Assignment – II

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Subject : FDL
Assignment – II

Q1] What is gate? Explain basic gates.

→ - Gate or better known as logic gates is an electronic device, which has one or many inputs but only one output.

- Logic gates perform the operation on binary data, so gates are called basic building blocks of computer.

Types of Gates (Logic)

I] Basic Gate
- → AND gate
- → OR gate
- → NOT gate

II] Universal Gates
- → NAND gate
- → NOR gate

III] Special Purpose
- → EX-OR
- → EX-NOR

I] Basic Gates :-

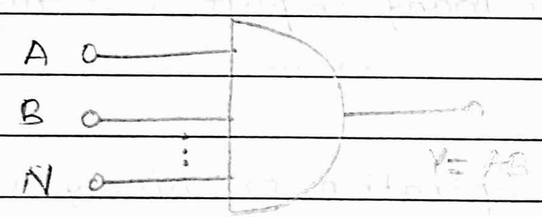
- The gates which performe operation such as multiplication, addition and complementation is called basic gate.

There are 3 type of basic gates :-

i) AND gate
ii) OR gate
iii) NOT gate

i) AND Gate :-

Symbol.



Truth Table

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

- Figure shows the symbol and truth table of AND gate.
- It is Basic Gate.
- It has many inputs but only one output
- Inputs are denoted by (A, B, ... N) and output is denoted by (Y).
- It performs the operation of binary multiplication.

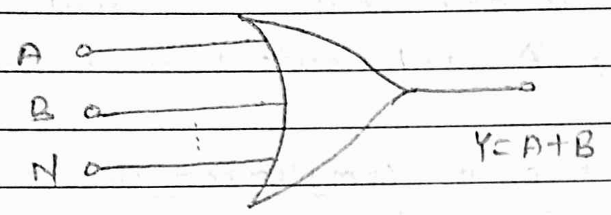
$\boxed{Y = A \cdot B}$ or $Y = A \times B \times \cdots N$.

☆ Operation

- from the truth table, it is clear that:
i) When both inputs are '1', then output is always '1'.
ii) If anyone of the input is '0', then output is always '0'.

ii) OR Gate :-

symbol.



Truth-Table

INPUT		OUTPUT
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

- figure shows the symbol and truth table of the OR gate.
- It is the Basic gate.
- It has many inputs but only one output.
- Input is denoted by (A, B, ... N) and output is denoted by (Y).

- It performs the operation of binary addition.

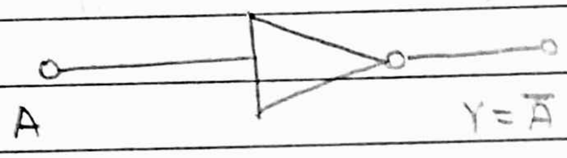
$$\boxed{Y = A + B + \cdots N}$$

☆ Operation

- from the truth table it is clear that:-
i) When both inputs are '0', Then output is always '0'.
ii) When anyone of input is '1', output is always '1'.

iii) NOT Gate :-

symbol



Truth - Table

INPUT	OUTPUT
A	$Y = \overline{A}$
0	1
1	0

- figure shows the symbol and truth-table of NOT gate.
- It is the basic gate.
- It has only one input and only one output.
- Input is denoted by 'A' and output is denoted by 'Y'.
- It performs the operation of complementation i.e. one's complement. In one's complement, '0' is replaced by '1' and '1' is replaced by '0'.
- NOT gate is also called as Inverter because output is completely reverse of the input.

* operation :-
- from the truth table, it is clear that :

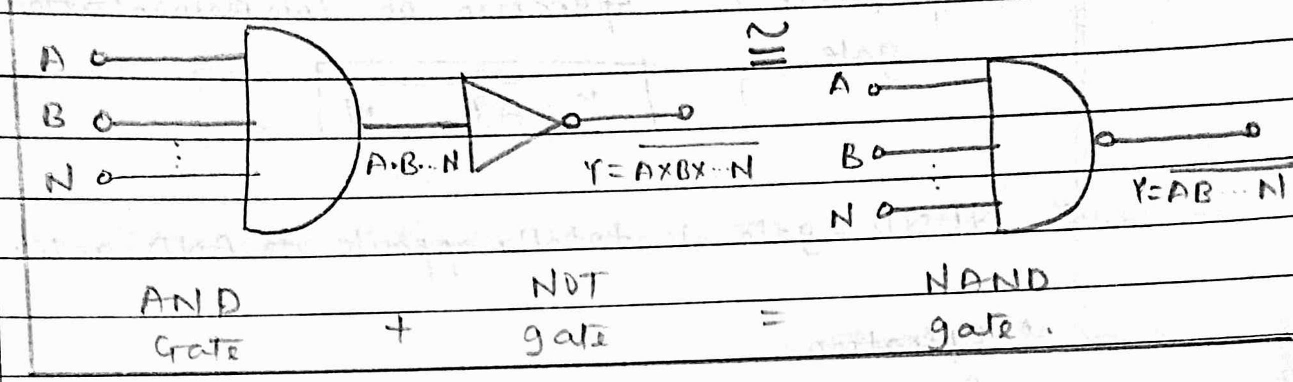
i) If input is '0', then output is always '1'.
ii) If input is '1', then output is '0'.

Q2] Explain NAND and NOR gate.

→

I] NAND gate:

symbol



Truth - Table

INPUT		OUTPUT
A	B	$Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

- figure shows the symbol and truth table of NAND gate.

- It is the universal gate. It is combination of two gates. i.e AND gate and NOT gate.

- It has many inputs but only one output.
- Inputs are denoted by (A, B, ... N) and outputs is denoted by (Y).

- It performs the operation of complementation of AND gate.

  i.e. $\boxed{\therefore Y = \overline{A \cdot B \cdots N}}$

- NAND gate is totally opposite to AND gate.

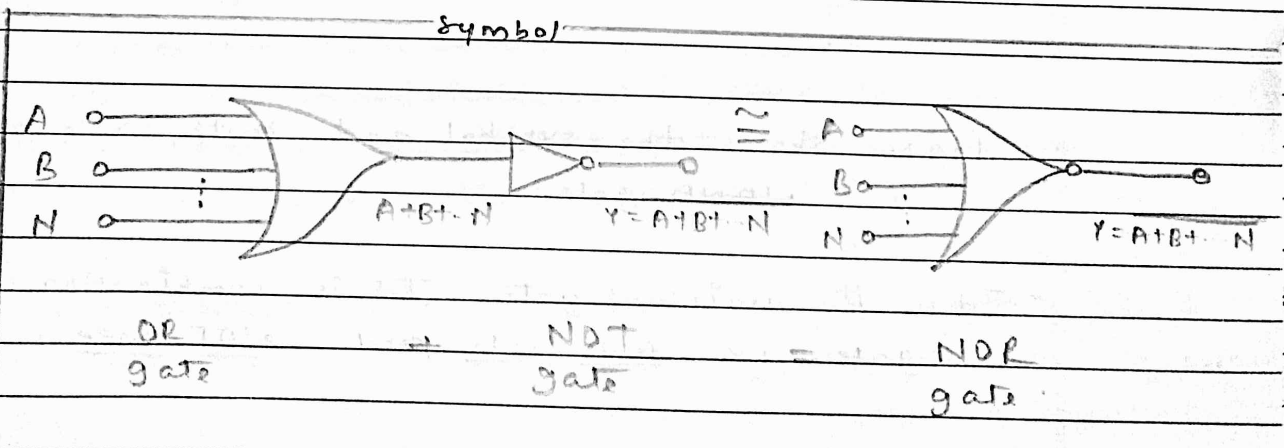
* **Operation:**

- From truth table, it is clear that -

i) When both the inputs are '1', then the output is always '0'.

ii) If any one of the input is '0', then output is always '1'.

ii) **NOR Gate:-**



Truth Table

INPUT A	B	OUTPUT $Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

- figure shows ~~that~~ the symbol and truth table of NOR gate.
- It is universal gate. It is combination of two gates. i.e <u>OR</u> gate and <u>NOT</u> gate
- It also has many inputs but only one output. Inputs are denoted by (A, B, ... N) and output is denoted by (Y)
- It performs the operation of <u>complementation of OR gate.</u>

$$\therefore \boxed{Y = \overline{A+B+\dots N}}$$

- NOR gate is totally opposite to OR gate.

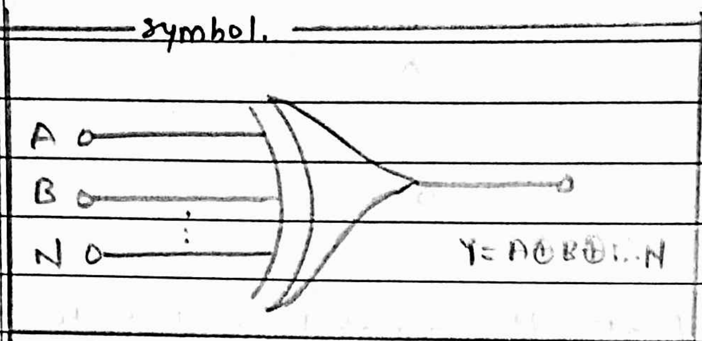
* <u>Operation</u>:
- from truth table, it is clear that:

i) When both inputs are '0', then output is always '1'.

ii) If anyone of the input is '1', then output is always '0'.

Q3] Explain EX-OR and EX-NOR gate :

→ i) <u>EX-OR gate</u> :-



Truth - Table

INPUT A	INPUT B	OUTPUT Y
0	0	0
0	1	1
1	0	1
1	1	$\boxed{0}$

- figure shows the symbol and truth table of EX-OR gate.
- It is special purpose gate because they are used to compare the inputs.
- It has many inputs but only one output.
- Inputs are denoted by (A, B, ···N) and output is denoted by (Y)
- It performs the operation of EX-OR

$$\boxed{\therefore Y = A \oplus B \oplus \cdots N}$$

- EX-OR operation is shown by + sign within a circle = ⊕
- Its operation is similar to OR-gate but the difference is in 4^{th} row of the truth-table.

* <u>Operation</u>

i) When both inputs are same, then output is always '0'.

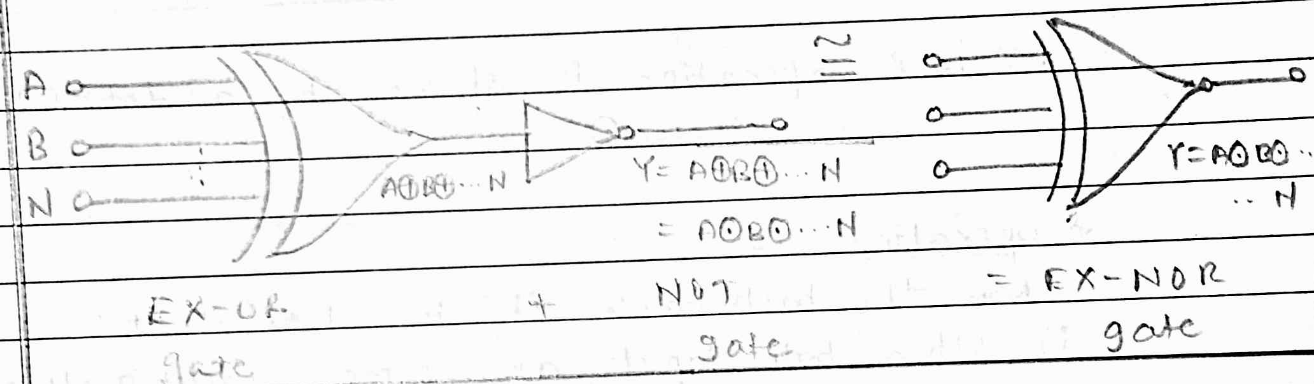
ii) If ~~any~~ both inputs are different, then output is always '1'.

* Operation

1) When there are odd numbers of '1', then output is always '1'.
2) When there are even number of '1', then output is always '0'

ii) EX-NOR gate

symbol



Truth-Table

INPUT A	INPUT B	OUTPUT Y
0	0	1
0	1	0
1	0	0
1	1	1

- figure shows ~~that~~ the truth table and symbol of X-NOR or EX-NOR gate.

- It is special purpose gate.
- It has many inputs but only one output
- Inputs are denoted by (A, B, ... N) and output is denoted by (Y).

- It performs the operation of EX-NOR

$$\boxed{\therefore Y = A \odot B \odot \cdots N}$$

- It's operation is similar to AND gate, but the difference is in the 1st row of truth table.

- EX-NOR operation is shown by a dot (·) within a circle ⇒ ⊙

* Operation

- from the truth table, it is clear that:

i) When both inputs are same, output is always '1'

ii) When both inputs are different, output is always '0'.

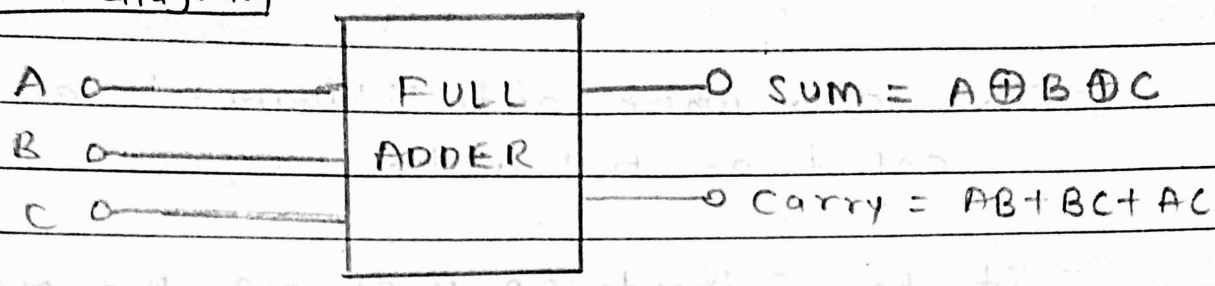
* operation

1) When there are even number of '1', then output is always '1'

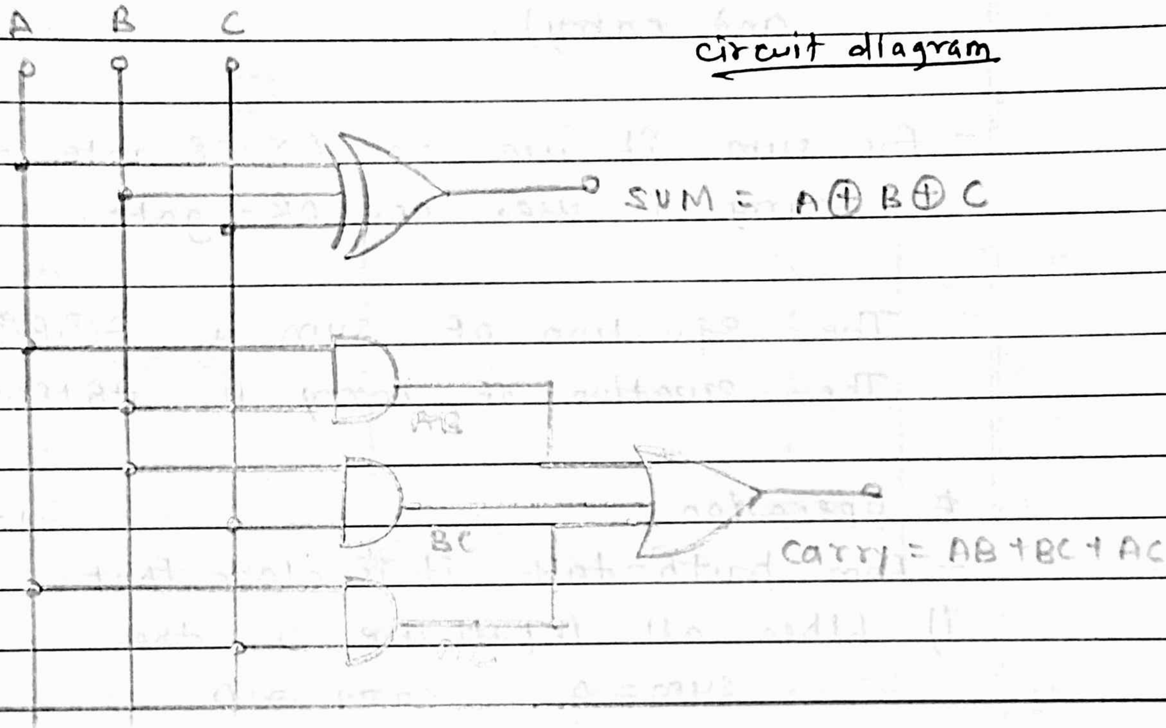
2) When there are odd number of '1', then output is always '0'.

Q4] Draw and explain full adder.

→ LOGIC diagram



circuit diagram



Truth - Table

INPUT			OUTPUT	
A	B	C	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Page No.
Date: / /

- figure shows the logic diagram, circuit diagram and truth table of full adder.

- The adder which adds 3 binary bits at a time is called as full adder.

- It has 3 inputs (A, B, C) and two outputs (sum and carry).

- for sum, it uses one EX-OR gate and for carry, it uses one OR-gate.

- The equation of sum is $A \oplus B \oplus C$
  The equation of carry is $AB + BC + AC$.

★ operation

- from truth-table it is clear that:

i) When all inputs are 0, then
   sum = 0, carry = 0.

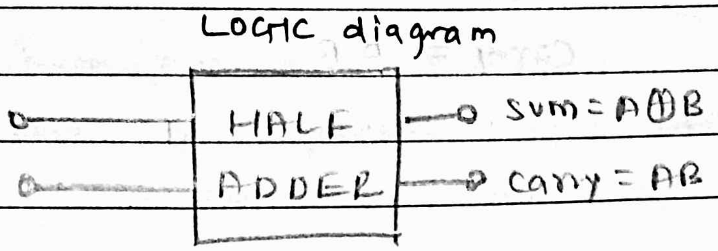
ii) When any one of the input = 1,
   sum = 1, carry = 0.

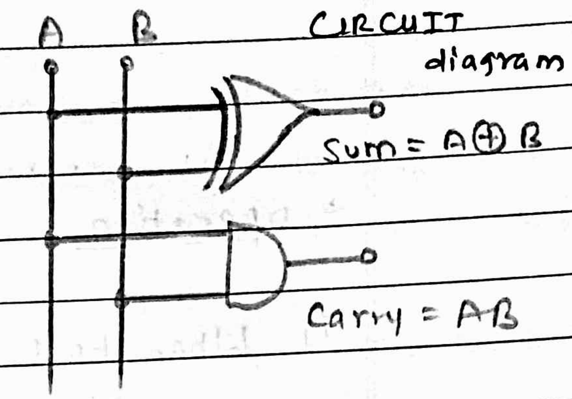
iii) When any 2 input are 1,
   sum = 0, carry = 1,

iv) When all 3 inputs are 1,
   sum = 1, carry = 1.

Q5] Draw and explain Half adder.

→





Truth-Table

INPUT		OUTPUT	
A	B	sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

- figure shows the logic diagram, circuit diagram and truth table of half-adder.

- Half Adder :- The adder which adds two-binary bits at a time is called as half adder.

- It has two inputs (A and B) and two outputs (sum and carry).

- for sum, it uses EX-OR gate and for carry, it uses AND gate.

- The equation :

$$\text{For sum} = A \oplus B$$

$$\text{carry} = A \cdot B$$

* **Operation :**

i) When both the inputs are '0', then
sum = 0, carry = 0.

ii) When any one of input is '1', then
sum = 1, carry = 0.

iii) When both inputs are '1', then
sum = 0, carry = 1.

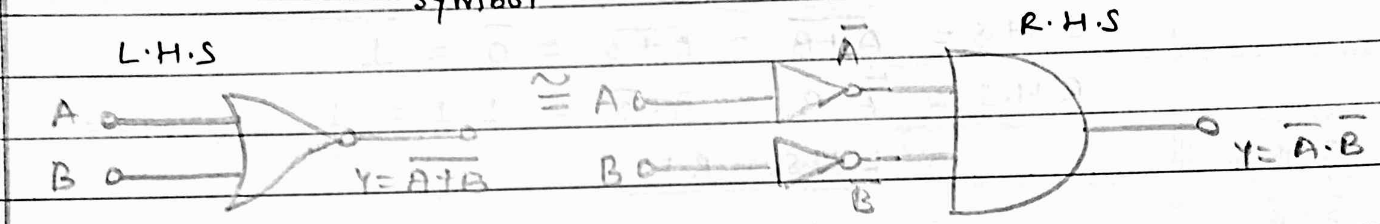
Q6] State and prove De-Morgan's theorem.

→ There are two, De-Morgan's theoreme, both are used to seperate the variables from the bar (Complement).

I FIRST THEOREM :-

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

symbol



Truth-Table

INPUT	(L.H.S)	OUTPUT			(R.H.S)
A B	$A+B$	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0 0	0	1	1	1	1
0 1	1	0	1	0	0
1 0	1	0	0	1	0
1 1	1	0	0	0	0

* Statement

- The complement of sum is equal to the product of their individual complement.

- From the truth table, it is clear that L.H.S = R.H.S
  $\therefore$ Theorem is proved.

* operation :

1) When $A = 0$ and $B = 0$

$L.H.S = \overline{A+B} = \overline{0+0} = \overline{0} = 1$

$R.H.S = \overline{A}\cdot\overline{B} = \overline{0}\cdot\overline{0} = 1\cdot1 = 1$

$\therefore L.H.S = R.H.S$

2) When $A = 0$ and $B = 1$,

$L.H.S = \overline{A+B} = \overline{0+1} = \overline{1} = 0$

$R.H.S = \overline{A}\cdot\overline{B} = \overline{0}\cdot\overline{1} = 1\cdot0 = 0$

$\therefore L.H.S = R.H.S$

3) When $A = 1$, and $B = 0$,

$L.H.S = \overline{A+B} = \overline{1+0} = \overline{1} = 0$

$R.H.S = \overline{A}\cdot\overline{B} = \overline{1}\cdot\overline{0} = 0\cdot1 = 0$

$\therefore L.H.S = R.H.S$

4) When $A = 1$ and $B = 1$,

$L.H.S = \overline{A+B} = \overline{1+1} = \overline{1} = 0$

$R.H.S = \overline{A}\cdot\overline{B} = \overline{1}\cdot\overline{1} = \overline{1} = 0$

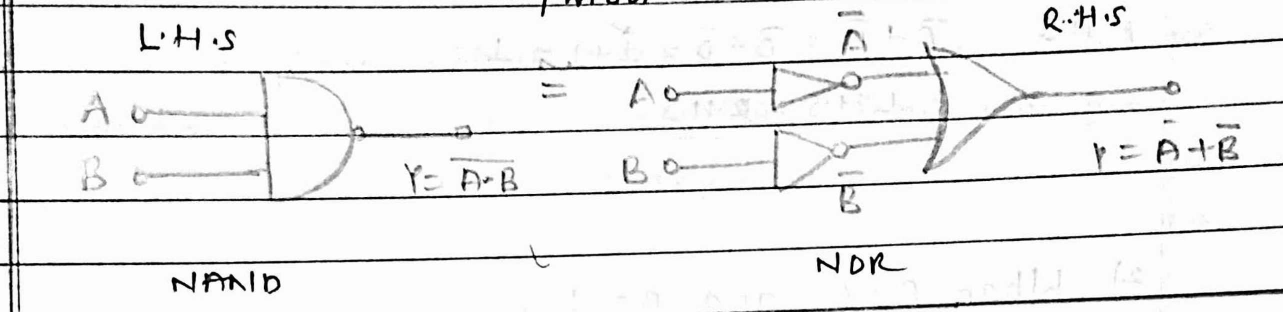
$\therefore L.H.S = R.H.S$

Hence, theorem is proved.

II SECOND THEOREM

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

symbol



Truth-Table

INPUT			OUTPUT			
			L.H.S			R.H.S
A	B	$A \cdot B$	$\overline{A \cdot B}$	$\bar{A}$	$\bar{B}$	$\bar{A} + \bar{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

Statement:

- The complement of product is equal to the sum of their individual complements.
- From the truth table it is clear that - L.H.S = R.H.S
  Hence theorem is proved.

Page No. :
Date : / /

operation :

1) When $A=0$, and $B=0$,

$L.H.S = \overline{A \cdot B} = \overline{0 \cdot 0} = \overline{0} = 1$

$R.H.S = \overline{A} + \overline{B} = \overline{0} + \overline{0} = 1 + 1 = 1$

$\therefore L.H.S = R.H.S$

2) When $A=0$ and $B=1$,

$L.H.S = \overline{A \cdot B} = \overline{0 \cdot 1} = \overline{0} = 1$

$R.H.S = \overline{A} + \overline{B} = \overline{0} + \overline{1} = 1 + 0 = 1$

$\therefore L.H.S = R.H.S$

3) When $A=1$, and $B=0$,

$L.H.S = \overline{A \cdot B} = \overline{1 \cdot 0} = \overline{0} = 1$

$R.H.S = \overline{A} + \overline{B} = \overline{1} + \overline{0} = 0 + 1 = 1$

$\therefore L.H.S = R.H.S$

4) When $A=1$, and $B=1$,

$L.H.S = \overline{A \cdot B} = \overline{1 \cdot 1} = \overline{1} = 0$

$R.H.S = \overline{A} + \overline{B} = \overline{1} + \overline{1} = 0 + 0 = 0$

$\therefore L.H.S = R.H.S$

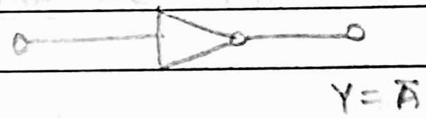
$\therefore$ Theorem is proved.

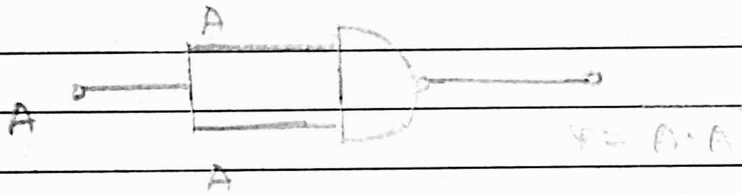
Q7) Why NAND and NOR Gate are called as Universal Gate?

→ NAND and NOR are called as universal gate because from NAND gate and NOR gate, we get the operation of any gate i.e. any basic gate (AND, OR and NOT).

$\boxed{I}$ NAND as universal gate:

i) NOT gate using NAND gate



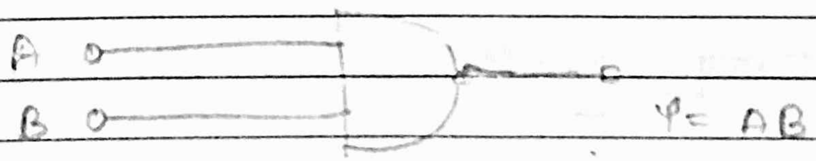


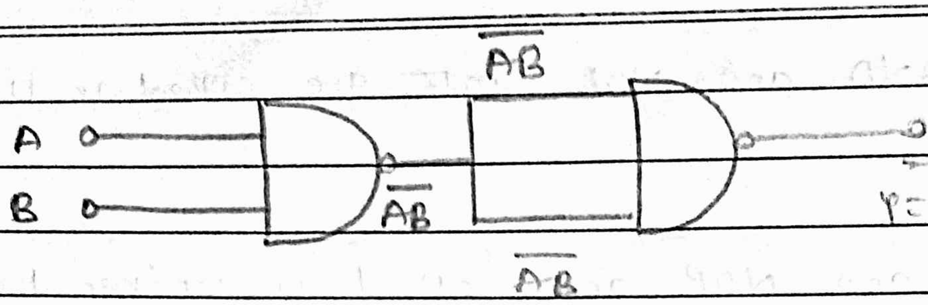
put $A = 1 \Rightarrow \overline{A \cdot A} = \overline{1 \cdot 1}$

$= \overline{1}$

$= \overline{A}$

ii) AND gate using NAND gate:-





$Y = \overline{\overline{AB} \cdot \overline{AB}}$

put, $AB = 1 \Rightarrow$ $Y = \overline{\overline{AB} \cdot \overline{AB}}$

$= \overline{\overline{AB}} + \overline{\overline{AB}}$

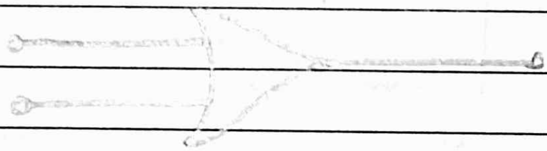
$= AB + AB$

$= 1 + 1$

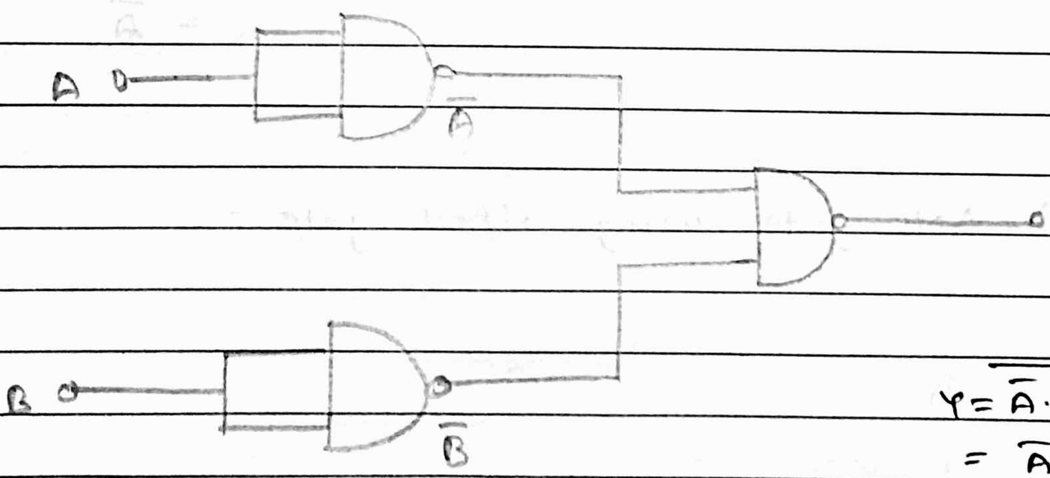
$= 1$

$= AB$.

iii) <u>OR gate using NAND gate</u> :



$Y = A + B$



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

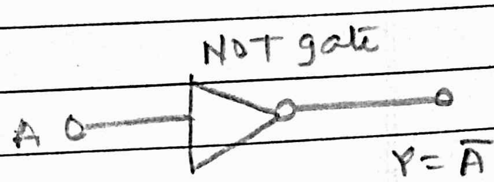
$Y = \overline{\bar{A} \cdot \bar{B}}$

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

$= A + B$

II NOR as a UNIVERSAL Gate :-

i) NOT gate using NOR gate:



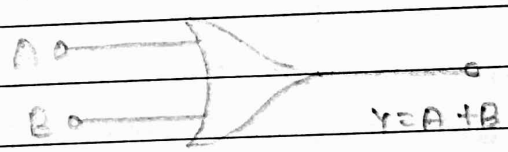
$Y = \overline{A + A}$

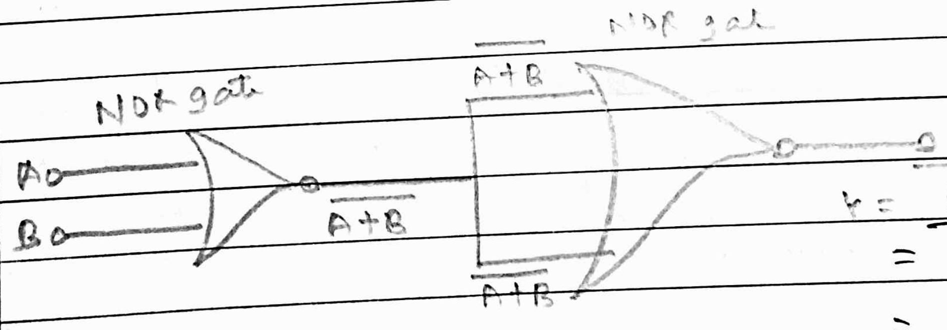
put, $A = 1 \Rightarrow \overline{1 + 1}$

$= \overline{1}$

$= \overline{A}$

ii) OR gate using NOR gate.





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

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

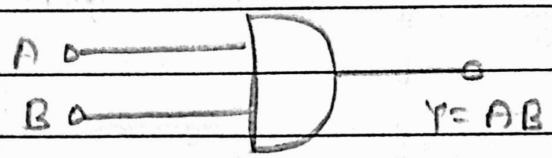
$= A+B \cdot A+B$

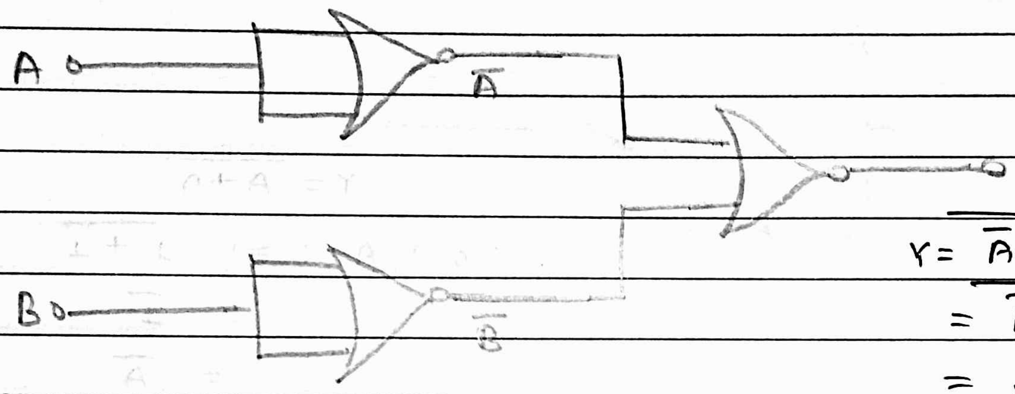
put, $A+B = 1 \Rightarrow 1 \cdot 1$

$= 1$

$= A+B$

iii) AND gate using NOR gate :





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

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

$$= A \cdot B$$