Experiment - 1

★ **Aim :-** Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, EXOR and EXNOR gates.

★ **Apparatus :-** Bread board, logic gates / IC's, wires.

★ **Theory :-** Logic gates are basic building blocks of any digital system. Logic gates are electronic circuits having one or more than one input and only one output. The relationship between the input and output is based on a certain logic. Based on this logic gates are named as
1) AND gate 2) OR gate 3) NOT gate 4) NAND gate 5) NOR gate
6) EX-OR gate 7) Ex-NOR gate.

1) **AND Gate :-** It is an electronic circuit that gives a high output (1) only if all its inputs are high. A dot is used to show this. $Y = A \cdot B$
A simple 2-input logic AND gate can be constructed using RTL (Resistor - Transistor Logic). Both transistors must be saturated "ON" for an output at Q.

2) **OR Gate :-** the OR gate is an electronic circuit that gives a high output (1) if one or more of its inputs are high. A plus (+) is used to show this.

$$Y = A + B$$

OR gate can be realised by DRL (Diode - Resistance - Logic) or by TTL (Transistor - Transistor - Logic). to realise OR gate, we will use a diode at every input of the OR gate. the anode part of diode is connected with input while the cathode part is joined together and a resistor connected with the cathode is grounded. When both the inputs are at logic 0 or low state then the diodes D_1 and D_2 become reverse biased.

3) <u>NOT Gate</u> :- It is an electronic circuit that produces an inverted version of the input at its output. It is also known as inverter.

$$Y = A'$$

Not gate can be realized through transistor. The input is connected through resistor R_2 to the transistor base. When no voltage is present on the input, the transistor is off. When the transistor is off, no current flows through the collector emitter path. Thus, current from the supply voltage (VCC) flows through resistor R_1 to the output. In this way the circuit output is high when its input is low.

4) <u>NAND Gate</u> :- This is a NOT-AND gate which is equal to an AND gate followed by a NOT gate. The outputs of all NAND gates are high if any of the inputs are low.

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

The simple 2-input logic NAND gate can be constructed using RTL (Resistor-Transistor-Logic). Either transistor must be cut-off or "OFF" for an output at Q.

5) <u>NOR Gate</u> :- This is a NOT-OR gate which is equal to an OR gate followed by a NOT Gate. The output of all NOR gates are low if any of the inputs are high

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

A simple 2-input logic NOR gate can be constructed using RTL (Resistor-Transistor-Logic). Both transistor must be cut-off or "OFF" for an output at Q.

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6) Ex-OR Gate :- the 'Exclusive -OR' Gate is a circuit which will give a high output if either, but not both of its two ~~to~~ inputs are high. An encircled plus sign ⊕ is used to show Ex-OR operation

$$Y = A \oplus B$$

Ex-OR ~~opera~~ gate is created from AND, NAND and OR gates. the output is high only when both the inputs are different.

7) Ex-NOR Gate :- this gate is a circuit which will give a low output if either, but not both of its two inputs are high. An encircled ~~to~~ dot sign is its symbol.

$$Y = A \odot B \quad \text{or} \quad Y = \overline{A \oplus B}$$

this is created from AND, NOT and OR gates. the output is high only when both inputs are the same.

* Procedure :-

1. Connect the trainer kit to DC power supply.
2. Connect the inputs of any one logic gate to the logic source and its output to logic indicator.
3. Apply various inputs combinations and observe output for each one.
4. Varify the Truth table for each input/output combination.
5. Repeat the process of all logic gates.
6. Switch off the supply.

* Basic Laws of Boolean Algebra :-

1. $A + B = B + A$ { Commutative Law }

   $A \cdot B = B \cdot A$

2. $(A+B)+C = A+(B+C)$ { Associative Law }

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

3. $A\cdot(B+C) = A\cdot B + A\cdot C$ { Distributive Law }

4. $A + A\cdot B = A$

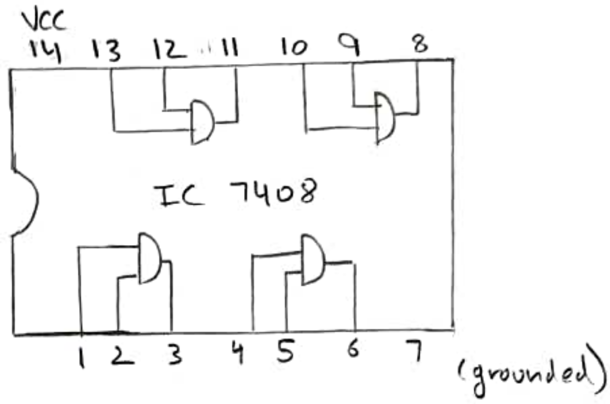
5. $\overline{A+B} = \overline{A}\cdot\overline{B}$ { De - Morgan's law }

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

★ **Result :-** Truth table and various gates are verified.

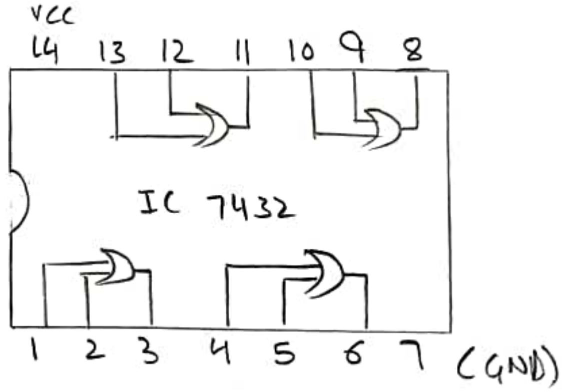
1) AND Gate :-

A	B	Y= A·B
0	0	0
0	1	0
1	0	0
1	1	1



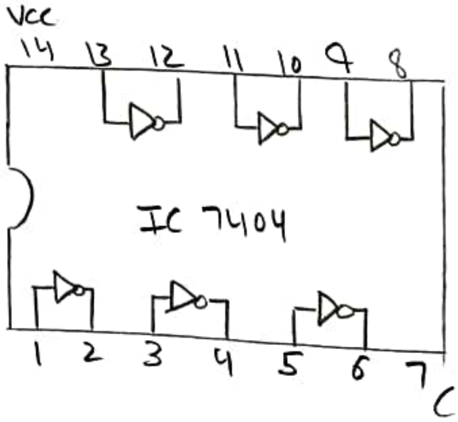
2) OR Gate :-

A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1



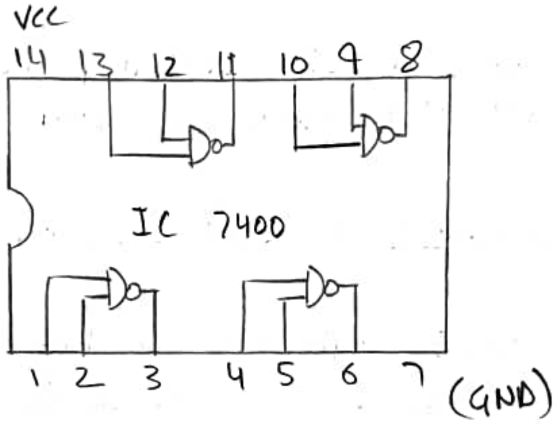
3) NOT Gate :-

A	$\bar{A}$
0	1
1	0



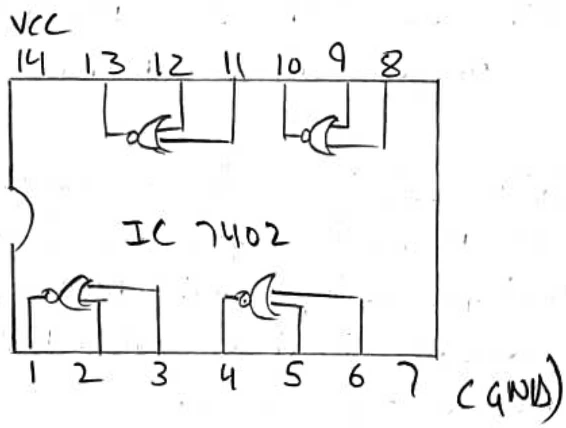
4) NAND Gate :-

A	B	$Y = \overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0



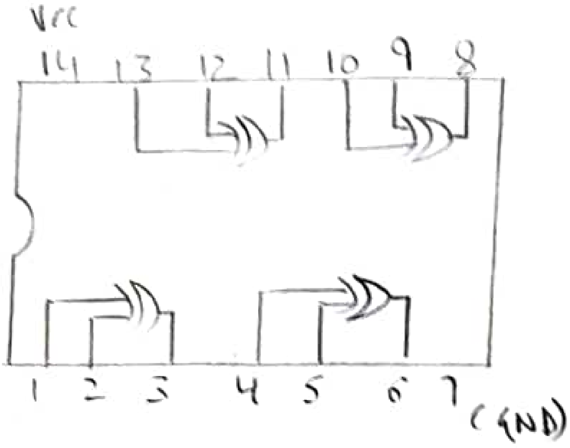
5) NOR Gate :-

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



6) XOR Gate :-

A	B	A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0



7) X NoR Gate :-

A	B	$\overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1