# I·N·D·E·X

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Experiment 1

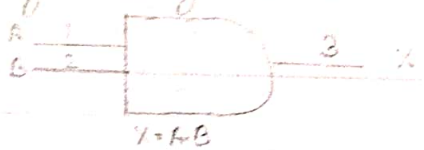
Aim : To study and verify the truth tables of basic gates.

Apparatus required : Connecting wires, power supply, digital trainer kit, Integrated Circuits.

AND gate

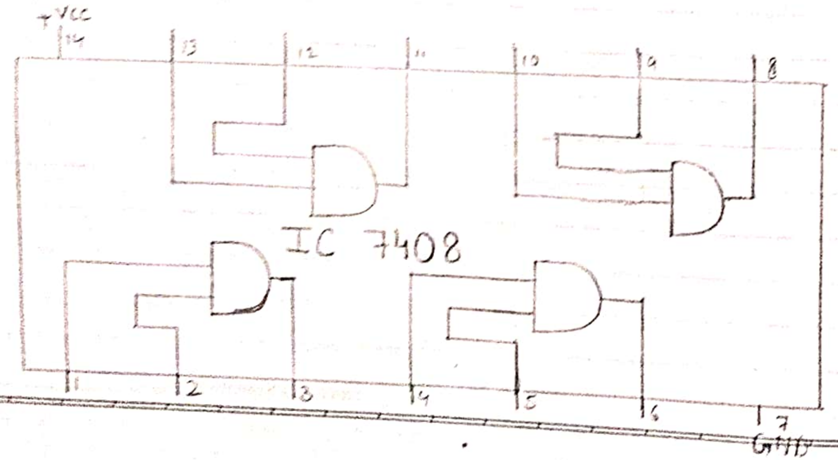
Boolean Expression $X = A . B$

Logic Symbol




Truth Table

| Input | | Output |
|---|---|---|
| A | B | X |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |




Date 18-7-25

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# Experiment - 1

Aim : To study and verify the truth tables of basic gates [ AND(7408), OR(7432), NOT(7404)]

Apparatus Required : Connecting wires, power supply, Digital trainer kit, Integrated circuits (ICs).

Theory : Basic gates - AND, OR and NOT - are electronic circuits that perform logical operations on binary inputs (0 or 1) to produce a binary output. Inputs and outputs exist only at two levels: High(1) and Low(0). A truth table lists all input combinations and their corresponding outputs, showing how the gate responds to each case.

## AND Gate (7408)

An AND gate has two or more inputs but only one output. The output assumes the logic 1 state only when each one of its inputs is at logic 1 state. The output assumes logic 0 state even if one of its input is at logic 0 state. AND gate is also called an 'all and nothing' gate.

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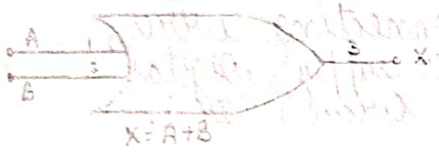
OR gate

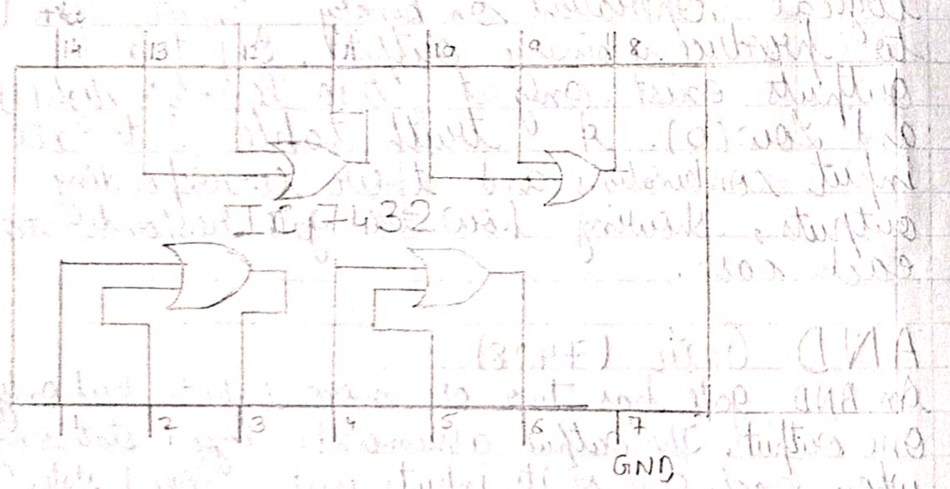
Boolean Expression $X = A + B$

Logic Symbol




Truth Table

| INPUT | | OUTPUT |
|---|---|---|
| A | B | X |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

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The symbol for AND operation is '.'

## OR Gate (7432)

An OR gate may have two or more inputs but only one output. The output assumes the logic 1 state, even if one of its input is in logic 1 state. Its output assumes logic 0 state, only when each one of its inputs is in logic 0 state. Also known as 'Any or all' gate. The symbol for OR operation is '+'.

## NOT Gate (7404)

A NOT gate is also known as inverter, has one input and only one output. It is a device where output is always complement of its input. That is the output of not gate assumes the logic 1 state when input is in logic 0 and vice versa. The symbol for NOT operation is '-' (bar).

Teacher's Signature________

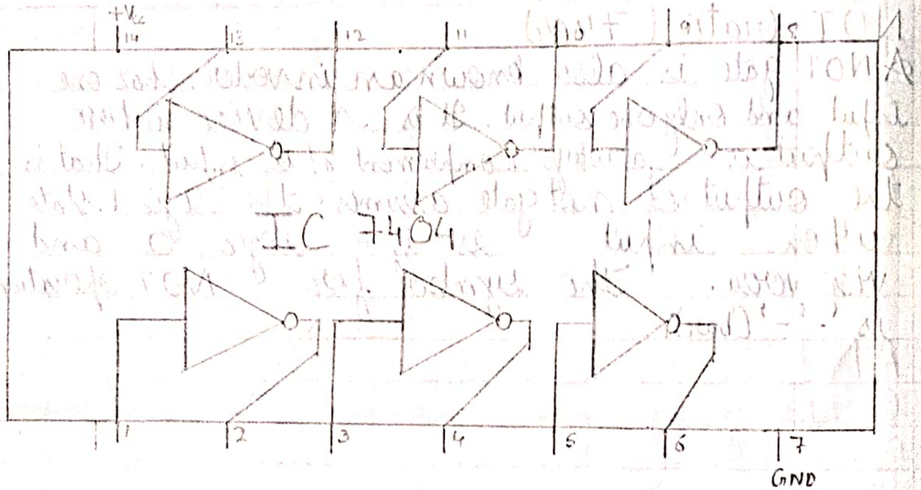
NOT gate

Boolean Expression $X = \overline{A}$

Logic Symbol


Truth table

| INPUT A | OUTPUT X |
|---|---|
| 0 | 1 |
| 1 | 0 |




IC 7404

Result
Truth table of all basic gates are verified.



Procedure:

1. Set up the breadboard.
2. Test all required ICs.
3. Give various combinations of inputs and check the output.
4. Repeat the procedure for each IC.

Precautions:

1. All the connections must be tight
2. The connections in the breadboard must be made carefully to prevent bending of IC pins.
3. Connecting wires in the trainer kit must be changed when power supply is off.

Result:
Truth Table of all basic gates are verified.

Experiment 2

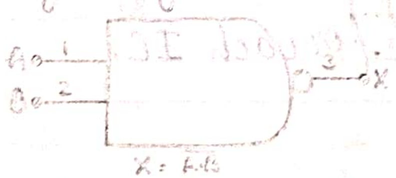
Aim : To study and verify the truth tables of universal gates [NAND(7400) and NOR(7402)]

Apparatus Required : connecting wires, Power supply, Digital trainer kit, integrated circuits.

NAND Gate

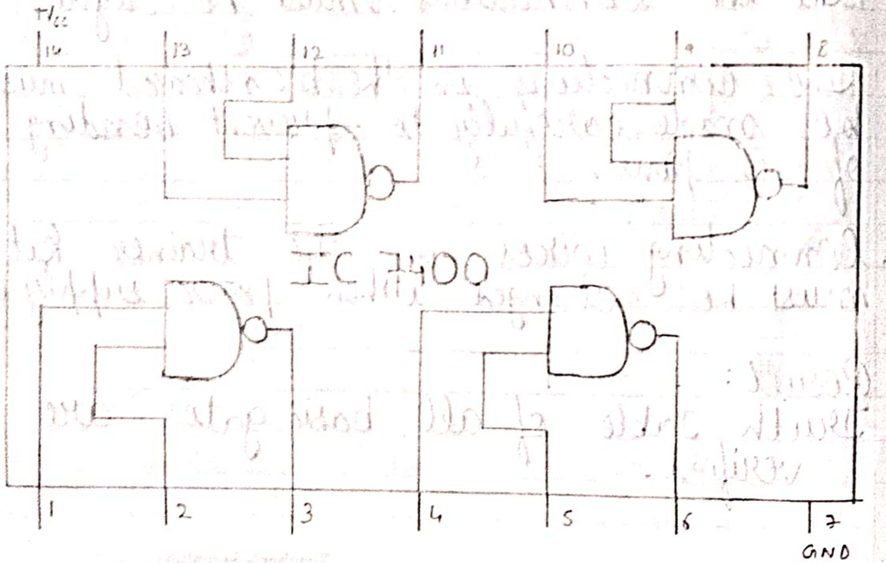
Boolean Expression $X = \overline{A \cdot B}$

Logic Symbol




Truth table

| INPUT | | OUTPUT |
| --- | --- | --- |
| A | B | X |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

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# Experiment 2

Aim: To study and Verify the truth tables of universal gates [NAND(7400) and NOR(7402)]

Apparatus Required: Connecting Wires, Power Supply, Digital Trainer kit, Integrated circuits.

Theory: Universal gates - NAND and NOR are electronic circuits that can be used to build any other logic gates or Boolean functions. They operate on binary inputs (0 or 1) to produce a binary output, with inputs and outputs existing only at two levels: HIGH(1) or LOW(0). A truth table lists all input combinations and their corresponding outputs, showing how each gate responds to every case.

NAND Gate (7400)

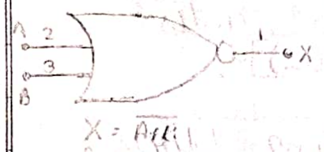
NAND gate is universal gate. It can perform all the basic logic function. NAND means NOT AND that is, AND output is NOTed, so NAND gate is the combination of AND gate and a NOT gate. The output is logic 0 levels, when each of its inputs assumes a logic 1 level. For any other

Teacher's Signature

NOR Gate (7402)

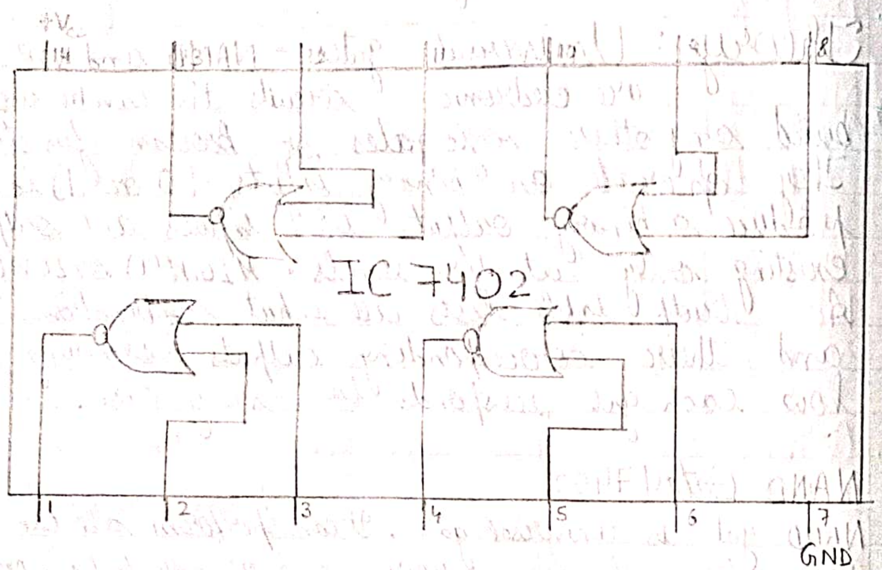
Boolean Expression $X = \overline{A+B}$

Logic Symbol




Truth Table

| INPUT | | OUTPUT |
|---|---|---|
| A | B | X |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |






combination of inputs, the output is logic 1 level. NAND is equivalent to a bubbled OR gate.

NOR Gate (7402)

NOR gate is a universal gate. It can perform all the basic logic function. NOR means NOT OR that is, OR output is NOTed, so NOR gate is combination of an OR gate and a NOT gate. The output is logic 1 level, only when each of its inputs assumes a logic 0 level. For any other combination of inputs, the output is logic 0 level. NOR is equivalent to a bubbled AND gate.

Procedure:

1. Set up the breadboard.
2. Test all required ICs.
3. Give various combinations of inputs and check the outputs.
4. Repeat the procedure for each IC.

## Result

Truth tables of all universal gates are verified.

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## Precautions:

1. All connections must be tight.
2. While using digital trainer kit, make sure that connecting wires are attached tightly and properly.
3. The pins of IC in breadboard should be handle carefully without damaging the pins.
4. Connections should be made when the circuit is OFF.

## Result:

The truth tables of all universal gates are verified.

Teacher's Signature ______

Experiment 3

Aim : To study the formation of basic gates from universal gates.

Apparatus Required : Connecting wires, Power supply, Digital Trainer kit, ICs.

Date 8-8-25

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# Experiment 3

**Aim :** To study the formation of basic gates from universal gates.

**Apparatus Required :** Connecting Wires, Power Supply, Digital Trainer kit, ICs.

## Theory :

### Universal gates :-

The Nand and Nor gates are called as universal gates, because it is possible to implement any Boolean expression with the help of only Nand or only Nor gates.

Hence a user can build any combinational circuit with the help of only Nand gates or only Nor gates.

The Nand or Nor gates are universal gates. Because it is possible to implement any Boolean expression with the help of only Nand or only Nor gate.

Teacher's Signature

NOT using NAND gate

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

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

But $A \cdot A = A$ $\because$ By AND logic

$Y = \overline{A}$


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The Boolean expression for NAND gate is
$X = \overline{AB}$

The Boolean expression for NOR gate is
$X = \overline{A+B}$

This is a great advantage because a user will have to make a stock of only Nand or Nor gates.

All gates using Nand gates :-

1. Not using Nand :-

The Boolean expression for NOT gate is $A = \overline{A}$
Figure shows the realization of a NOT gate using a two input Nand gate. As both input's are connected together we can write input $A = B = A$
So output is given as

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

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

But $A \cdot A = A$ $\because$ By AND law

$Y = \overline{A}$

Teacher's Signature

AND using NAND gate

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

But $\bar{\bar{A}} = A$

$Y = A.B$

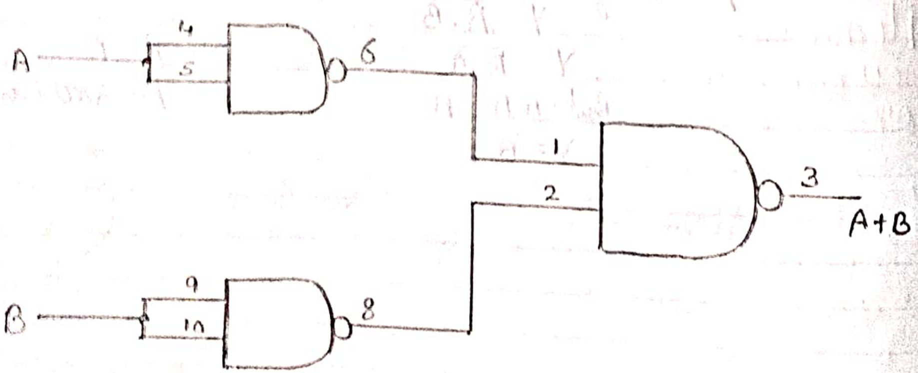

OR using NAND gate

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

But by De Morgan's theorem

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

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

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2. AND using NAND:-

The Boolean expression for an AND gate is $Y = A.B$

Taking double inversion,

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

But $\bar{\bar{A}} = A$

$Y = A.B$

This equation can be realized using only NAND gate as shown.

3. OR using NAND:-

The Boolean expression for an OR gate is $Y = A+B$

Taking double inversion

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

But by De-Morgan's theorem

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

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

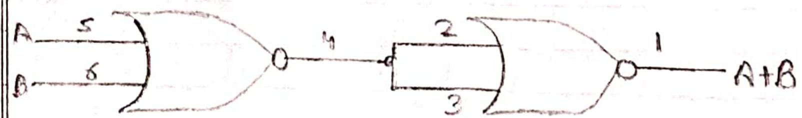
Teacher's Signature ______

NOT using NOR gate

$$Y = \overline{A+B}$$
$$Y = \overline{A+A} \qquad \because A = B$$
$$\text{But } A+A = A \qquad \because \text{By OR law}$$
$$Y = \overline{A}$$


OR using NOR gate

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

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## All gates using NOR gate:-

1. NOT using NOR:-

The Boolean expression for NOT gate is $A = \overline{A}$. Figure shows realization of a NOT gate using a two input NOR gate. As both inputs are connected together we can write input $A = B = A$.

So output is given as

$$Y = \overline{A+B}$$
$$Y = \overline{A+A} \qquad \because A = B$$
$$\text{But } A+A = A \qquad \because \text{By OR law}$$
$$Y = \overline{A}$$

2. OR using NOR:-

The Boolean expression for OR gate is $Y = A+B$

Taking double inversion

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

This equation can be realized using Only ~~NAND~~ NOR gate as shown.

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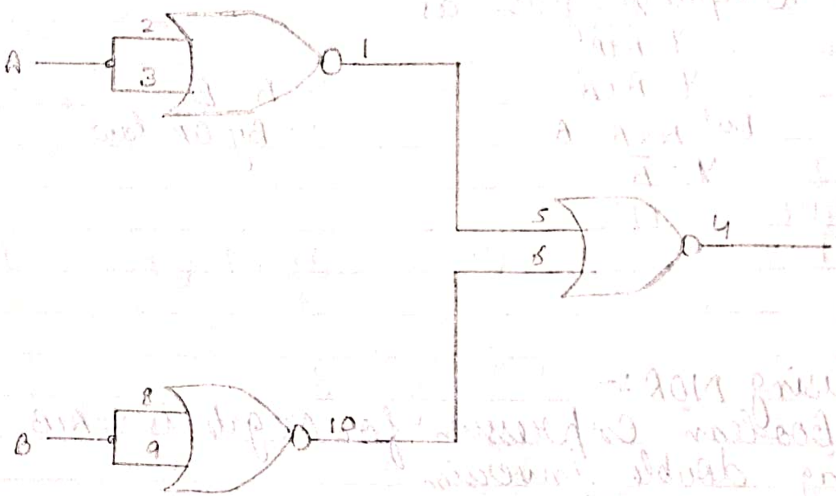
AND using NOR gate

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

But by De-Morgan's theorem

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

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




Result

Basic gates have been successfully realized from universal gate.



3. AND using NOR :-

The Boolean expression for an AND gate is $Y = A \cdot B$

Taking double inversion

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

But by De-Morgan's theorem

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

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

Procedure:

1. Place the IC on breadboard.
2. Wire inputs A and B from DIP switches to chosen gate inputs.
3. Connect each gate output Y to an LED.
4. For each gate, apply input combinations and record outputs.
5. Repeat for both NAND-only and NOR-only

Precautions:

1. Keep wiring short and neat to avoid loose contacts.
2. Power OFF while inserting / removing ICs.
3. Use current-limiting resistors with LEDs.

Result:

Basic gates have been successfully realized from universal g

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