XOR and XNOR Gates

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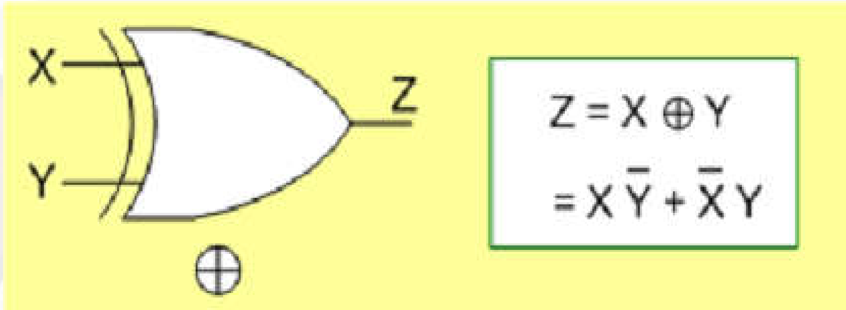
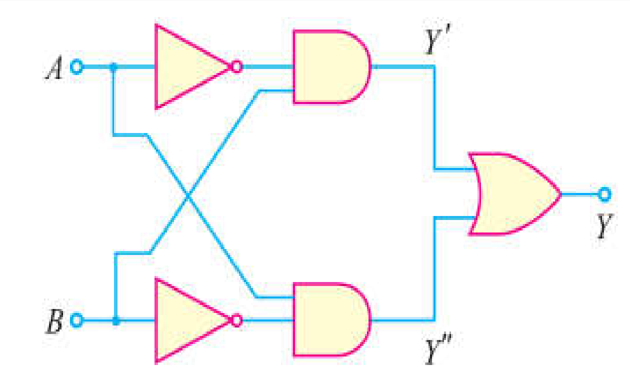
Introduction : XOR Gate

The exclusive-OR (XOR), operator uses the symbol ⊕, and it performs the following logic operation:
$X \oplus Y = X Y' + X' Y$



Logic Symbol

XOR Gate



When inputs are same , output will be 0

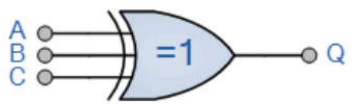
X	Y	XOR
0	0	0
0	1	1
1	0	1
1	1	0

Truth Table

The result is 1 only when either X is equal to 1 or Y is equal to 1, but not when both X and Y are equal to 1.

Three input XOR Gate

Symbol



3-input Ex-OR Gate

Truth Table

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

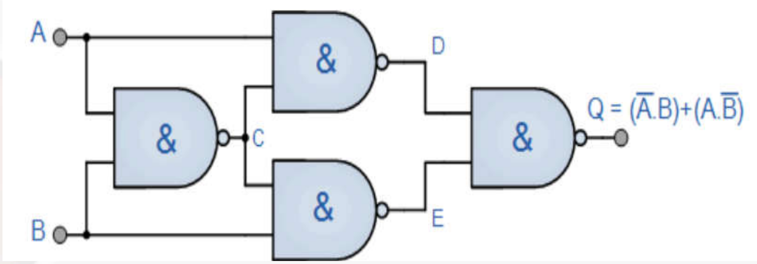
Boolean Expression $Q = A \oplus B \oplus C$

"Any **ODD** Number of Inputs" gives Q

$$Q = A\overline{BC} + \overline{A}B\overline{C} + \overline{AB}C + ABC$$

XOR Gate Realization using NAND gates

Exclusive-OR Gates are used mainly to build circuits that perform arithmetic operations and calculations especially **Adders** as they can provide a “carry-bit” function or as a controlled inverter, where one input passes the binary data and the other input is supplied with a control signal.

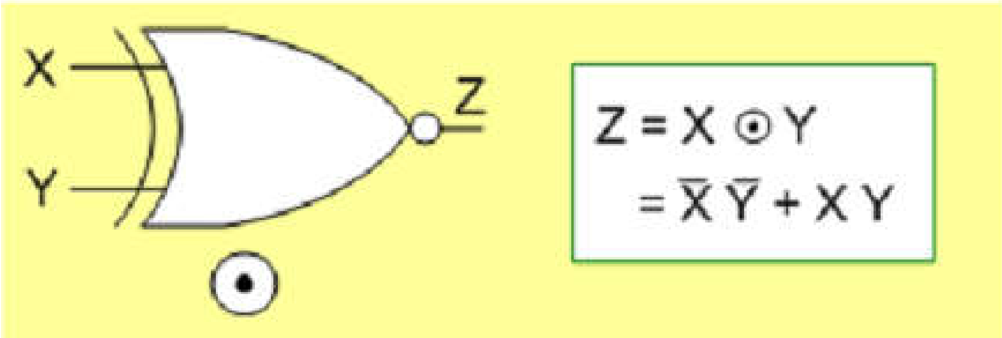


XNOR Gate

The exclusive-NOR (XNOR), operator uses the symbol ⊙, and it performs the following logic operation

$X \odot Y = X Y + X' Y' = (X \oplus Y)'$

Logic Symbol



XNOR Gate

The result is 1 when either both X and Y are 0's or when both are 1's. That is why this gate is often referred to as the **Equivalence** gate.

The truth tables clearly show that the exclusive-NOR operation is the complement of the exclusive-OR.

This can also be shown by algebraic manipulation as follows:

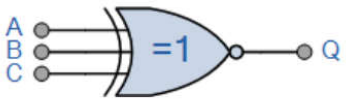
$$(X \oplus Y)' = (X Y' + X' Y)'$$
$$= (X Y')' (X' Y)' = (X' + Y) (X + Y')$$
$$= (XY + X'Y')$$
$$= X \odot Y$$

Truth Table

X	Y	XNOR
0	0	1
0	1	0
1	0	0
1	1	1

3-input Ex-NOR Gate

Symbol



3-input Ex-NOR Gate

Truth Table

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

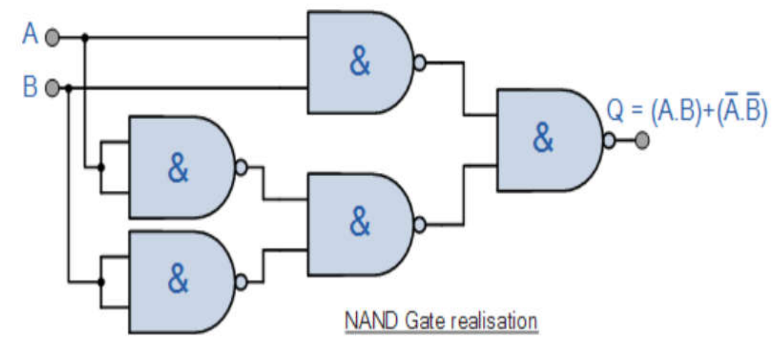
Boolean Expression $Q = \overline{A \oplus B \oplus C}$

Read as "any **EVEN** number of Inputs" gives Q

$$Q = \overline{A}\,\overline{B}\,\overline{C} + AB\overline{C} + A\overline{B}C + \overline{A}BC$$

XNOR Gate Realization using NAND gates

5 NAND logic gates can be used to realise the XNOR gate



Application of XNOR gate

XNOR gates are used mainly in electronic circuits that perform arithmetic operations and data checking such as *Adders*, *Subtractors* or *Parity Checkers*, etc. As the Ex-NOR gate gives an output of logic level “1” whenever its two inputs are equal it can be used to compare the magnitude of two binary digits or numbers and so Ex-NOR gates are used in Digital Comparator circuits.

References:

- Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
- Digital Fundamentals, Thomas L. Floyd, 11th Ed., 2015, Pearson Education Limited
- Modern Digital Electronics, R P Jain, 4th Ed., 2010, Tata McGraw Hill