UNIVERSITY OF ASIA PACIFIC

Department of Computer Science & Engineering

Course Title – Digital Logic & System Design Lab

Course Code – CSE 210

Experiment No. – 03

Experiment name – Universality of NAND-Gate & NOR-Gate.

SUBMITTED BY

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PROBLEM STATEMENT :

a. Test and verify the Universality of NAND gate.
b. Test and verify the Universality of NOR gate.

OBJECTIVE : The objective of the experiment is to prove universality of NAND Gate & NOR Gate.

APPARATUS :

- IC-7400(NAND Gate)
- IC-7402(NOR Gate)
- Logic Display
- Logic Switch.

INTRODUCTION :

A Compound gate will be called universal gate if we can use them as three basic gates (NOT, OR, AND). NAND gate and NOR gates are called Universal gate because we can use them as basic gates. In our experiment we will prove the universality of NAND & NOR gate. To prove it we have to make logic circuit using only NAND gate or NOR gate which will perform as three basic gates.

- **NAND Gate :** (More than one Input and only one Output) The output will be Low/0 when all the input are High/1. Otherwise the output will be High/1. We will use IC-7400 which is 2 input NAND gate.

- **NOR Gate :** (More than one Input and only one Output) The output will be High/1 when all the input are Low/0. Otherwise the output will be Low/0. We will use IC-7402 which is 2 input NOR gate.

TRUTH TABLE

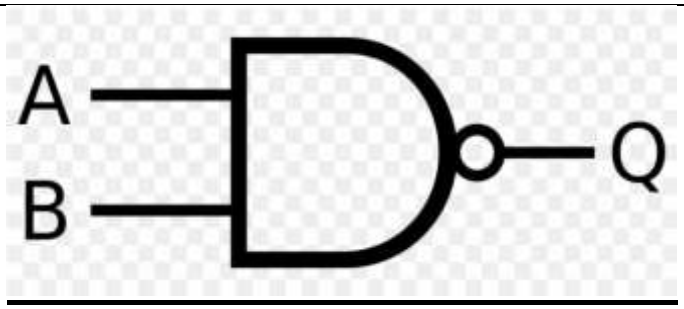
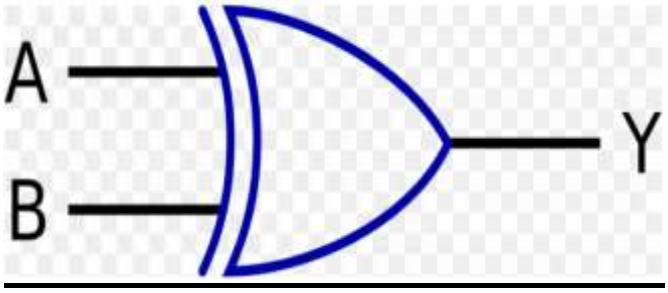
NAND Gate

Input		Output
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

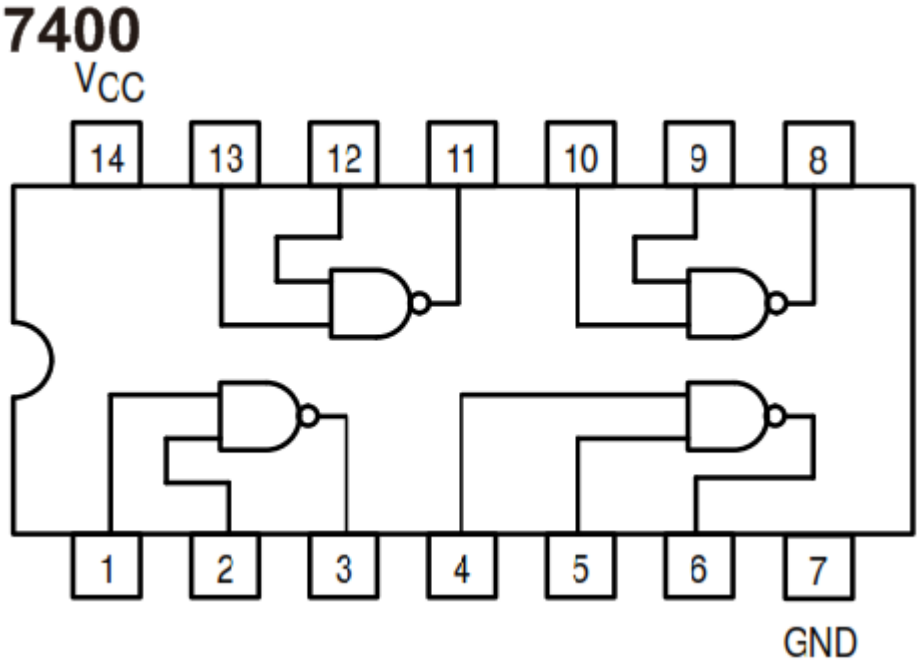
Input		Output
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

LOGIC EXPRESSIONS

Logic Gate	Logic Expression	Logic Diagram
NAND	$X = \overline{A \cdot B}$	
NOR	$X = \overline{A + B}$	

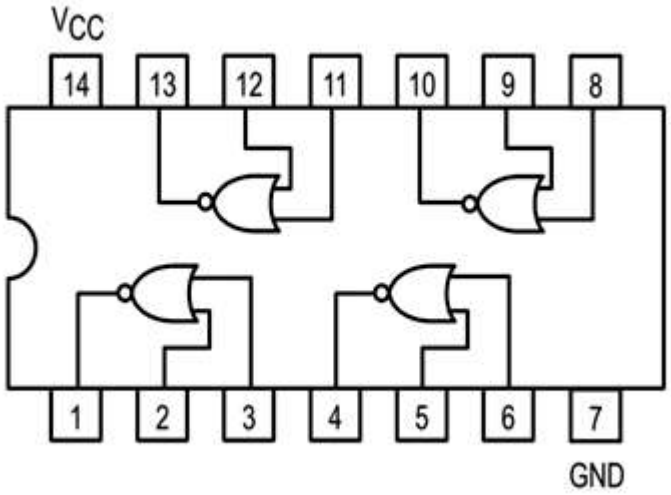
PIN CONFIGURATION

- **NAND Gate :**



IC – 7400

- **NOR Gate :**



IC - 7402

❖UNIVERSALITY OF NAND GATE

➢ NAND AS NOT GATE :

NOT gate output : X = $\overline{A}$ = $\overline{A \,.\, A}$

Simplified Table

Input	Output
A	$\overline{A.A}$
0	1
1	0

NOT Gate

Input	Output
A	X
0	1
1	0

➢ NAND AS AND GATE :

AND gate output : X = A . B = $\overline{\overline{A \,.\, B}}$ = $\overline{(\overline{A \,.\, B}) \,.\, (\overline{A \,.\, B})}$

Simplified Table

Input		Output
A	B	$\overline{\overline{A.B}}$
0	0	0
0	1	0
1	0	0
1	1	1

AND Gate

Input		Output
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

➢ NAND AS OR GATE :

OR gate output X = A + B

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

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

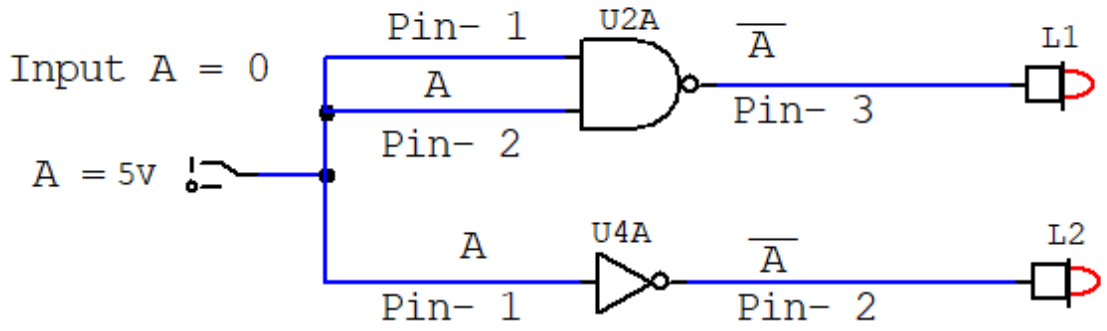
Simplified Table

Input					Output
A	B	$\overline{A}$	$\overline{B}$	$(\overline{A} \cdot \overline{B})$	Y
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

OR Gate

Input		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

CIRCUIT DIAGRAM



NAND gate as NOT

❖UNIVERSALITY OF NOR GATE

➢ NOR AS NOT GATE :

NOT gate output : X = $\overline{A}$ = $\overline{A + A}$

Simplified Table

Input	Output
A	$\overline{A + A}$
0	1
1	0

NOT Gate

Input	Output
A	X
0	1
1	0

➢ NOR AS OR GATE :

OR gate output: X = A + B = $\overline{\overline{A + B}}$ = $\overline{(\overline{A + B}) + (\overline{A + B})}$

Simplified Table

Input		Output
A	B	$\overline{\overline{A + B}}$
0	0	0
0	1	1
1	0	1
1	1	1

OR Gate

Input		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

➢ NOR AS AND GATE :

AND gate output X = A . B

$$= \overline{\overline{(A \,.\, B)}}$$

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

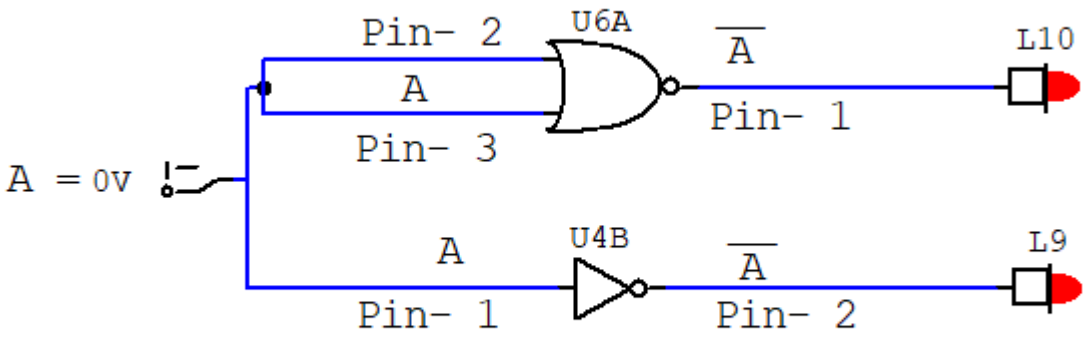
Simplified Table

Input					Output
A	B	$\overline{A}$	$\overline{B}$	$(\overline{A} + \overline{B})$	Y
0	0	1	1	1	0
0	1	1	0	1	0
1	0	0	1	1	0
1	1	0	0	0	1

AND Gate

Input		Output
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

CIRCUIT DIAGRAM



NOR gate as NOT

DISCUSSION: In this experiment we learned about universal gate. Hence we learned to use universal gates. We also have verified that NAND gate & NOR gate is universal gate. We have use NAND gate & NOR gate as basic logic gates AND, OR, NOT gate. We have also verified the truth tables. We made logic circuits of basic gates (AND, OR, NOT) using NAND gate and NAND gate. In that case if we don't have basic gates, we can use NAND gate or NOR gates.