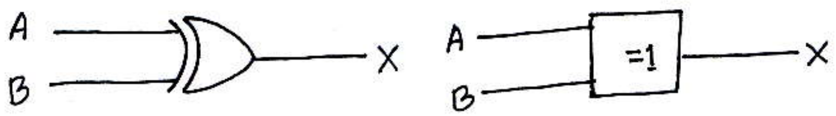
Digital Logic Design :

Lecture 2

Exclusive OR or XOR operation : The XOR operation produces a HIGH when one and only one of two inputs is HIGH.

The XOR gate has only two inputs.

Logic symbol for XOR gate



Truth table for an XOR gate :

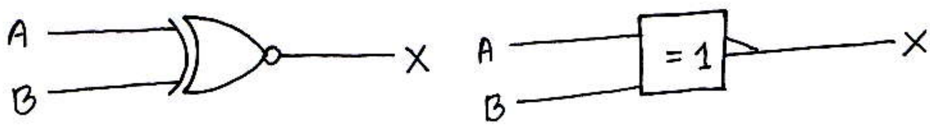
Inputs		Outputs
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

The operational symbol for XOR is $\oplus$

$\therefore \quad X = A \oplus B$

The Exclusive NOR or XNOR gate : The XNOR gate has only two inputs and its output is oppossite to that of XOR gate.

Logic symbol for XNOR gate :



Truth table for an XNOR gate :

Inputs		Outputs
A	B	X
0	0	1
0	1	0
1	0	0
1	1	1

$$X = \overline{A \oplus B} \quad \text{or,} \quad (A \oplus B)'$$

$$X = A \odot B$$

Number system :

Decimal numbers :

$$245.32 = 2\times10^2 + 4\times10^1 + 5\times10^0 + 3\times10^{-1} + 2\times10^{-2}$$

$$= 200 + 40 + 5 + 0.3 + 0.02$$

Binary numbers :

$$(1011)_2 = 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0$$

$$= 8 + 0 + 2 + 1$$

$$= (11)_{10}$$

$$(0.1011)_2 = 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3} + 1\times2^{-4}$$

$$= 0.5 + 0 + 0.125 + 0.0625$$

$$= (0.6875)_{10}$$

Counting in Binary :

Decimal Number	Binary Number (4 digit representation)
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
10	1 0 1 0
11	1 0 1 1
12	1 1 0 0
13	1 1 0 1
14	1 1 1 0
15	1 1 1 1

Binary Addition :

4 basic rules for adding binary digits :

0+0 = 0
0+1 = 1
1+0 = 1
1+1 = 10

add 1010 and 1110 :

$$\begin{array}{r} 1010 \\ +\ 1110 \\ \hline 11000 \end{array} \qquad \begin{array}{r} 10 \\ +\ 14 \\ \hline 24 \end{array}$$

Binary multiplication :

4 basic rules for multiplying binary digits :

0×0 = 0
0×1 = 0
1×0 = 0
1×1 = 1

multiply 111 × 101 :

$$\begin{array}{r} 111 \\ \times\ 101 \\ \hline 111 \\ 000\times \\ 111\times\times \\ \hline 100011 \end{array} \qquad \begin{array}{r} 7 \\ \times\ 5 \\ \hline 35 \end{array}$$

Hexadecimal Numbers :

The Hexadecimal number system has 16 digits,

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F,
10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 1A, 1B, 1C, 1D, 1E, 1F,
20, 21, ...

Binary to Hexadecimal conversion :

$$\overbrace{1100}\ \overbrace{1010}\ \overbrace{0101}\ \overbrace{0111}$$

$$C \quad A \quad 5 \quad 7 \quad = (CA57)_{16}$$

$$10\ \overbrace{1110}$$

$$2 \quad E \quad = (2E)_{16}$$

Hexadecimal to Decimal Conversion:

$$
\begin{aligned}
(A1C5)_{16} &= 10 \times 16^3 + 1 \times 16^2 + 12 \times 16^1 + 5 \times 16^0 \\
&= 10 \times 4096 + 256 + 192 + 5 \\
&= 40960 + 256 + 192 + 5 \\
&= (41413)_{10}
\end{aligned}
$$

Octal Numbers :

The octal number system is composed of eight digits.

0, 1, 2, 3, 4, 5, 6, 7,
10, 11, 12, 13, 14, 15, 16, 17,
20, 21, ...

Octal to Decimal conversion :

$$(437)_8 = 4\times8^2 + 3\times8^1 + 7\times8^0$$
$$= 4\times64 + 24 + 7$$
$$= (287)_{10}$$

Octal to Binary conversion :

$$(753)_8 = (\overbrace{111}^{7}\ \overbrace{101}^{5}\ \overbrace{011}^{3})_2$$

Binary to Octal conversion :

$$\underbrace{11}_{3}\quad \underbrace{100}_{4}\quad \underbrace{101}_{5}\quad \underbrace{110}_{6} = (3456)_8$$

1's Complement of a Binary Number :

10110010 Binary number

↓↓↓↓↓↓↓↓

01001101 1's complement

2's Complement of a Binary Number :

2's complement = 1's complement + 1

10110010 Binary number

↓↓↓↓↓↓↓↓

01001101 1's complement

+ 1

01001110 2's complement