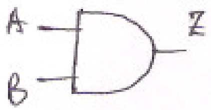
Logic gates

Name | Symbol | Logical operation | Truth Table.

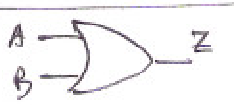
AND



$Z = A \cdot B$

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

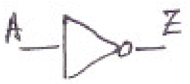
OR



$Z = A + B$.

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

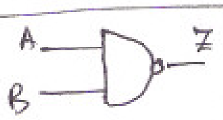
NOT



$Z = \overline{A}$

A	Z
0	1
1	0

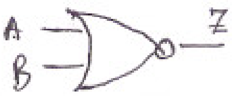
NAND



$Z = \overline{A \cdot B}$

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

NOR



$Z = \overline{A + B}$

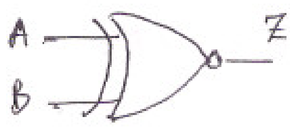
A	B	Z
0	0	1
0	1	0
1	0	0
1	1	0

XOR

$Z = A \oplus B$

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

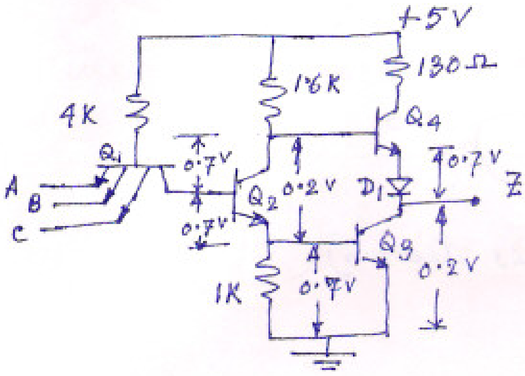
X NOR



$Z = A \odot B$

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

TTL - NAND Gate



D_1 ensures that Q_4 is OFF when Q_2 and Q_3 are ON.

Z = Low → current sinking in Q_3.

Z = High → Current Sourcing by Q_4.

Postulates of Boolean Algebra:-

1) $A \cdot 1 = A$
2) $A + 0 = A$
3) $A \cdot \bar{A} = 0$ } complement law.
4) $A + \bar{A} = 1$ }
5) $AB = BA$ } Commutative Law.
6) $A + B = B + A$ }
7) $A \cdot (B + C) = AB + AC$ distributive Law.
8) $A \cdot (B \cdot C) = (AB)C$ } Associative Law.
9) $A + (B + C) = (A + B) + C$ }

De Morgan's Theorem: It States that the inverse of any logical function is found by complementing all input variables and replacing all AND operations with OR and all OR operations with AND.

Illustrations:

$$\overline{AB} = \bar{A} + \bar{B}$$

$$AB = \overline{\bar{A} + \bar{B}}$$

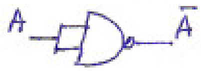
$$\overline{A+B} = \bar{A} \cdot \bar{B}$$

$$A + B = \overline{\bar{A} \cdot \bar{B}}$$

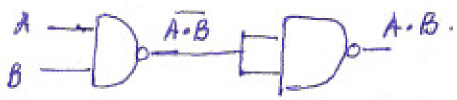
Realisation of diff. gates using only NAND gates

~~1. AND~~

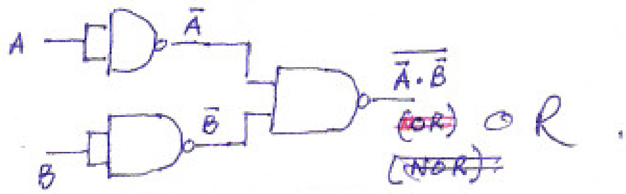
1) NOT :



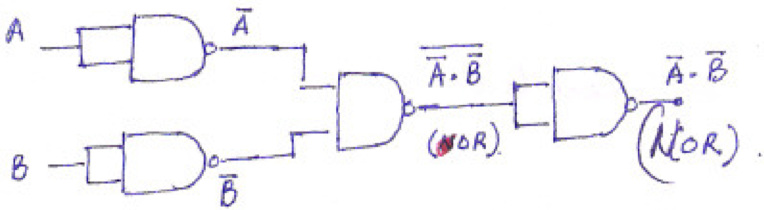
2) AND : $A \cdot B = \overline{\overline{A \cdot B}}$



3) OR : $\overline{\overline{A+B}} = \overline{\bar{A} \cdot \bar{B}}$ (using De Morgan's theorem).



4) NOR = invert OR / Alternatively $\overline{A+B} = \bar{A} \cdot \bar{B}$ (using De Morgan's Theorem).

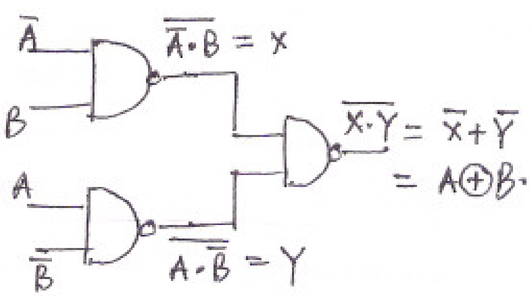


5) XOR : $A \oplus B = \bar{A}B + A\bar{B}$

Let $\overline{\bar{A} \cdot B} = X$; $\overline{A \cdot \bar{B}} = Y$

$\bar{X} = \bar{A} \cdot B$; $\bar{Y} = A \cdot \bar{B}$

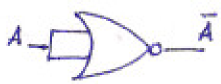
$\overline{X \cdot Y} = \bar{X} + \bar{Y} = A \oplus B$



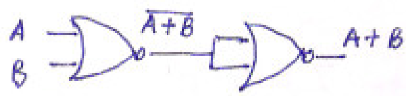
6) XNOR : $A \odot B = \overline{A \oplus B}$

Realisation of diff. gates using only NOR gates

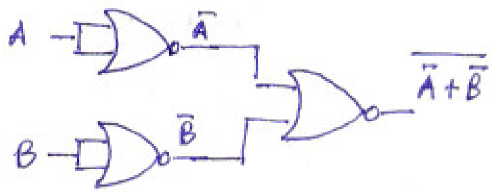
1) NOT :



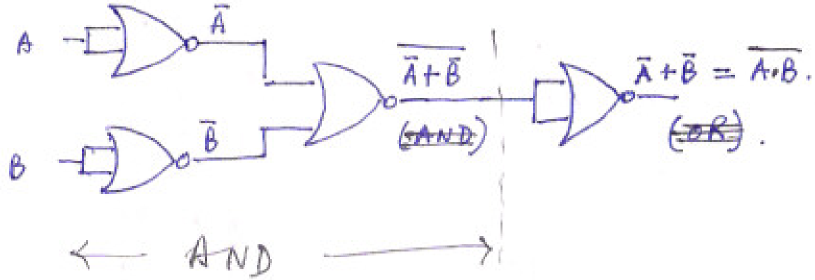
2) OR = Invert NOR



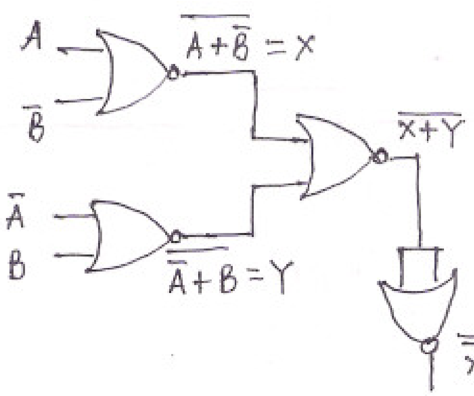
3) AND : $AB = \overline{\bar{A} + \bar{B}}$ (using De Morgan's theorem).



4) NAND = Invert AND: $AB = \bar{A} + \bar{B}$



5) XOR: $A \oplus B = \bar{A}\cdot B + A\cdot\bar{B} = X+Y$ (say).



$\bar{A}\cdot B = \overline{A + \bar{B}} = X$

$A\cdot\bar{B} = \overline{\bar{A} + B} = Y$

$\overline{\overline{X+Y}} = \overline{\bar{X}\cdot\bar{Y}} = X+Y$.

$\overline{\overline{X+Y}} = X+Y = \bar{A}\cdot B + A\cdot\bar{B} = A \oplus B$