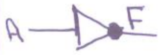
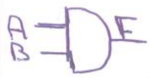
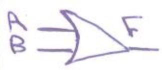
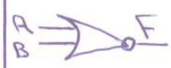
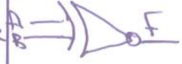
Logic Gates:-

Circuits used to process digital signals are called (logic gates). Logic symbols are used to identify these ccts. The seven gates that are the fundamental logic elements in digital system are shown below:-

Logic Function	Logic gate symbol	Truth Table	Boolean Expression
1- Inverter or NOT		input A | output $F=\bar{A}$ 0 | 1 1 | 0	$F=\bar{A}$
2- AND		A B | F 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1	$F=A \cdot B$ ← رمز الـ AND
3- NAND (AND-NOT)		A B | F 0 0 | 1 0 1 | 1 1 0 | 1 1 1 | 0	$F=\overline{A \cdot B}$
4- OR		A B | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 1	$F=A+B$ ← رمز الـ OR
5- NOR (OR-NOT)		A B | F 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 0	$F=\overline{A+B}$
6- Exclusive OR Ex-OR (XOR)		A B | F 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 0	$F=A \oplus B = AB' + A'B$ ← رمز الـ Ex-OR
7- Exclusive NOR Ex-NOR (Ex-OR-NOT) (XNOR)		A B | F 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 1	$F=A \odot B = AB + A'B'$ ← رمز الـ Ex-NOR

Note:- $A \oplus B = \overline{A \odot B}$

$A \odot B = \overline{A \oplus B}$

Ex:- Write the bolean algebra expression of the following ccts:-

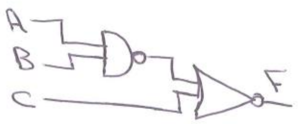
a)

$F = (A+B)\cdot C$

b)

$F = \bar{A} \oplus (A\cdot B)$

c)



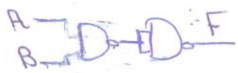
$F = \overline{(\overline{A\cdot B}) + C}$

Universal Gates:-

NAND and NOR gates have the proprity that they indivi dually can be used to hardware-implement a logic circuit corresponding to any given Boolean expression. That is, it is possible to use either only NAND gates or only NOR gates to implement any Boolean expression

1- NOT gate:- $F = \bar{A}$

2- AND gate:- $F = \overline{\overline{AB}}$

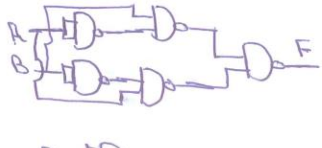


3- OR gate:- $F = \overline{\overline{A+B}} = \overline{\bar{A}\cdot\bar{B}}$

4- NOR gate:- $F = \overline{\overline{\overline{A+B}}} = \overline{\overline{\bar{A}\cdot\bar{B}}}$

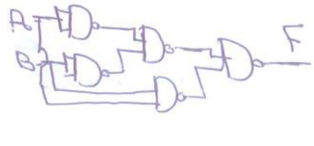
5- XOR gate = $A \oplus B = \overline{\overline{A\bar{B} + \bar{A}B}}$

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



6- XNR-gate = $A \odot B = \overline{\overline{\bar{A}\bar{B} + AB}}$

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



Ex: – Implement the following Functions by using NAND gates only:- (mixed)

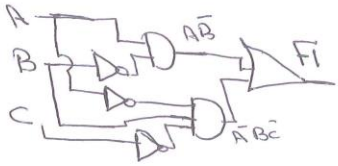
a) $F_1 = A\bar{B} + \bar{A}B\bar{C}$ b) $F_2 = AB + C\bar{D}$

Solution:-

a)

Mixed gates

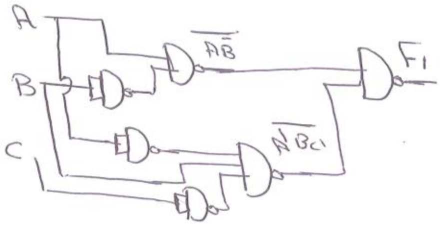
$F_1 = A\bar{B} + \bar{A}B\bar{C}$



NAND gates

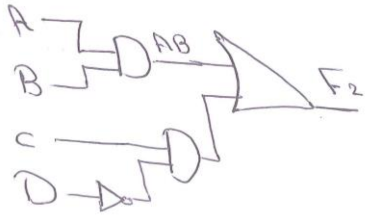
$F_1 = \overline{\overline{A\bar{B} + \bar{A}B\bar{C}}}$

$F_1 = \overline{\overline{A\bar{B}} \cdot \overline{\bar{A}B\bar{C}}}$



Mixed gates

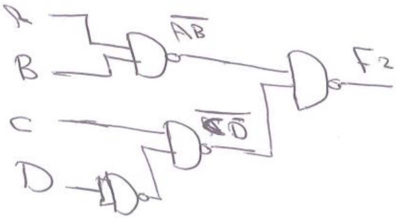
b) $F_2 = AB + C\bar{D}$



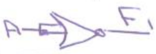
NAND gates

$F_2 = \overline{\overline{AB + C\bar{D}}}$

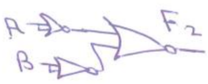
$F_2 = \overline{\overline{AB} \cdot \overline{C\bar{D}}}$



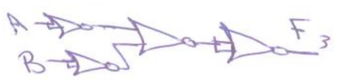
1- NOT gate $F_1 = \bar{A}$



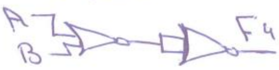
2- AND gate $F_2 = \overline{\overline{AB}}$ $\overline{\bar{A} + \bar{B}}$



3- NAND gate $F_3 = \overline{\overline{\overline{AB}}} = \bar{A} + \bar{B}$



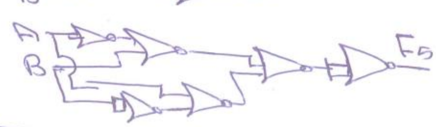
4- OR gate - $F_4 = \overline{\overline{A + B}}$



5- EX-OR :- $F_5 = \overline{\overline{A\bar{B} + \bar{A}B}}$

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

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



6- EX-NOR = $\overline{F_5}$

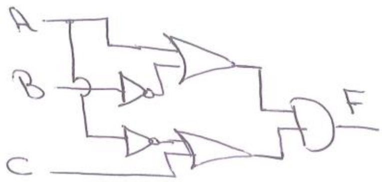
Ex:- Implement following function by using Mixed NOR gates only:-

$F = (A+\bar{B}) \cdot (\bar{A}+C)$

Solution:-

Mixed gates

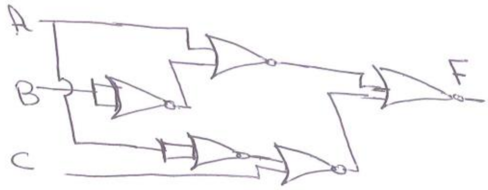
$F = (A+\bar{B}) \cdot (\bar{A}+C)$



NOR gates

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

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



Combinational logic circuits:-

Digital system are composed of compinations logic gates described by a truth table and boolean expression or logic symbol diagram. In Combination logic, the output of the cct. depends only on the inputs to the circuit.

- Demorgan's Theorem:-

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

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