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I025
I-1

LDCA Experiment 2: Basic Gates using Universal Gates.

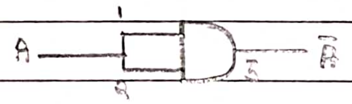
Aim :- To implement Basic gates using universal gates NAND (HC7400) and NOR (HC74)

Apparatus :- TinkerCad Software.

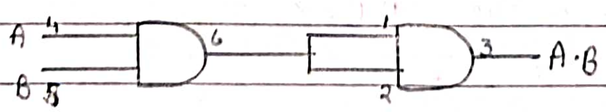
Components :- 330Ω resistor, LED 5V power input, breadboard, input pins, IC7400, IC74

Description :- The NAND and NOR gates are called as universal gates because it is possible to implement any Boolean equation with the help of NAND or NOR gates.
Boolean expression for NAND and NOR is
$X = \overline{AB}$ $X = \overline{A+B}$ respectively.

1) NOT using NAND
o/p is $\overline{A \cdot B} = y$ $Y = \overline{A \cdot A}$ $\because A = B$ But $A \cdot A = A$ $Y = \overline{A}$



2) AND using NAND
expression for AND is $y = A \cdot B$ $Y = \overline{\overline{A \cdot B}}$ But $\overline{\overline{A}} = A$ $Y = A \cdot B$



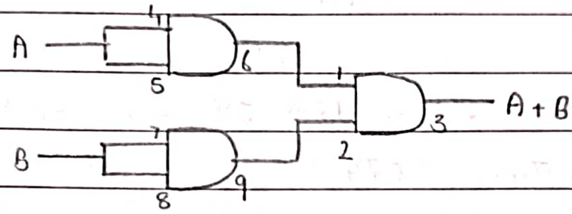
3) OR using NAND

Boolean equation is $Y = A + B$

Double Inversion:- $Y = \overline{\overline{A+B}}$

$\overline{A+B} = \overline{A} \cdot \overline{B}$ --- demorgan's Theorem

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



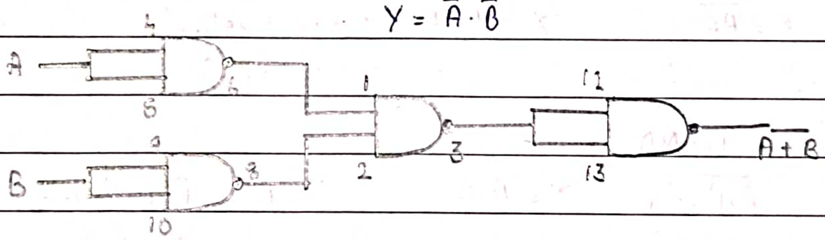
4) NOR using NAND

Boolean expression :- $Y = \overline{A+B}$

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

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

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



5) EX-OR using NAND

Boolean Eq^n $\longrightarrow$ $Y = A \oplus B$

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

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

Let $\overline{A} \cdot B = X$ and $A \cdot \overline{B} = Z$

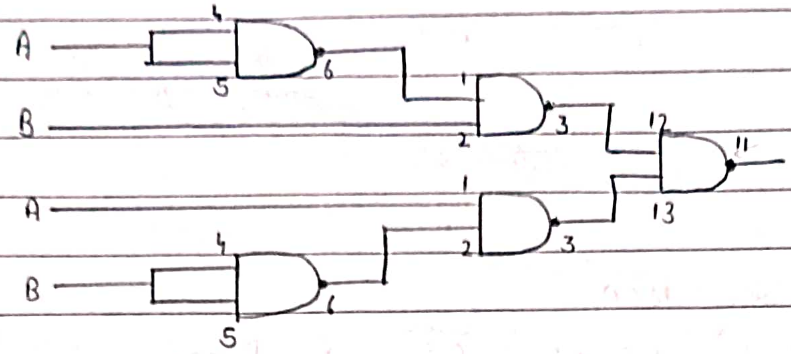
$Y = \overline{\overline{X + Z}}$

Using Demorgans Theorem

$\overline{X+Z} = \overline{X} \cdot \overline{Z}$

$Y = \overline{\overline{X} \cdot \overline{Z}}$

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



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

All gates using NOR gates.

1) NOT gr using NOR

Boolean eqn : $A = \bar{A}$ O/p is $Y = \overline{A+B}$

$y = \overline{A+A}$ $\because B = A$

But $A+A = A$ $\because$ By OR law

$Y = \bar{A}$

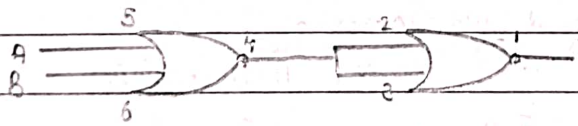
2) OR using NOR

Boolean Eqn $\rightarrow Y = A+B$

Take double inversion $Y = \overline{\overline{A+B}}$

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

$Y = A+B$



$A+B$

3) AND ~~gr~~ using NOR.

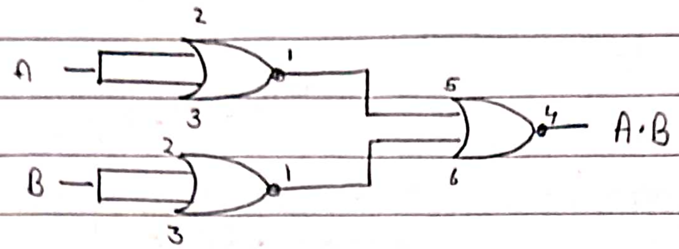
Boolean eqn $\rightarrow Y = A\cdot B$

Taking double inversion, $Y = \overline{\overline{A\cdot B}}$

But by De-Morgan's law

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

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



4) NAND using NOR

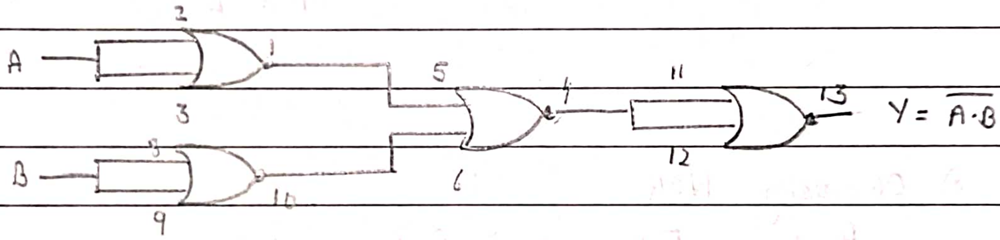
Boolean eqⁿ → $Y = \overline{A \cdot B}$ By Demorgons Law

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

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

Taking Double Inversion.

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



5) EX-OR using NOR

Boolean eqⁿ → $Y = A \oplus B$

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

Taking double inversion.

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

Let $\overline{A} \cdot B = X$ and $A \cdot \overline{B} = Y$

$Y = \overline{\overline{X + Z}}$

Using De Morgan's Theorem

$\overline{X + Z} = \overline{X} \cdot \overline{Z}$

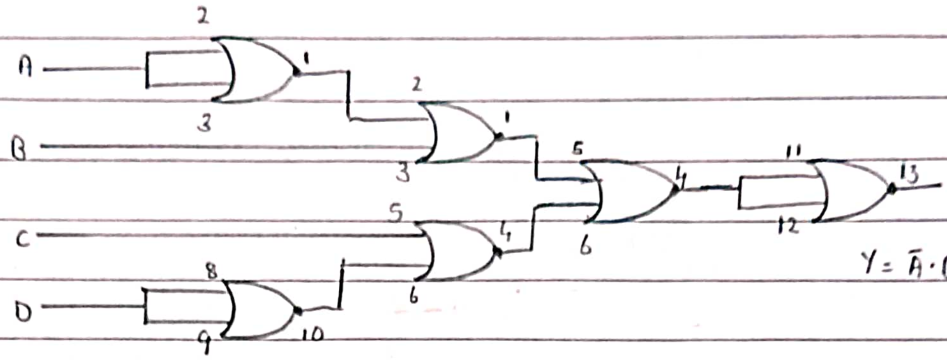
$Y = \overline{\overline{X} \cdot \overline{Z}}$

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

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

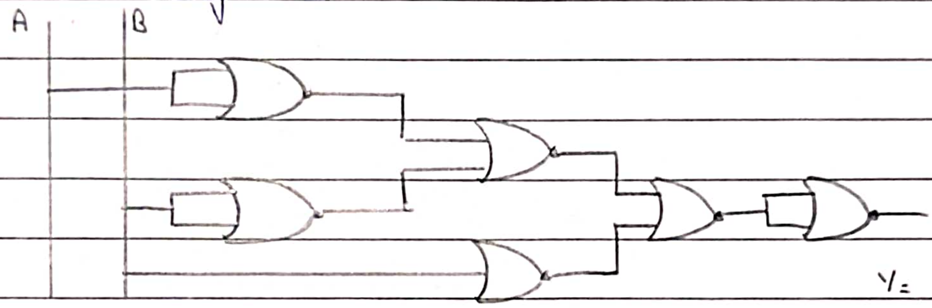
~~Y = A~~ $Y = \overline{(A + \overline{B}) \cdot (\overline{A} + B)}$

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



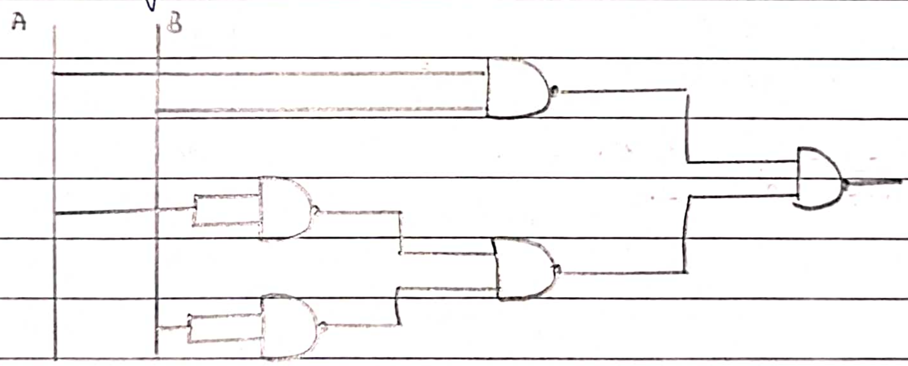
$Y = \bar{A} \cdot B + A \cdot \bar{B}$

6) EX - NOR using NOR

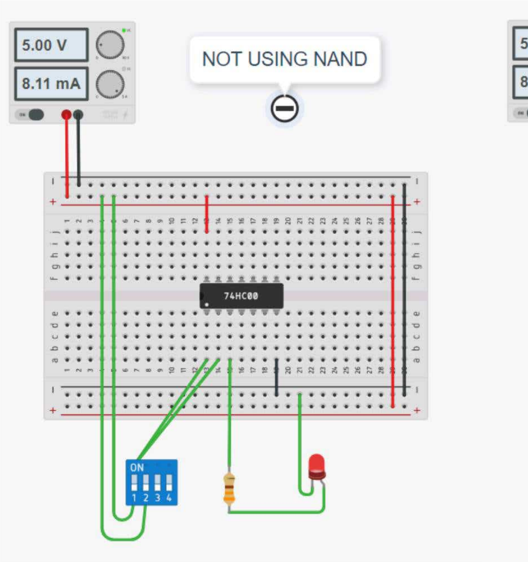


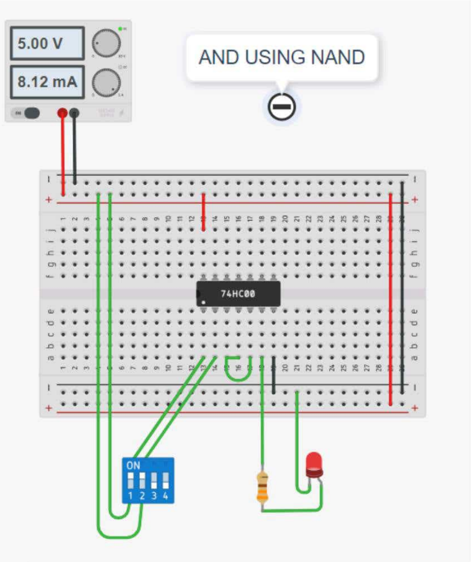
$Y = \bar{A} \cdot B + B \cdot \bar{A}$

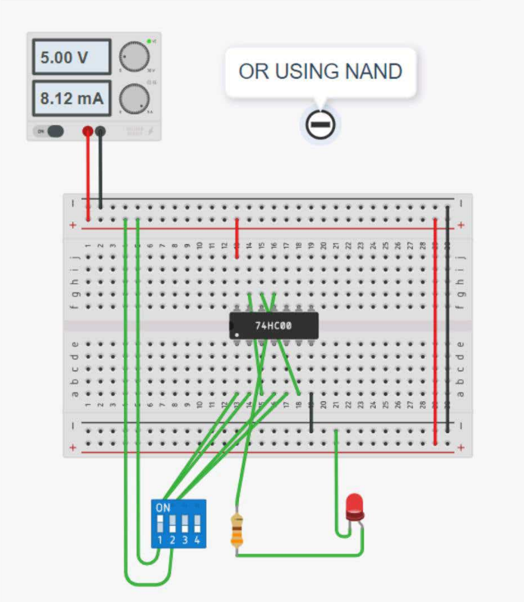
EX-NOR using NAND

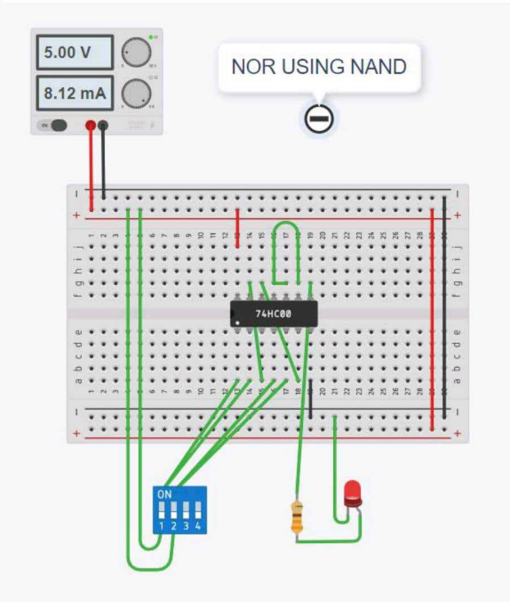


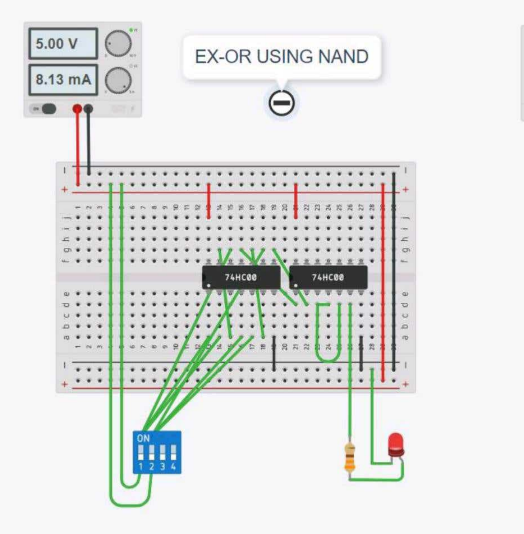
Conclusion All the gates are constructed using NAND and NOR gates and truth tables and equations are verified.

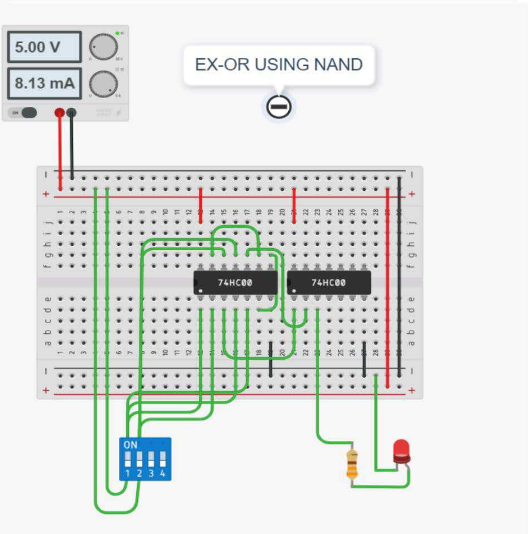

5.00 V
8.11 mA
NOT USING NAND
74HC00
ON
1 2 3 4

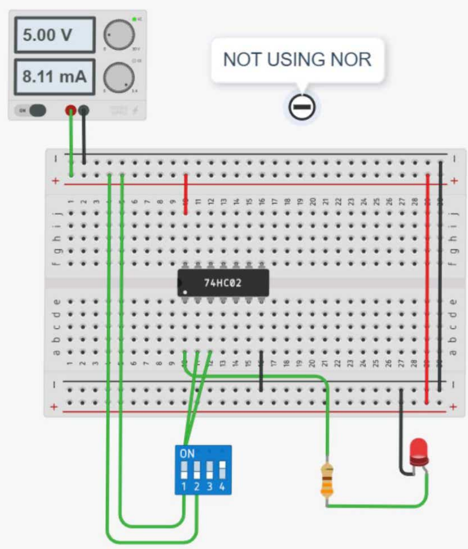

5.00 V
8.12 mA
AND USING NAND
74HC00
ON
1 2 3 4

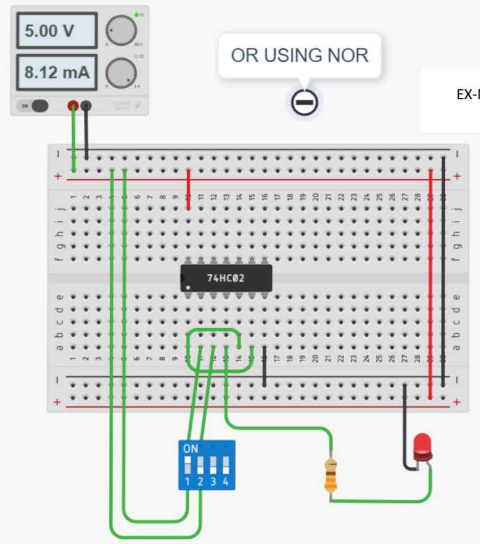

5.00 V
8.12 mA
OR USING NAND
74HC00
ON
1 2 3 4


5.00 V
8.12 mA
NOR USING NAND
74HC00
ON
1 2 3 4

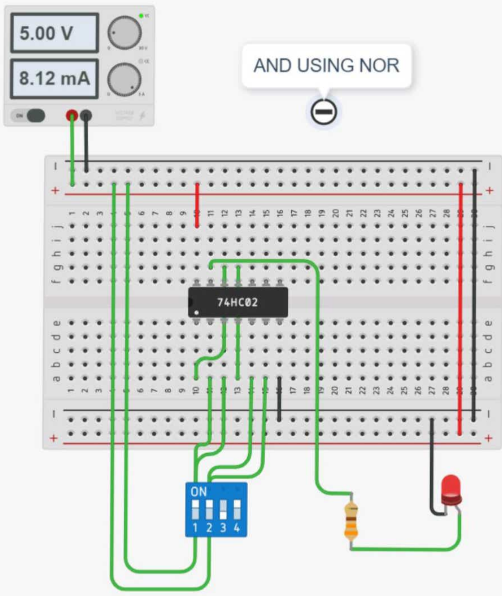

5.00 V
8.13 mA
EX-OR USING NAND
74HC00
74HC00
ON
1 2 3 4

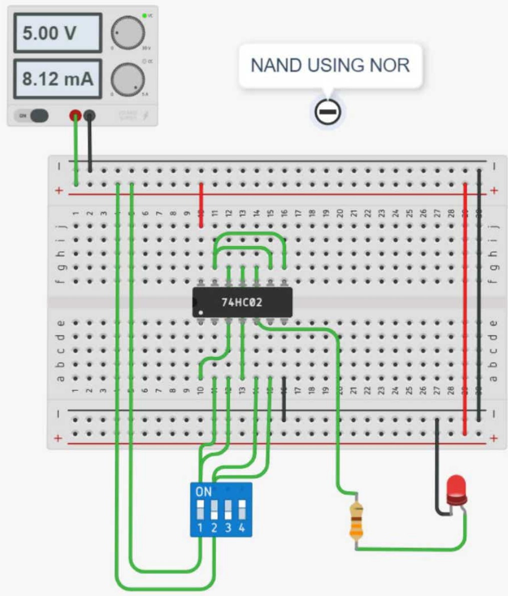

5.00 V
8.13 mA
EX-OR USING NAND
74HC00
74HC00
ON
1 2 3 4

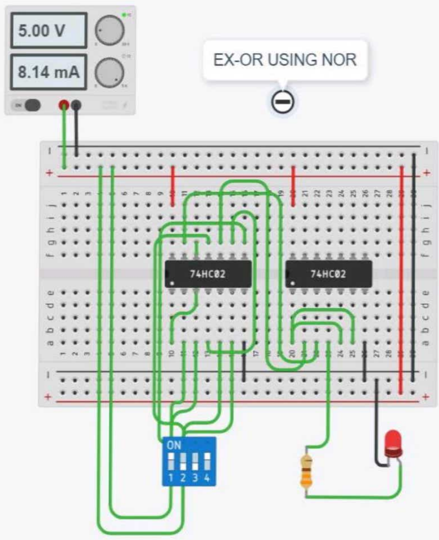

5.00 V
8.11 mA
NOT USING NOR
74HC02
ON

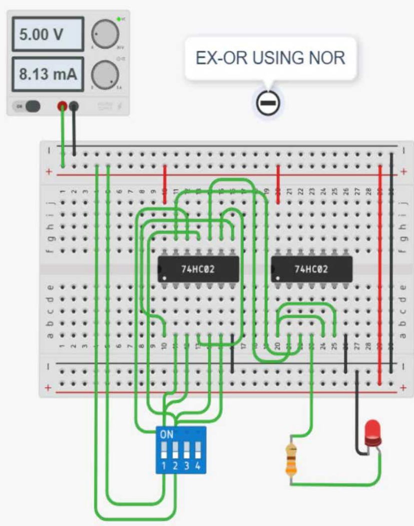

5.00 V
8.12 mA
OR USING NOR
74HC02
ON

EX-NOR


5.00 V
8.12 mA
AND USING NOR
74HC02
ON


5.00 V
8.12 mA
NAND USING NOR
74HC02
ON


5.00 V
8.14 mA
EX-OR USING NOR
74HC02
74HC02
ON


5.00 V
8.13 mA
EX-OR USING NOR
74HC02
74HC02
ON