

BASICS OF DIGITAL ELECTRONICS

Digital electronics represent signals by discrete bands of analog levels, rather than by a continuous range (Source Wikipedia)

There are only two signal levels **0** or **1 (Binary)**

Circuits which works on this is called as
Logic circuits

Circuits need design, which can be done by some set of equations, called as Boolean equation.

A variable is called as Boolean variable

Example: A represents 1 and $\bar{A}$ represents 0

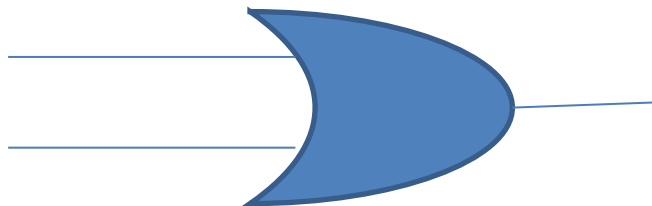
Various operations can be done with these variables, which are called as OR (+), AND (.) ,NOT (basic operations).

NOR, NAND,XOR,XNOR are derived from the basic operations.

Ex. $Y=A+B$ is an **OR** operation

The result of this operation for various combination A and B is represented by a table called as Truth Table.

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



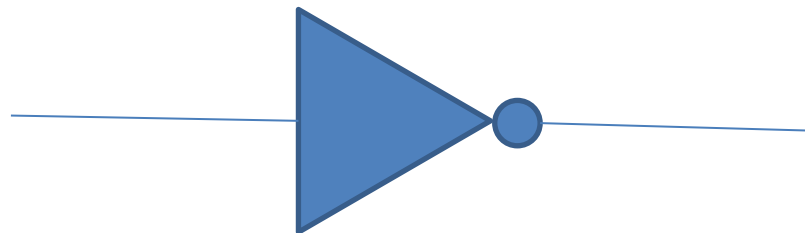
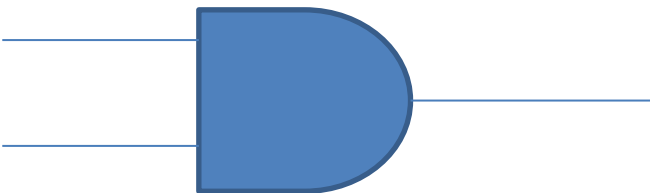
Similarly the truth table for the AND & NOT operations is given by

$$Y = A.B$$

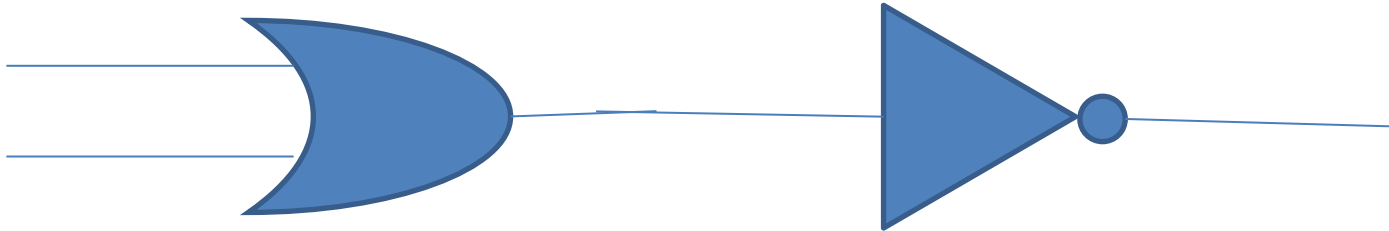
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

$$Y = \overline{A}$$

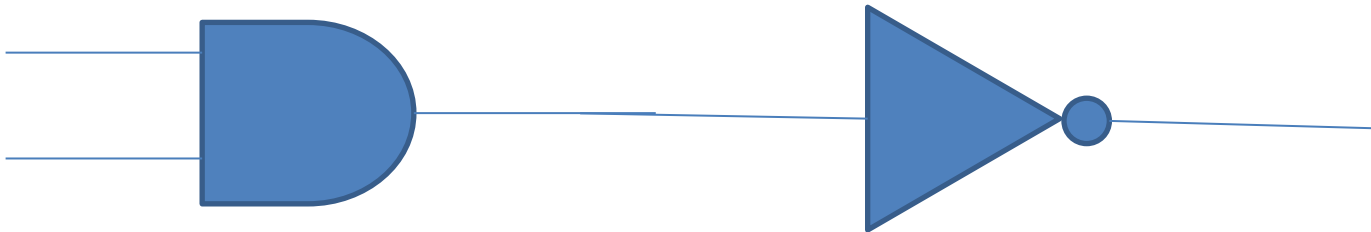
A	Y
0	1
1	0



NOR



NAND

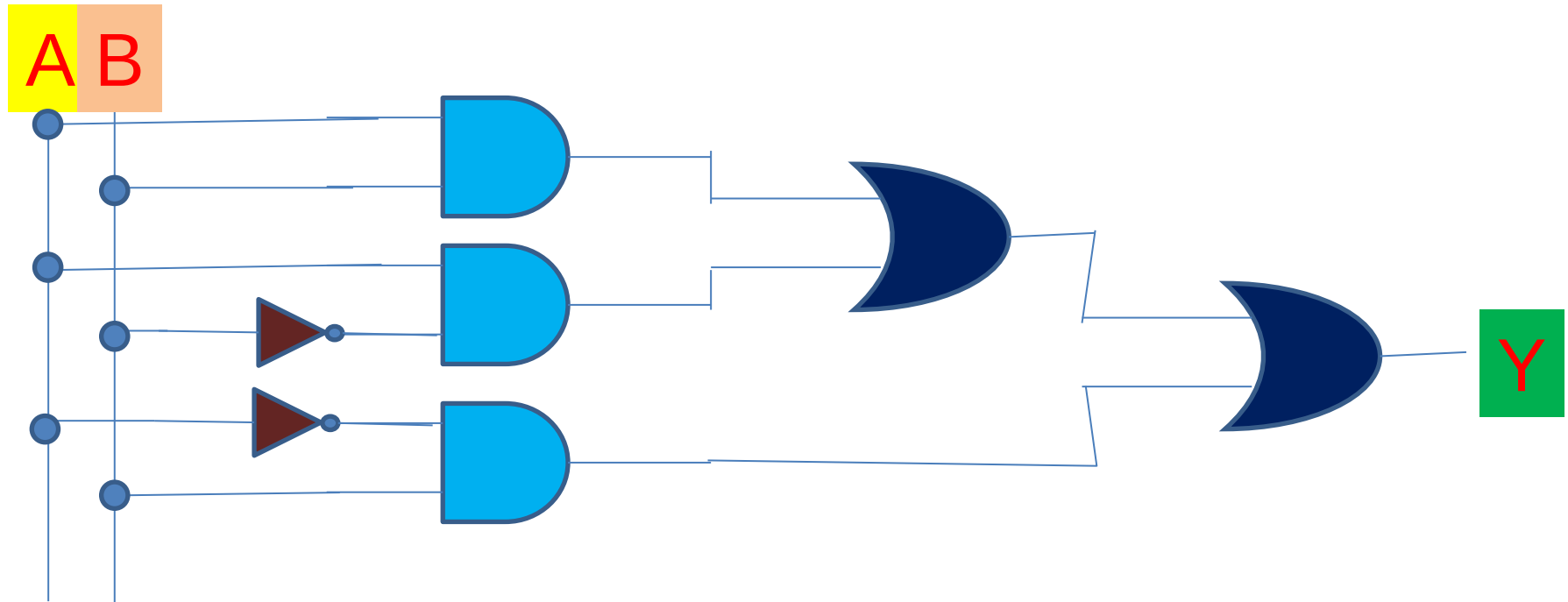


Write the truth table in your notebook ? ? ?

BOOLEAN EQUATION AND ALGEBRA

Let us consider an equation $Y = AB + A\bar{B} + \bar{A}B$

To implement this as it is



The same equation can be reduced to minimum number of literals using Boolean algebra

Commutative Law

(a) $A + B = B + A$

(b) $A B = B A$

Associate Law

(a) $(A + B) + C = A + (B + C)$

(b) $(A B) C = A (B C)$

Distributive Law

(a) $A (B + C) = A B + A C$

(b) $A + (B C) = (A + B) (A + C)$

Identity Law

$$(a) A + A = A$$

$$(b) A A = A$$

Redundance Law

$$(a) A + A B = A$$

$$(b) A (A + B) = A$$

$$0 + A = A$$

$$0 . A = 0$$

$$1 + A = 1$$

$$1 A = A$$

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

$$(A + B)(A + \bar{B}) = A$$

$$A + \bar{A} = 1$$

$$A\bar{A} = 0$$

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

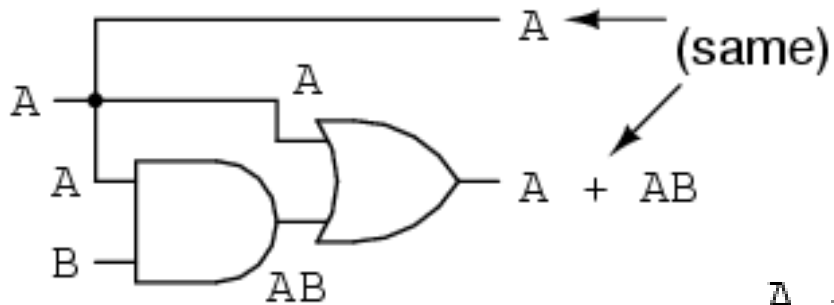
$$A(\bar{A} + B) = AB$$

De Morgan's Theorem

$$\overline{(A + B)} = \bar{A} \bar{B}$$

$$\overline{(\bar{A}\bar{B})} = \bar{A} + \bar{B}$$

$$\mathbf{A + AB = A}$$



$$A + AB$$



$$A(1 + B)$$



$$A(1)$$



$$A$$

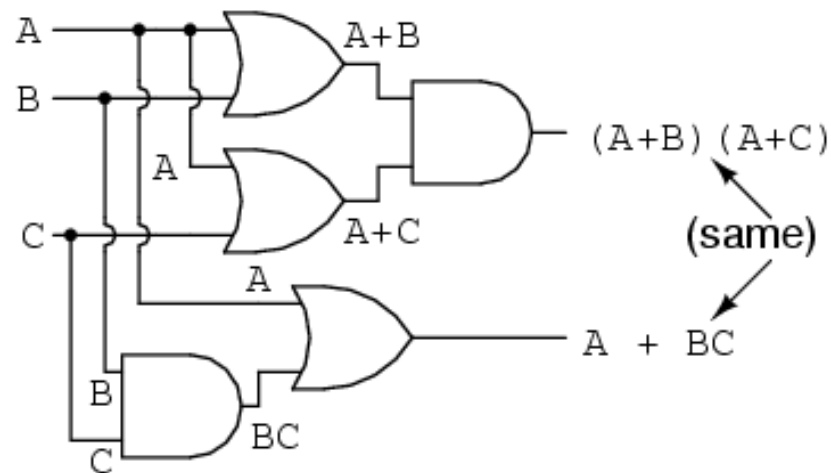
Factoring **A** out of both terms

Applying identity $\mathbf{A + 1 = 1}$

Applying identity $\mathbf{1A = A}$

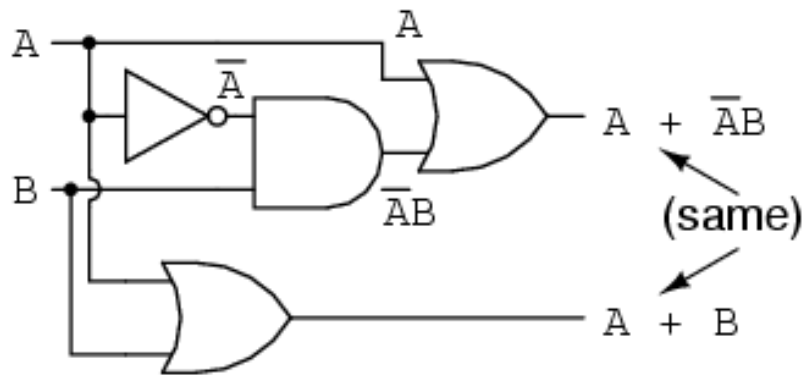


$$(A + B)(A + C) = A + BC$$



$$\begin{aligned} & (A + B)(A + C) \\ & \downarrow \text{Distributing terms} \\ & AA + AC + AB + BC \\ & \downarrow \text{Applying identity } \mathbf{AA = A} \\ & A + AC + AB + BC \\ & \downarrow \text{Applying rule } \mathbf{A + AB = A} \text{ to the } A + AC \text{ term} \\ & A + AB + BC \\ & \downarrow \text{Applying rule } \mathbf{A + AB = A} \text{ to the } A + AB \text{ term} \\ & A + BC \end{aligned}$$

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



$$\begin{aligned}
 & A + \overline{A}B \\
 & \downarrow \text{Applying the previous rule to expand } A \text{ term} \\
 & A + AB + \overline{A}B \\
 & \downarrow \text{Factoring } B \text{ out of 2}^{\text{nd}} \text{ and 3}^{\text{rd}} \text{ terms} \\
 & A + B(A + \overline{A}) \\
 & \downarrow \text{Applying identity } A + \overline{A} = 1 \\
 & A + B(1) \\
 & \downarrow \text{Applying identity } 1A = A \\
 & A + B
 \end{aligned}$$