Paper 7, TDC Part-3
Chapter– 1, Fundamental Concept of Digital Electronics
Lecture - 4

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Fundamental Concepts of Digital Electronics

In 3rd lectures we have discussed about "NAND" Gate and realization of basic gates using "NAND" gate.

In this lecture we will discuss about "NOR" gates and realization of basic gates using "NOR" gate.

- **The NOR Logic : -**

The NOR logic (operation) is a combination of two basic logics, the NOT & OR logics. This means that the output of the NOR gate is the inverted (complement) output of OR gate.

The NOR operation is defined as:- When all the inputs are at logic “0” then the output is at logic “1” else the output is at logic “0”. The N0R Gate can have N numbers of inputs $(\mathrm{N} \geq 2)$ and One output.

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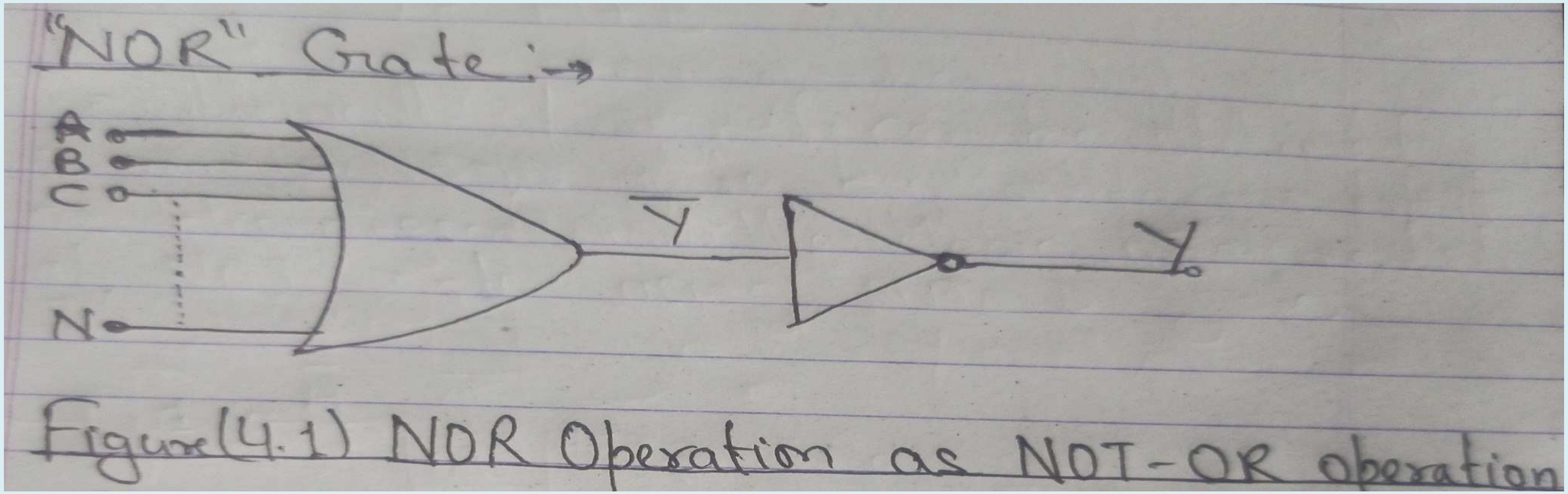
The logical expression of NOR operation is given by

$$Y = \overline{A \text{ OR } B \text{ OR } C \text{ OR } \ldots\ldots\ldots\ldots\ldots \text{ OR } N}$$

$$Y = \overline{A + B + C + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + N}$$

- **<u>Symbol for NOR Gate : -</u>**



Figure(4.1) NOR Operation as NOT-OR operation

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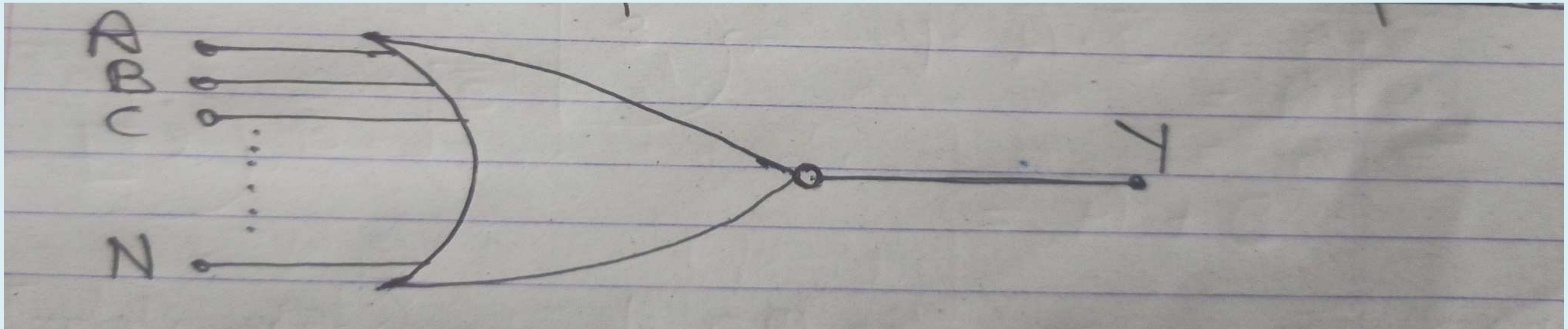
- **<u>Symbol for NOR Gate : -</u>**



Fig(4.2) Standard Symbol of the NOR Gate

Symbol shown in above figure is usually used to represent “NOR” gate.

A bubble on the output side of the “NOR” gate represent “NOT” operation.

- **Logic Equation & Truth Table for NOR Gate : -**
  - **2 input NOR Gate**

    Logic equation for 2 input NOR gate is:-

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

Input (A)	Input (B)	Output (Y)
0	0	1
0	1	0
1	0	0
1	1	0

Truth Table for 2- Input NOR Gate

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- **3 input NOR Gate**

Logic equation for 3 input NOR gate is:-

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

Input (A)	Input (B)	Input (C)	Output (Y)
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Truth Table for 3 Input NOR Gate

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Similarly the truth table of a NOR Gate with any numbers of input signals can be written. The output of a NOR Gate will be at logic “1 (High)” when all the input signals are at logic “0 (Low)” otherwise for any other combinations of inputs signal, the output will be at logic “0 (Low).

All three basic gates, “NOT”, “OR” & “AND” gate can also be realized using “NOR” Gate

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Similarly the truth table of a NOR Gate with any numbers of input signals can be written. The output of a NOR Gate will be at logic “1 (High)” when all the input signals are at logic “0 (Low)” otherwise for any other combinations of inputs signal, the output will be at logic “0 (Low).

All three basic gates, “NOT”, “OR” & “AND” gate can also be realized using “NOR” Gate

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Realization of "OR" Gate using "NOR" Gate:→

Since the output of "NOR" gate is complement of "OR" gate so to realize ~~NOR~~ "OR" Gate using "NOR" gate can be done by complementing the output of "NOR" gate, as shown in below figure

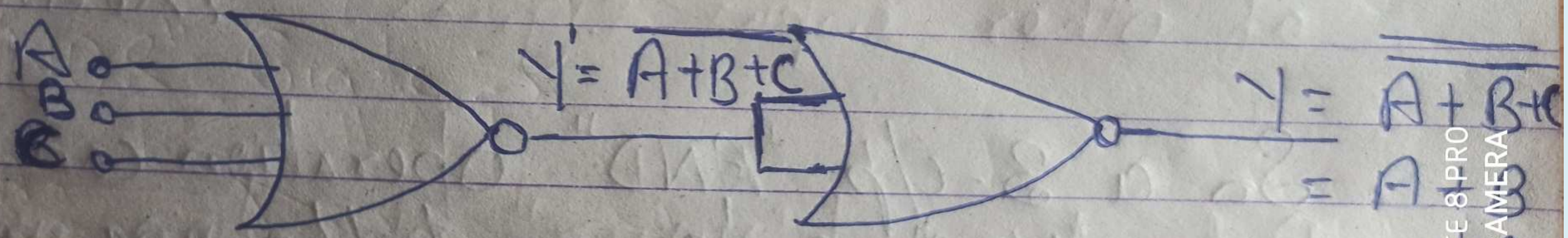

figure (4.4)→ "OR" Gate using "NOR" Gate

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The above operation can be understand from the truth table of above diagram.

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

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Realization of "AND" Gate using "NOR" Gate

Realization of 3-I/P "AND" operation

Output of 3-I/P AND operation is

$$Y = ABC.$$

or

$$Y = \overline{\overline{ABC}}$$

$$Y = \overline{\bar{A} + \bar{B} + \bar{C}}$$ [As Per Demorgan's Theorem]

So a 3-i/p "AND" operation can be realized using "NOR" gate in following manner :-

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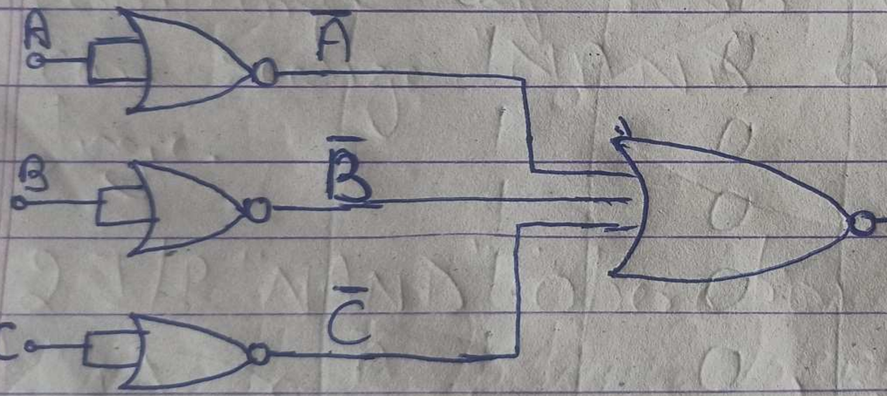
i) Complement all the input signal seperately using "NOR" gate.

(ii) Now apply these signals at the input of next "NOR" gate.



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

Figure (4.5) Realization 3 i/p "AND" Operation using "NOR" Gate

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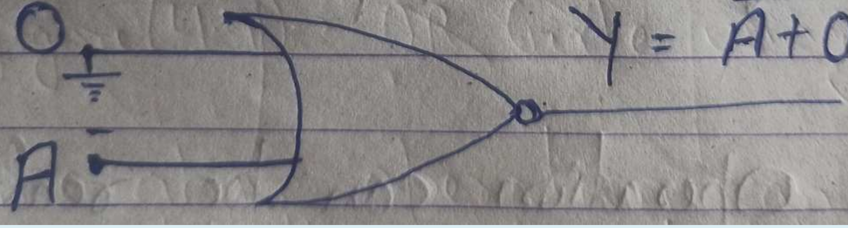
In similar manner "AND" operation with any no. of input signal can be realized using "NOR" gate.

Example 1.9) a If one of the input of a "NOR" gate is connected to logic 0 voltage, find the output voltage in terms of the other input.

(b) Repeat (a) if one of the inputs is connected to logic 1 voltage.

Solution :- (a)



$Y = \overline{A+0}$

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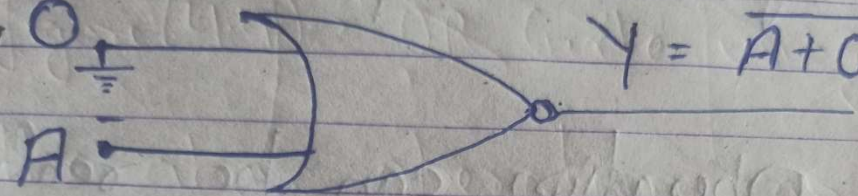
Solution:-

(a)



$Y = \overline{A+0}$

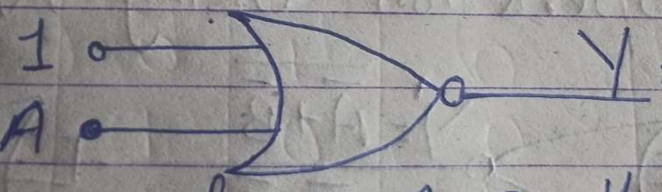
Now when $A=0$ then $Y = \overline{0+0} = \overline{0} = 1$

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

So the o/p voltage in terms of the input A is,

$Y = \overline{A}$

(b)



$Y = \overline{1+A}$

Now when $A=0$ then $Y = \overline{1+0} = \overline{1} = 0$

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

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So If one of the input is connected to logic '1' (High) then the output is always at logic "0" (low) irrespective of the state of input signal, for a "NOR" Gate

In case of 2 input "NOR" gate if one of the input is connected to logic "0" (low) then the output is always inversion of other input signal.

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- **<u>Realization of NAND Logic using NOR Logic :-</u>**

A "NAND" operation can be realized using "NOR" logic. We have ~~seen that~~ realize the "AND" & "NOT" operation using "NOR" operation. "NAND" operation is inversion/complement of "AND" operation. Hence we can realize "NAND" operation using "NOR" logic.

<u>2 I/P "NAND" operation using 'NOR' logic</u>

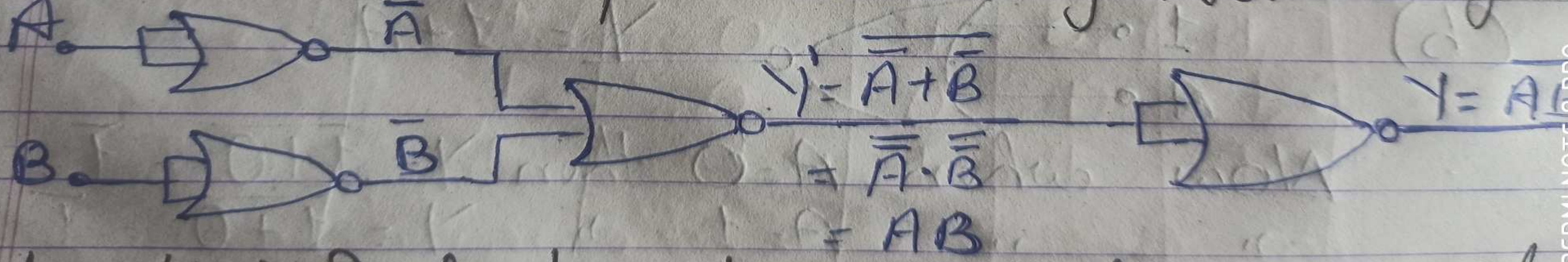

figure (4-6) Realization of NAND operation using NOR logic

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In a similar manner NOR operation can be realized using the NAND logic. Implementation of NOR logic using NAND logic has been left as a task.

We have realize all types of logic gate through either “NAND” or “NOR” logic. So we can design any type of digital circuit through only either NAND or NOR logic. Due to this reason NAND and NOR gate are also referred as universal gate.