Digital Logic Design (EL-227)

LABORATORY MANUAL

SPRING - 2021

LAB 03
Secondary Gates

LAB#03

SECONDARY GATES:

"Secondary gates can be made by the combinations of primary gates".

There are four types of secondary gates: -

1. The NAND Gate.
2. The NOR Gate.
3. The XOR Gate.
4. The XNOR Gate.

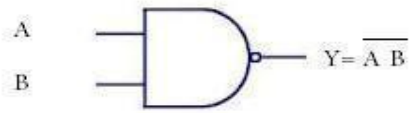
NAND and NOR Gates are also known as universal gates because any Boolean function can be implemented by using NAND or NOR gates individually.

The NAND Gate:

"It is a device whose output is 1 if at least one or all of the inputs are low (0)".

The NAND Gate is a popular logic element because it can be used as a universal gate; that is, NAND gates can be used in combi nation to perform the AND, OR and inverter operations.

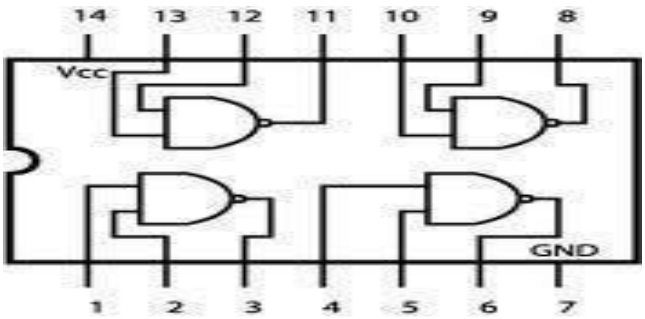
Logic symbol:



Truth Table:

2 Input NAND gate		
A	B	$\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Pin Diagram of 74LS00 IC:



NAND gate can also be implemented by using primary gates.

The NOR Gate:

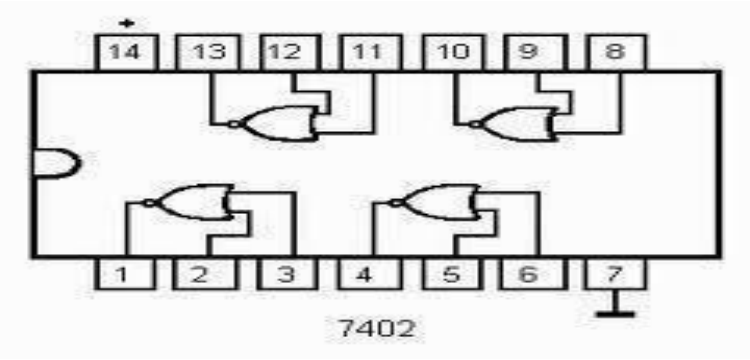
"It is a device whose output is 1 if all the given inputs are low (0)".
The NOR gate, like NAND gate, is a useful logic element because it can also be used as a universal gate; i.e., NOR gates can be used in combination to perform the AND, OR and inverter operations. The term NOR is contraction of NOT-OR and implies an OR function with an inverted output.

Logic symbol:

Truth Table:

2 Input NOR gate		
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Pin Diagram of 74LS02:



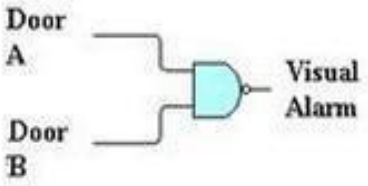
NOR Gate can also be implemented by using primary gates.

Applications of Logic Gates

1. Car Door Open System of an Automobile

A car needs to be designed that the driver gets a visual indication if any of the doors of the car is open so that it helps to avoid accident and injury to the passengers. Assuming there are two doors (just for simplicity, it works for more doors as well) where this system is fitted, the circuit can be designed using a NAND gate as follows You can see from the figure that when any of the switches is open due to the door position, the NAND gate energies the lamp inside the car, hence warning the driver.

A Car Door Open Warning System using a NAND Gate



(3) The Exclusive-OR Gate (XOR Gate):

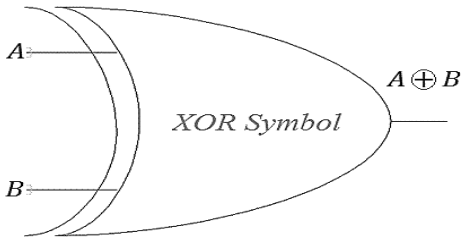
The exclusive OR function is an interesting and useful logical operation. As the name implies, it is similar to the previously studied OR function, but it's a new and distinct operation.

"It is a device whose output is 1 only when the two inputs are different, but 0 if the inputs are the same."

This is useful for circuits that compare inputs; if the inputs are different, then the output will be true, otherwise it is false.

The symbol for exclusive-OR function is $\oplus$ *and the logical expression is shown in fig below*

Logic Symbol:

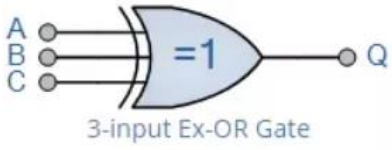


Truth table for XOR gate:

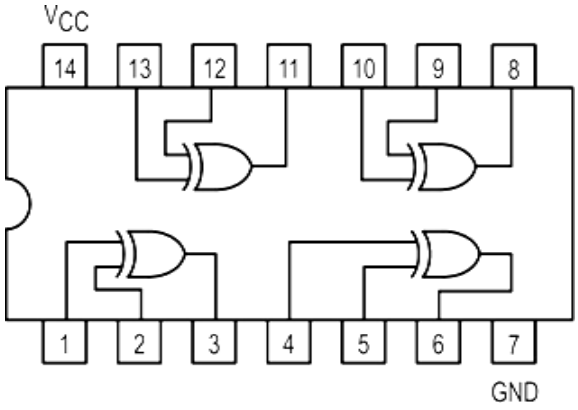
Inputs		Output
A	*B*	*X*
0	0	0
0	1	1
1	0	1
1	1	0

Multiple input XOR gate

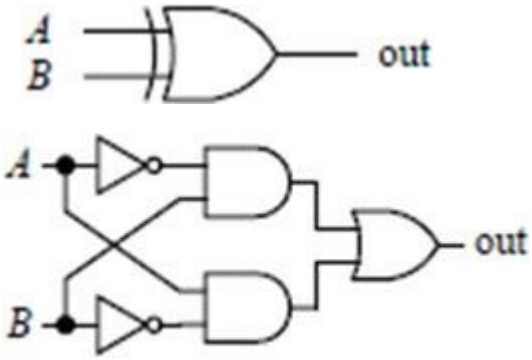
"The XOR gate is an odd function, that is, it is equal to 1 if the input variables have an odd number of 1's."

Symbol	Truth Table			
 3-input Ex-OR Gate	C	B	A	Q
	0	0	0	0
	0	0	1	1
	0	1	0	1
	0	1	1	0
	1	0	0	1
	1	0	1	0
	1	1	0	0
	1	1	1	1

IC Diagram:

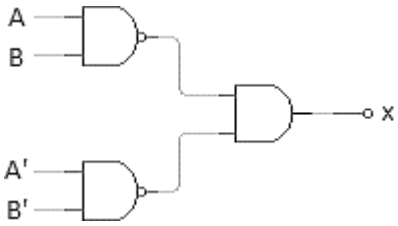


The XOR gate can be implemented by using primary gates as follows:



A xor B = A'B + AB'

A second logic circuit which perform the exclusive OR operation is shown in fig 1.2



X=A.B + A.B = A.B + A.B

Fig.1.2

Parity-Check Circuit:

The parity of a binary number simply refers to the number of 1's in the binary number. If there are an even number of 1's, it is said to have even parity. If there are an odd number of one's, it is said to have odd parity.
For example, the binary number 1001110 has four 1's in it (an even number of 1's) and its parity is thus even. Alternately, the binary number 1110011 has odd parity.
The circuit shown in fig.1.3 provides a means for checking the parity of a 4-bit word ABCD. The output (x) will be 0 for an even-parity word and 1 for an odd-parity word.
For example, A=1, *B*=0, *C*=0, *D*=1 yields *X*=0.

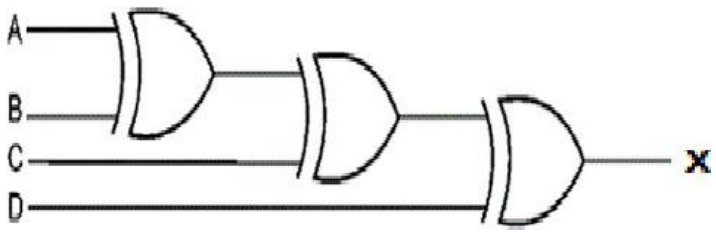
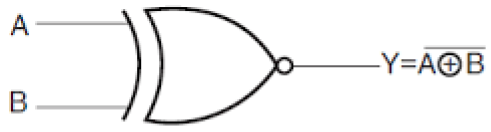


Fig 1.3.

Exclusive-NOR Gate (XNOR)

An XNOR gate (sometimes referred to as Exclusive NOR gate) is a digital logic gate with two or more inputs and one output that performs *logical equality*. The output of an XNOR gate is **1** when all of its inputs are **same**. If some of its inputs are **1** and others are **0**, then the output of the XNOR gate is **0**

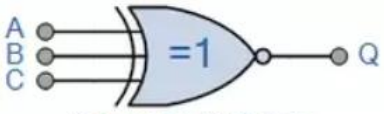


$$Y = \overline{(A \oplus B)} = (A.B + \overline{A}.\overline{B})$$

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

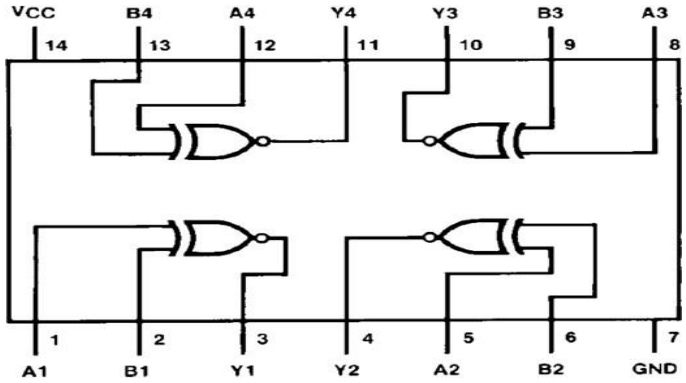
Multiple input XNOR gate

"The XOR gate is an even function, that is, it is output is equal to 1 if the inputs have an odd number of 0's."

Symbol	C	B	A	Q
	0	0	0	1
	0	0	1	0
	0	1	0	0
	0	1	1	1
	1	0	0	0
	1	0	1	1
	1	1	0	1
	1	1	1	0

3-input Ex-NOR Gate

Pin Diagram of 74266 IC:



XNOR Gate can also be implemented by using primary gates as follows.

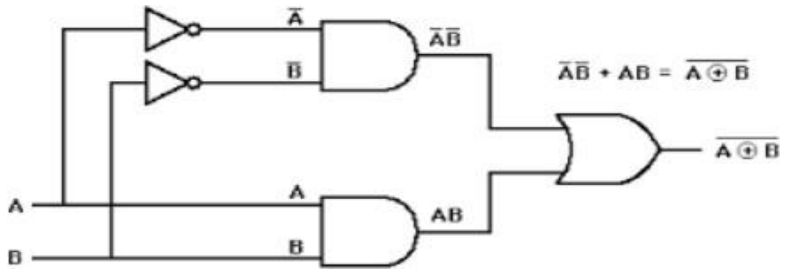


Fig.1.4