longer perform  $A+B+\text{Carry}$  operation with 2 inputs.**

**We need a new circuit for adding three addend**

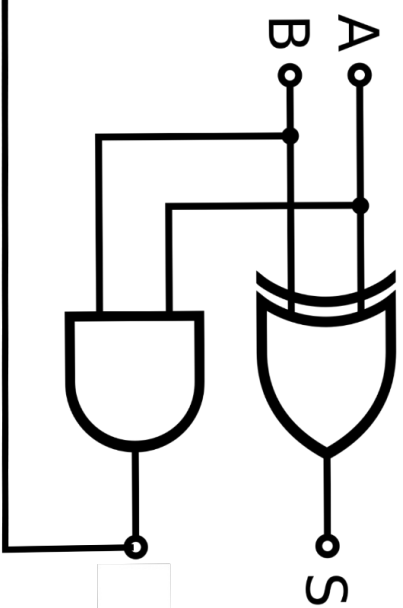
# Full Adder

A	B	$C_{in}$	$C_{out}$	Sum
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

# Full Adder

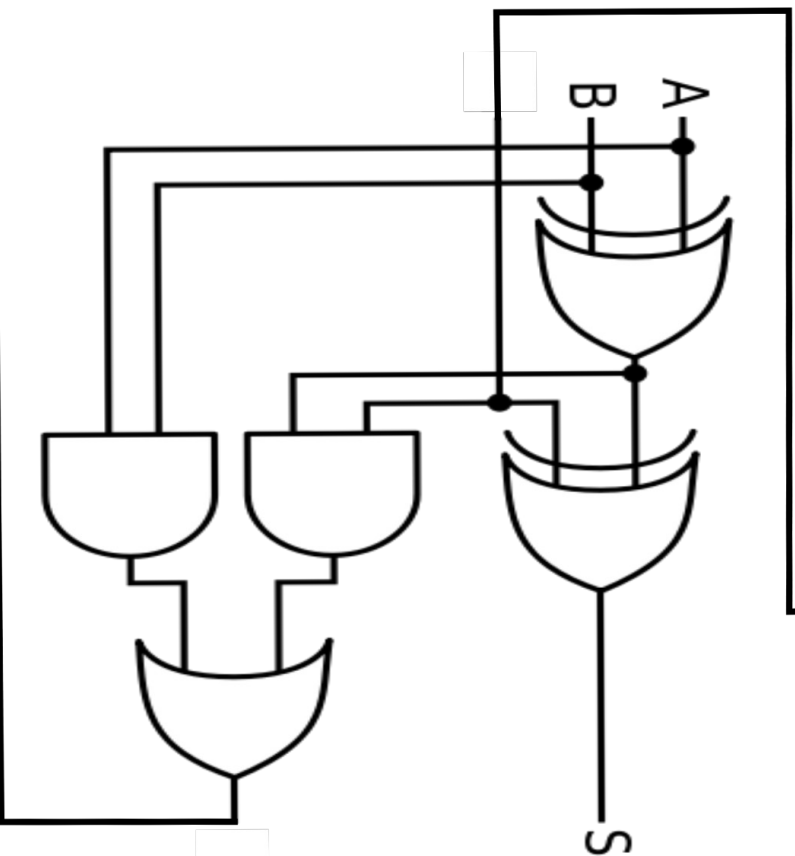


0



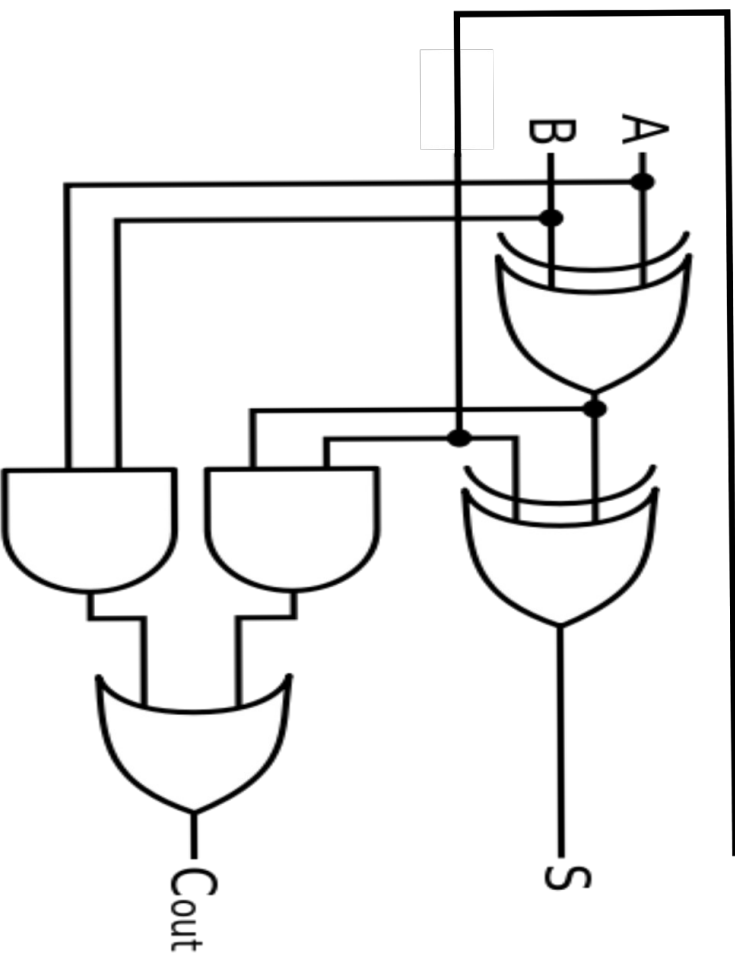
0

1



1

2



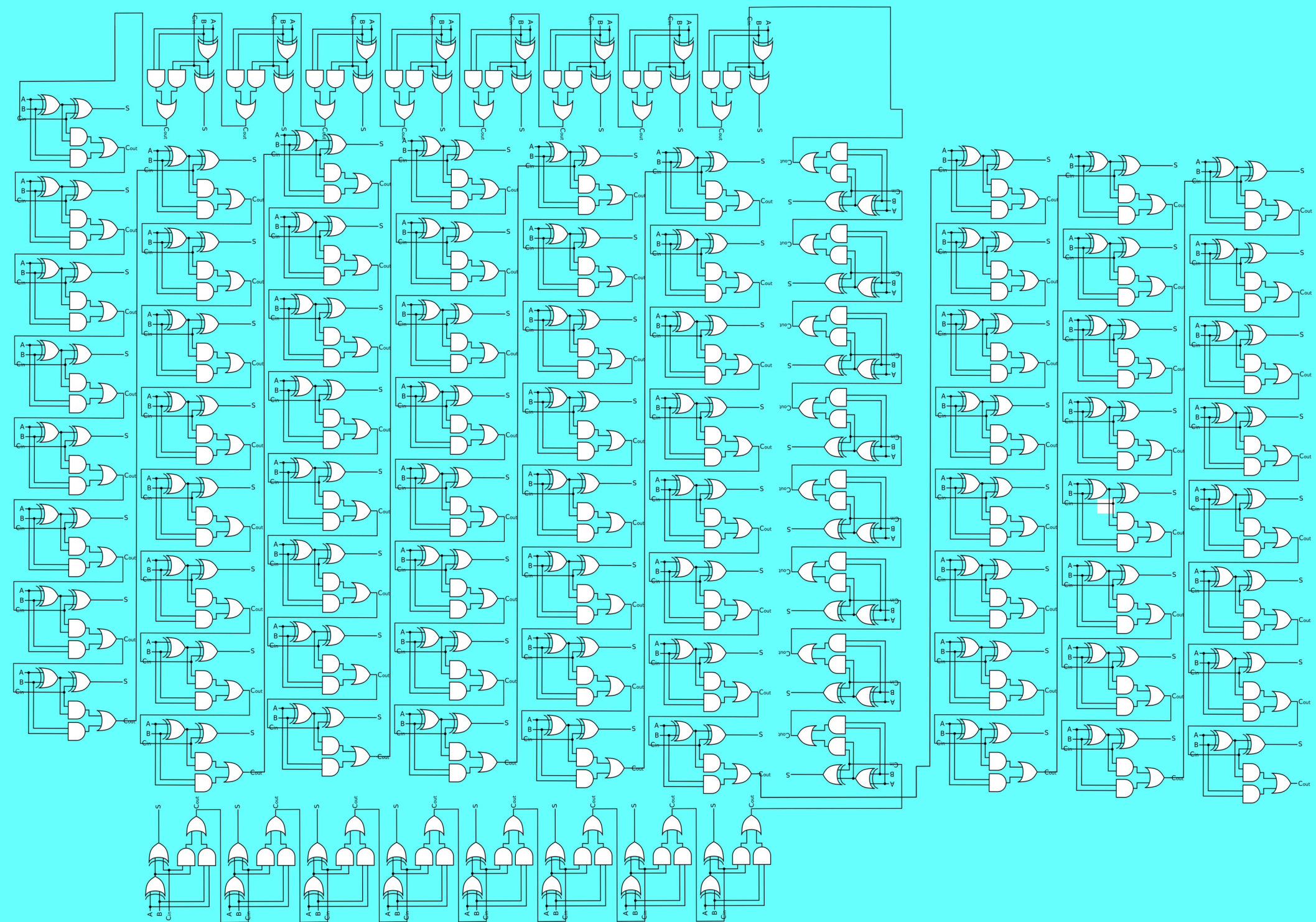
2

3

# Using Quantum Mechanics

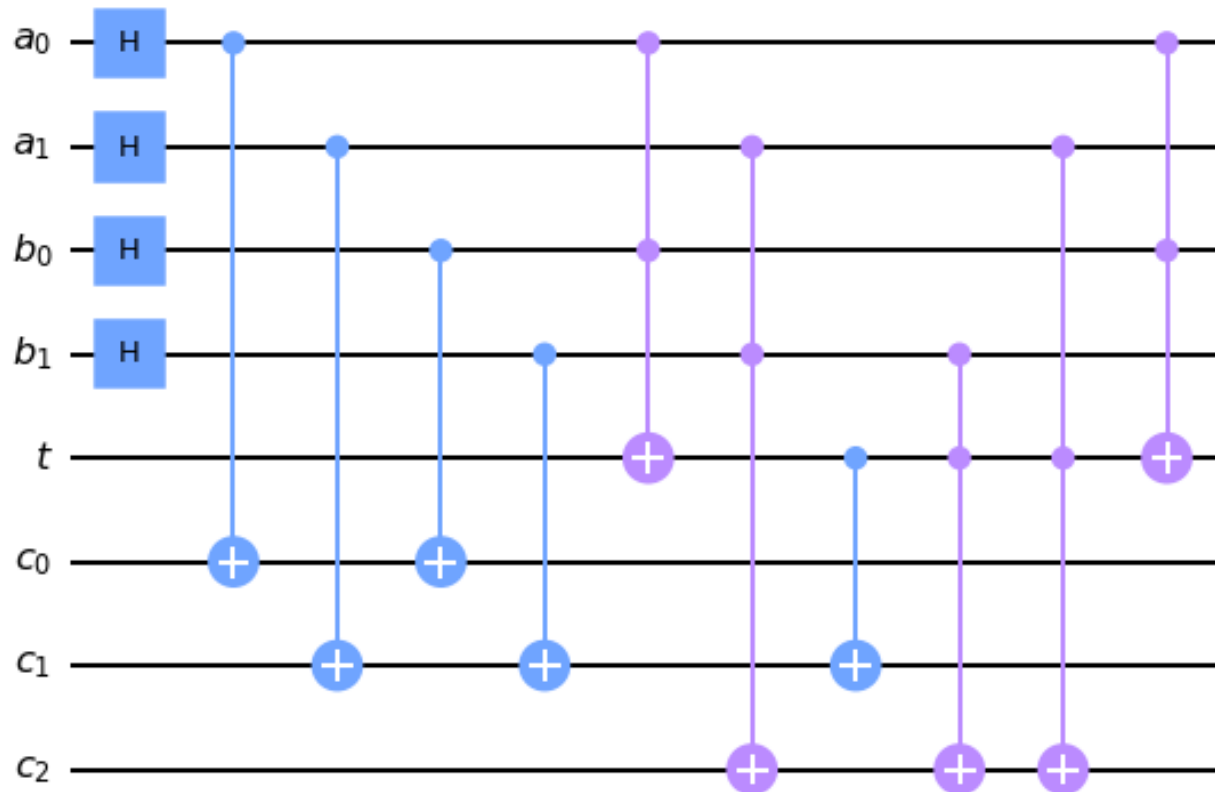
**Quantum mechanics accelerates addition insanely.**

**We are able to perform 64 summing operations in the same instance if we use previous adder circuit .**





# Quantum Adder



0=0+0	000000-00000-00000
0=1+3	000000-00001-00011
0=3+1	000000-00011-00001
1=0+1	000001-00000-00001
1=1+0	000001-00001-00000
2=0+2	000010-00000-00010
2=1+1	000010-00001-00001
2=2+0	000010-00010-00000
3=0+3	000011-00000-00011
3=1+2	000011-00001-00010
3=2+1	000011-00010-00001
3=3+0	000011-00011-00000
4=2+2	000100-00010-00010
5=2+3	000101-00010-00011
5=3+2	000101-00011-00010
6=3+3	000110-00011-00011
16	

# References

**[1] OxfordLearningDictionaries,viewed 21 Oct 2021 ,<  
<https://www.oxfordlearnersdictionaries.com/> >**

**Thank you for your time**