Experiment : 1

Date

Page No.

a. Aim → Verify the truth table for AND gate.

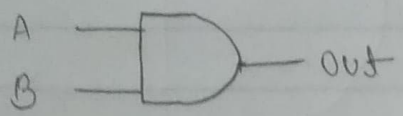
Theory → The AND gate is an electronic circuit that gives a high output (1) only if all its inputs are high. A dot (.) is used to show the AND operation i.e. A.B

Input		Output
A	B	Y = A.B
0	0	0
0	1	0
1	0	0
1	1	1

Procedure -

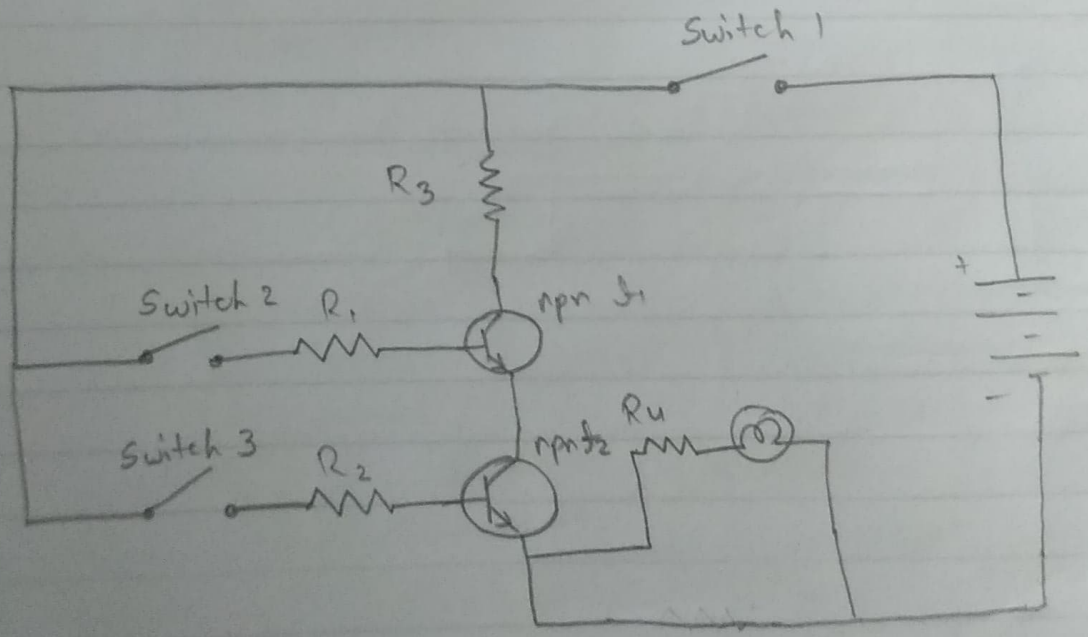
1. Connect the supply (+5 V) battery to the circuit.
2. Press the switches for inputs "A" and "B".
3. The bulb glows if both the switches are off else it won't glow.
4. Repeat step-2 & 3 for all state of inputs.

Result - Truth table of AND gate is proved.



Logic Symbol of AND Gate

Simulation →



Experiment :

Date

Page No.

6. Aim → Verify the truth table of OR gate.

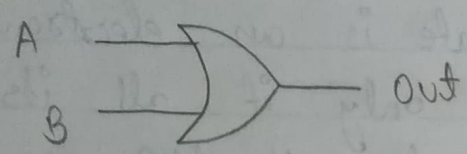
Theory → The OR gate is an electronic circuit that gives a high output (1) if one or more of its inputs are high. A plus (+) is used to show the OR operation.

Input		Output
A	B	Y = A + B
0	0	0
1	0	1
0	1	1
1	1	1

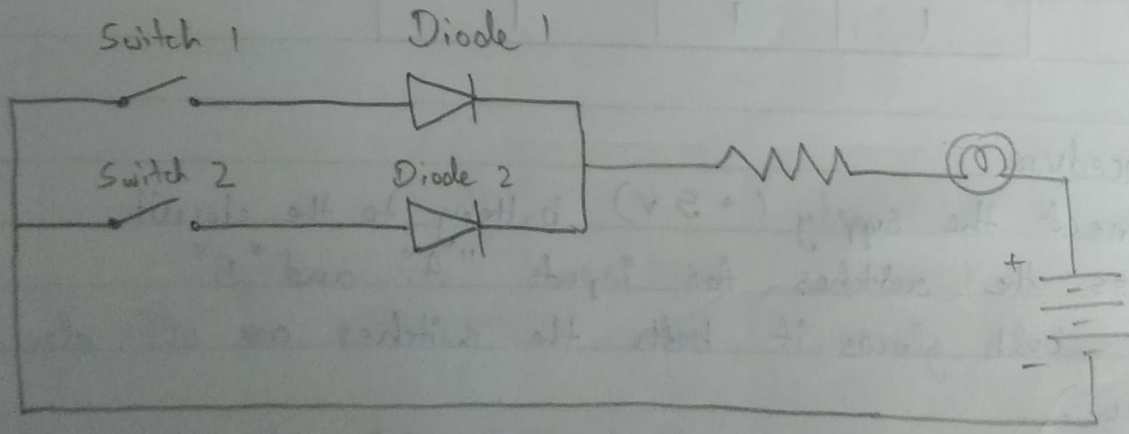
Procedure →

1. Connect the supply (+5V) battery to the circuit.
2. Press the switches for inputs "A" and "B".
3. The bulb glows if any one or both the switches are ON else it won't glow.
4. Repeat step-2 and step-3 for all state of inputs.

Result - The truth table of OR gate is verified.



Logic Symbol of OR Gate



Experiment :

Date

Page No.

Aim → Verify the truth table of NOT gate.

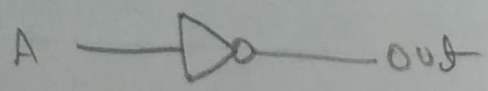
Theory → The NOT gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an inverter. If the input variable is A, the inverted output is known as NOT A. This is also shown as A' or A with a bar over the top.

Input	Output
A	Y
0	1
1	0

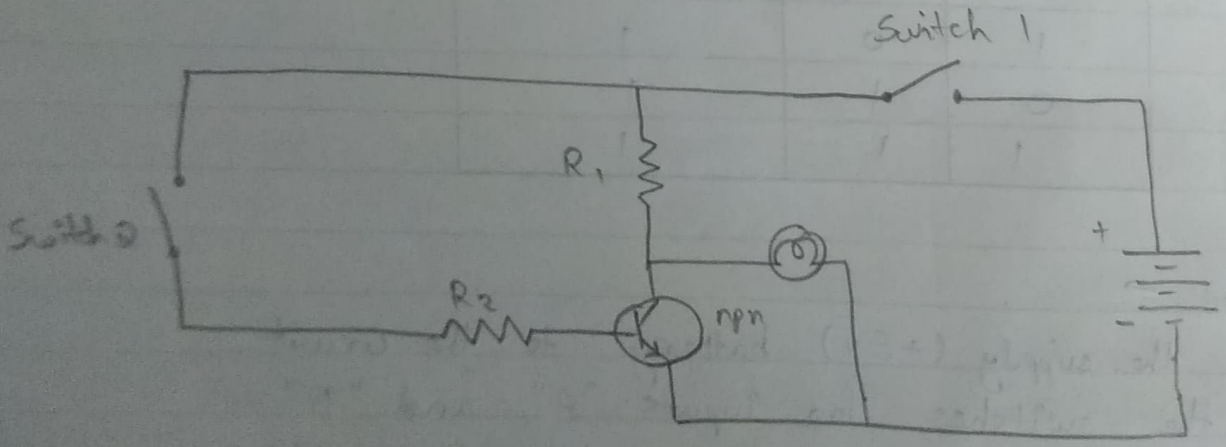
Procedure →

1. Connect the supply (+5v) battery to the circuit.
2. Press the switch 1 to connect battery to the circuit.
3. Press the switches 2 ~~and 3~~ for input "A".
4. The bulb glows if switch 2 is OFF else it won't glow.

Result → The Truth table of NOT gate is verified.



Logic symbol of NOT Gate



Experiment :

Date

Page No.

d. Aim → Verify the truth table of NAND gate.

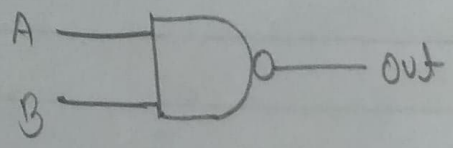
Theory → This is a NOT - AND gate which is equal to an AND gate followed by a NOT gate. The outputs of all NAND gates are high if any of the inputs are low. The symbol is an AND gate with a small circle on the output. The small circle represents inversion.

Input		Output
A	B	$Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

Procedure →

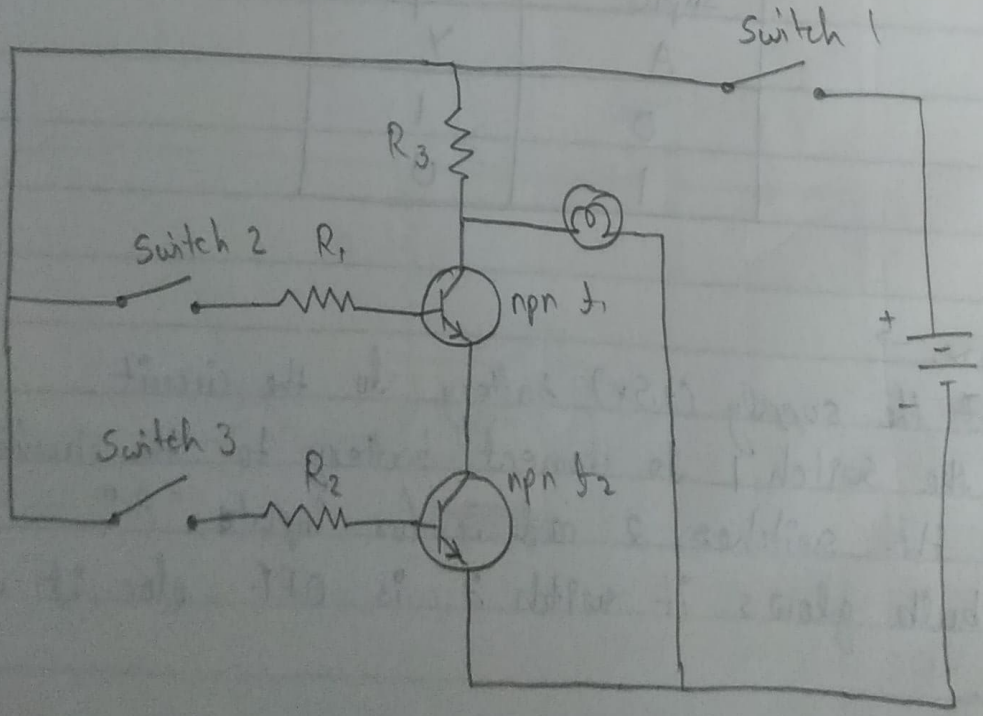
1. Connect the supply (+5V) battery to the circuit.
2. Press the switch 1 to connect battery to the circuit.
3. Press the switches 2 and 3 for inputs "A" and "B".
4. The bulb glows if any one or both the switches are OFF else it won't glow.

Result → Truth table of NAND gate is proved.



Logic Symbol of NAND Gate

Simulation -



Experiment :

Date

Page No.

e. Aim → Verify the truth table of NOR gate.

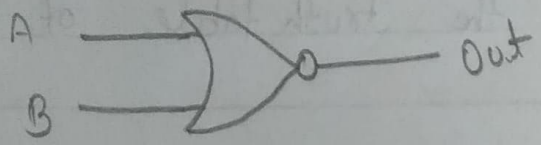
Theory → This is a NOT - OR gate which is equal to an OR gate followed by a NOT gate. The outputs of all NOR gates are low if any of the inputs are high. The symbol is an OR gate with a small circle on the output. The small circle represents inversion.

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

Procedure →

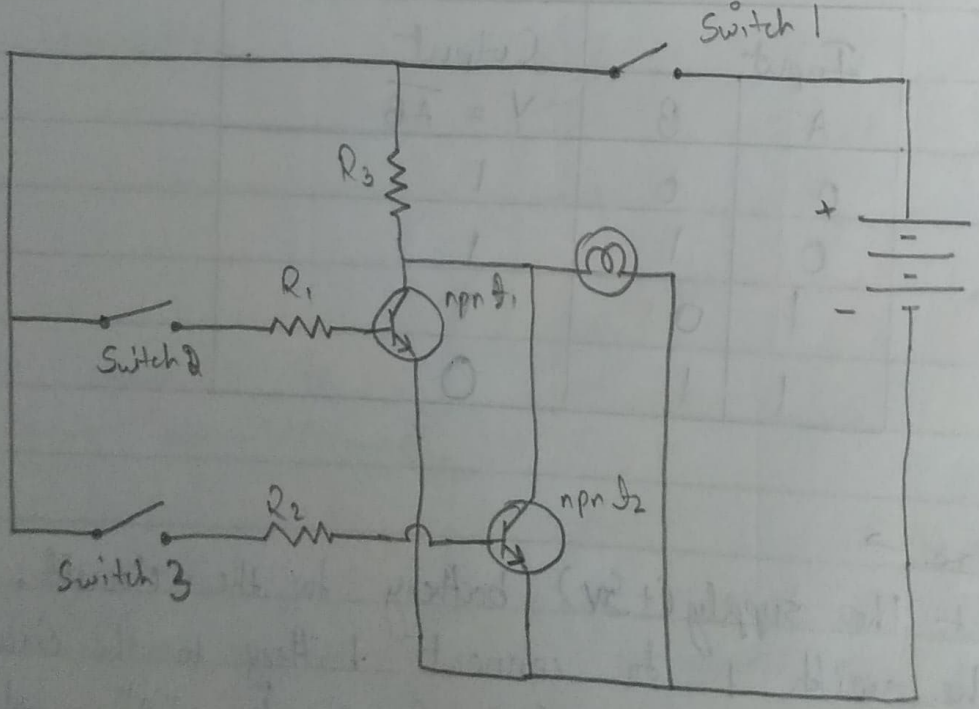
1. Connect the supply (+5v) battery to the circuit.
2. Press the switch 1 to connect battery to the circuit.
3. Press the switches 2 and 3 for inputs "A" and "B".
4. The bulb glows if both the switches are off else it won't glow.

Result → Truth table of NOR gate is verified.



Logic symbol of NOR Gate

Simulation →



Experiment :

Date

Page No.

1. Aim → Verify the truth table of Ex - OR gate.

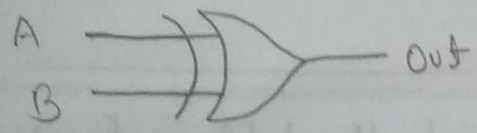
Theory - The Exclusive - OR gate is a circuit which will give a high output if either, but not both of its two inputs are high. An encircled plus sign (⊕) is used to show the Ex - OR operation. Ex - OR gate is created from AND, NAND and OR gates The output is high when inputs are diff.

Input		Output
A	B	$Y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Procedure →

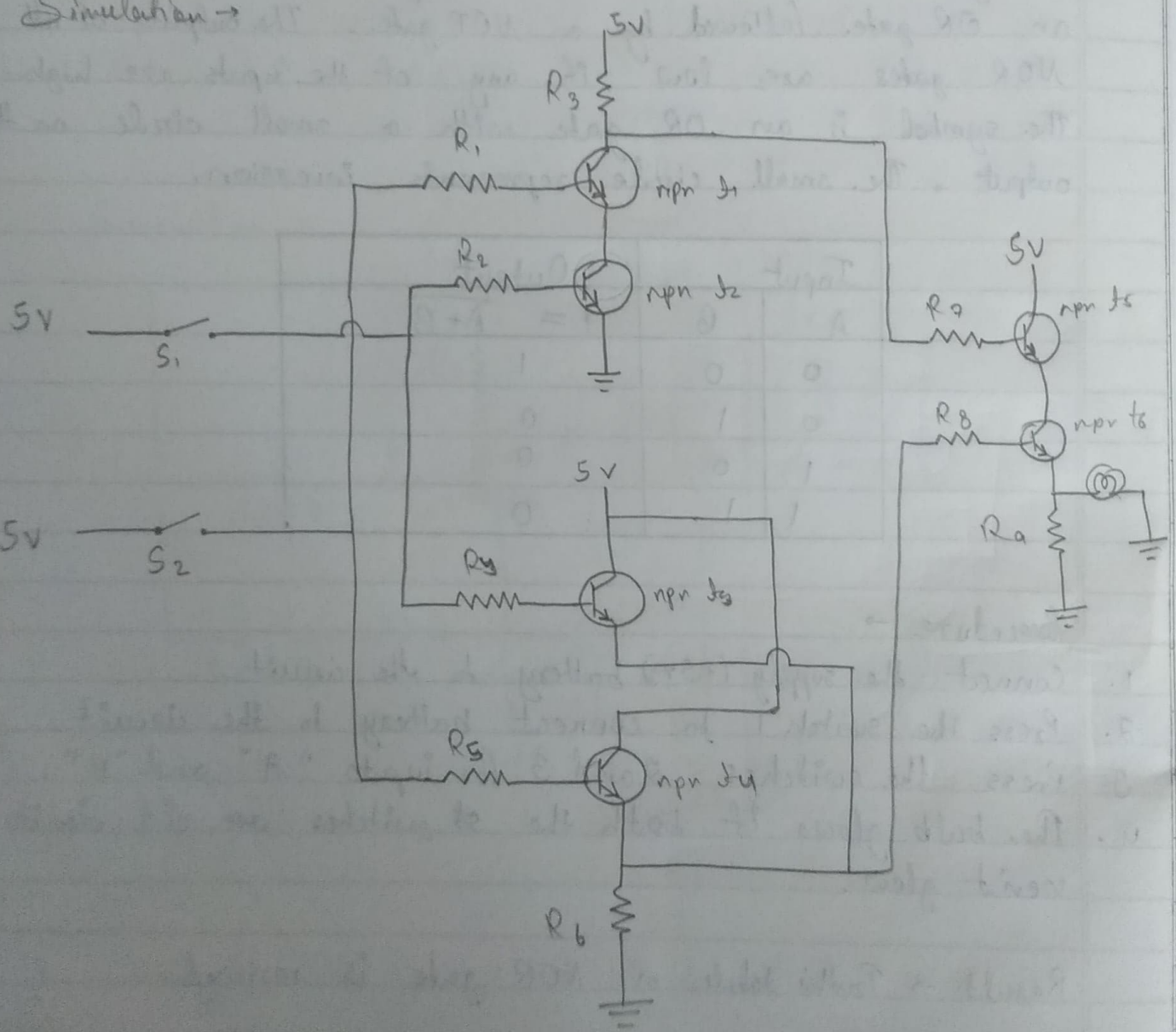
1. Connect the supply (+5v) to the circuit.
2. Press the switches for inputs "A" and "B".
3. The bulb glows if one of the switches is ON and one of the switches is OFF else it won't glow.

Result → Truth table of Ex - OR gate is verified.



Logic Symbol of XOR Gate

Simulation →



Experiment :

Date

Page No.

9. Aim → Verify the truth table of Ex - NOR gate.

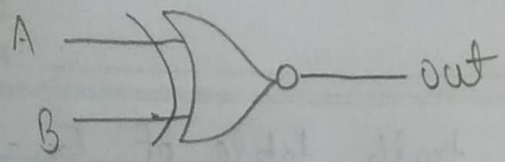
Theory → The Exclusive - NOR gate circuit does the opposite to the Ex - OR gate. It will give a low output if either, but not both of its two inputs are high. The symbol is an Ex - OR gate ⊕ with a small circle on the output. Ex - NOR gate is created from AND, NOT and OR gates. The output is high only when both the inputs are same.

Input		Output
A	B	$Y = \overline{A \oplus B}$
0	0	1
1	0	0
0	1	0
1	1	1

Procedure →

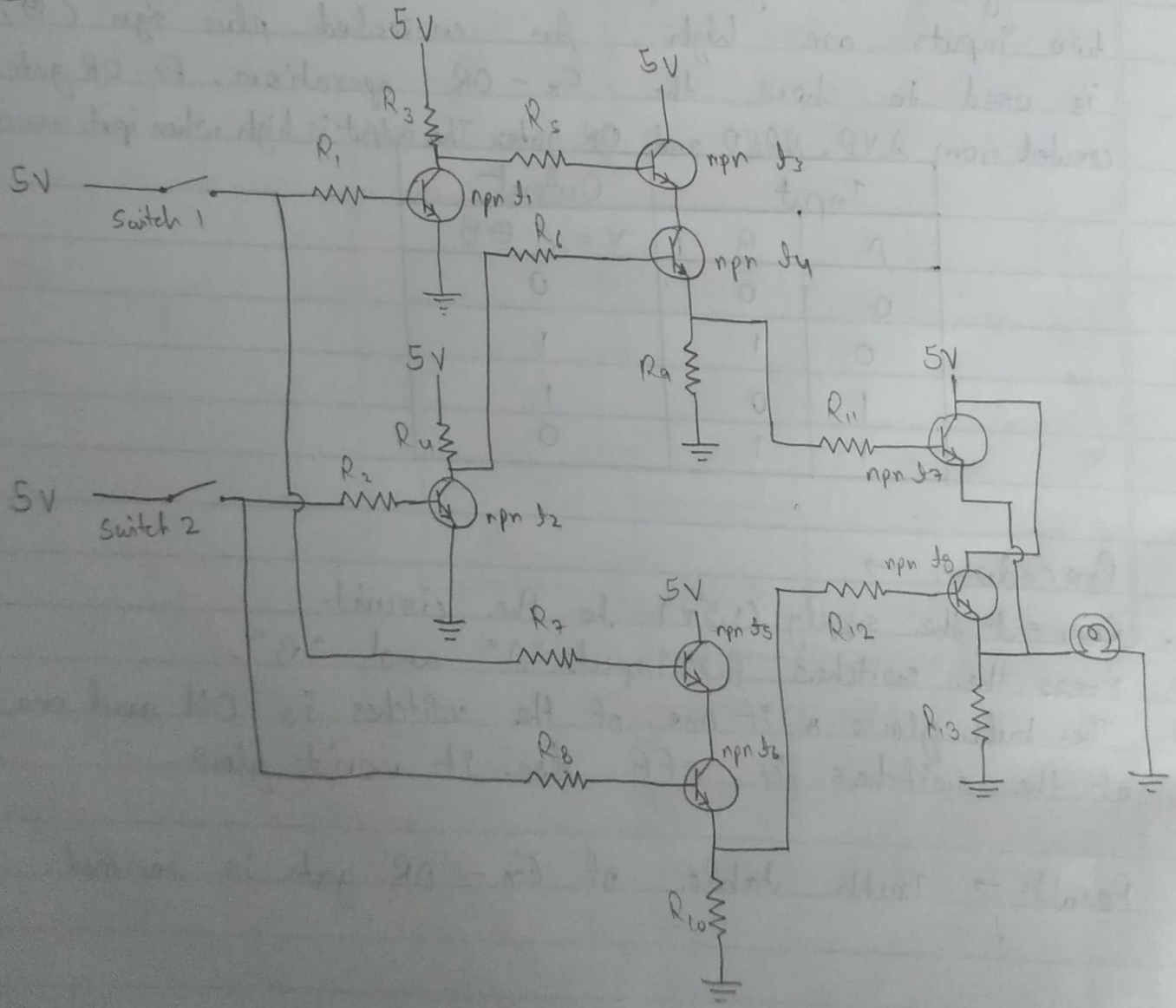
1. Connect the supply (+5V) battery to the circuit.
2. Press the switches for inputs "A" and "B".
3. The bulb glows if both the switches are ON or if both the switches are off else it won't glow.

Result → Truth table of Ex - NOR gate is verified.



Logic Symbol of XNOR Gate

Simulation →



R 1, 2, 5, 6, 7, 8, 11, 12 = 10 kilo-ohm

R 3, 4, 9, 10, 13 = 5 kilo-ohm

Experiment : 2

Date

Page No.

Aim → To implement the logic functions i.e. AND, OR, NOT, Ex-OR, Ex-NOR and a logic expression with the help of NAND and NOR universal gates.

Theory →

1. NAND gate as Universal gate - By using only NAND gates, we can realize all logic functions - AND, OR, NOT, X-OR, X-NOR, NOR. So this gate is also called as universal gate.

1.1 NAND gates as NOT gate - A NOT produces complement of the input. It can have only one input, tie the inputs of a NAND gate together. Now it will work as NOT gate.
Its output is $Y = (A.A)'$

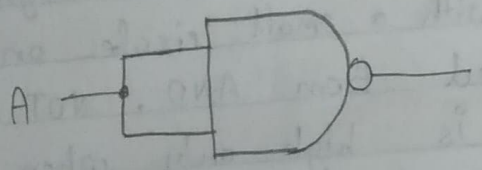
$Y = (A)'$

Input	Output
A	A'
0	1
1	0

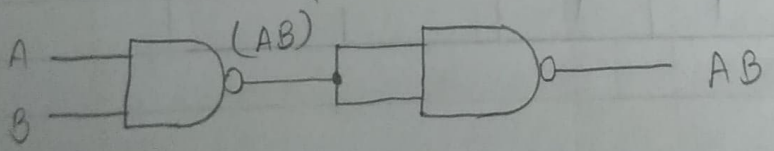
1.2 NAND gates as AND gate - A NAND produces complement of AND gate. So, if the output of a NAND gate is inverted, overall output will be that of an AND gate.

$Y = ((A.B)')'$

$Y = A.B$



1.1 NAND gates as NOT gate



1.2 NAND gates as AND gate

Experiment :

Date

Page No.

Input		Output
A	B	Y
0	1	0
1	0	0
0	0	0
1	1	1

1.3 NAND gates as OR gate -

from DeMorgan's theorems → $(A.B)' = A' + B'$

$(A'.B')' = A'' + B'' = A + B$

So, give the inverted inputs to a NAND gate obtain OR operation at output.

A	B	X = A+B
0	0	0
0	1	1
1	0	1
1	1	1

1.4 NAND gates as Ex-OR gate

Output from gate no. 4 is the overall output of the configuration

$$Y = ((A(AB)')' (B(AB)')')'$$

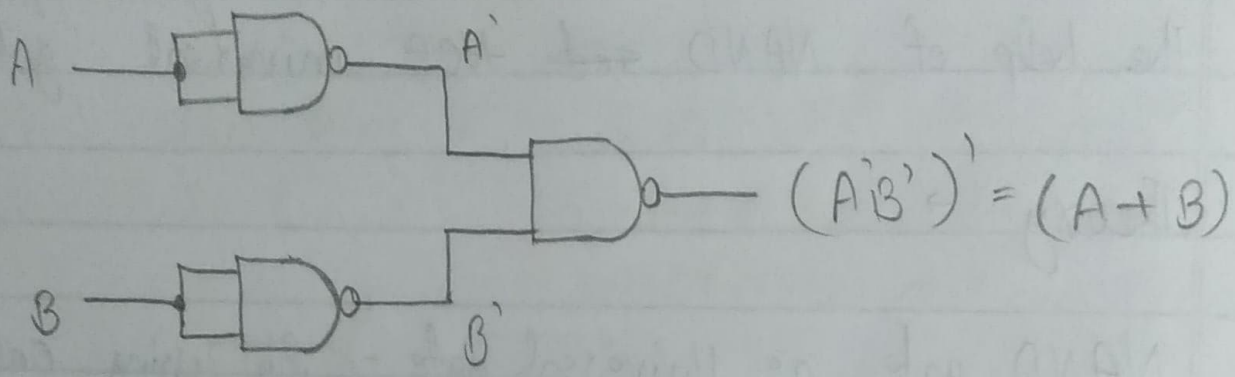
$$= ((A(AB)')'' + (B(AB)')''$$

$$= (A(A' + B')) + (B(A' + B'))$$

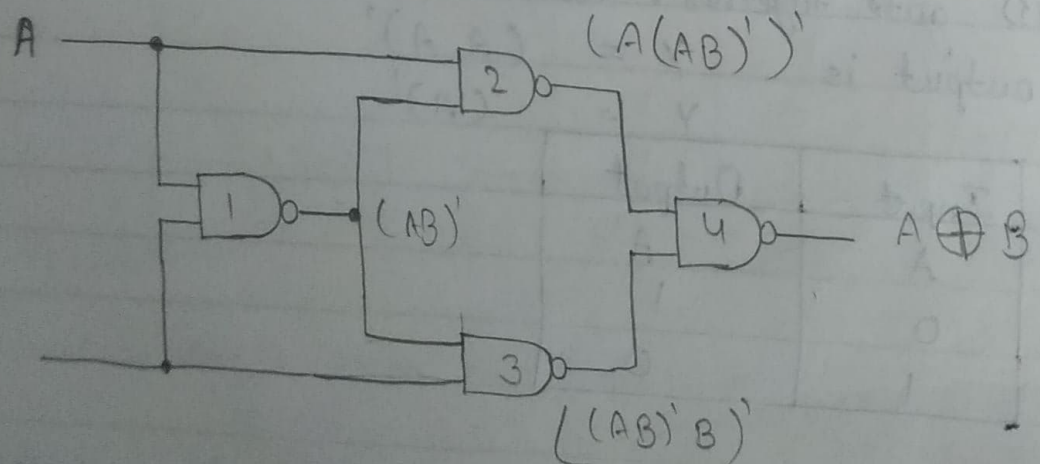
$$= AA' + AB' + BA' + BB'$$

$$= 0 + AB' + BA' + 0$$

$$Y \Rightarrow AB' + A'B$$



1.3. NAND gates as OR gate



1.4 NAND gates as Ex-OR gate

Experiment :

Date

Page No.

A	B	A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0

1.5 NAND gates as XNOR gate - Ex-NOR gate is actually Ex-OR gate followed by NOT gate. So give the output of XOR gate to a NOT gate, overall output is that of an XNOR gate. $Y = AB + A'B'$

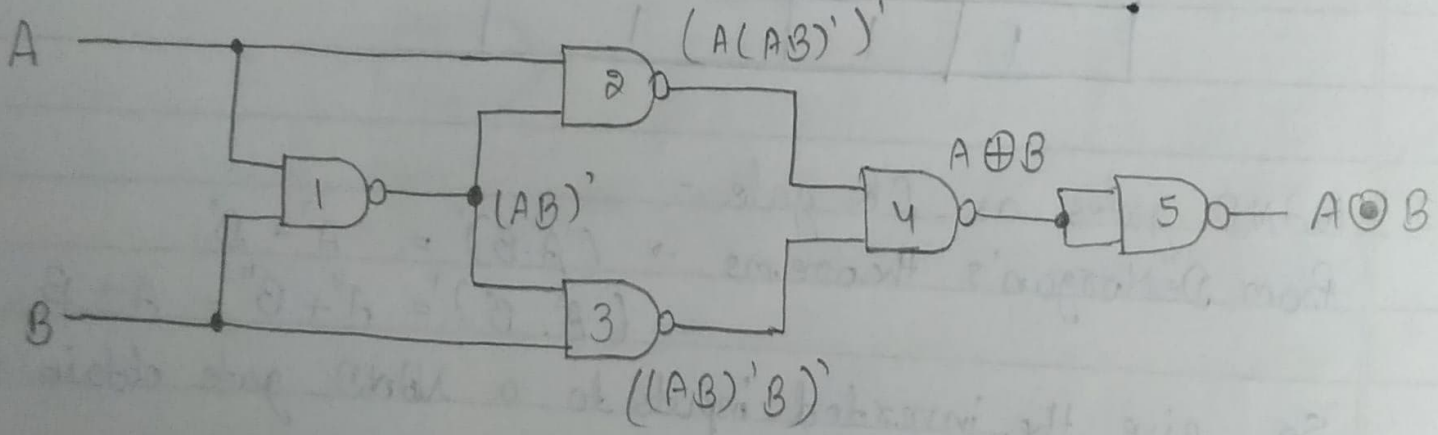
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Procedure -

1. Select and drag " ● " for generate wire of the circuit.
2. Join the wire to perform the require logic.

Note :- Follow these steps for all experiments.

Result - we've implemented the logic functions i.e. AND, OR, NOT, Ex-OR, Ex-NOR and ~~and~~ with the help of NAND universal gate.



1.5 NAND gates as 'XNOR gate

Experiment : 3

Date

Page No.

Aim - To implement the logic function i.e. AND, OR, NOT, Ex-OR, Ex-NOR and a logical expression with the help of NOR universal gate.

Theory → By using only NOR gates, we can realize all logic functions : AND, OR, NOT, XOR, XNOR, NAND. So this gate is also called universal gate.

1. NOR gates as NOT gate - A NOT produces complement of the input. It can have only one input, tie the inputs of a NOR gate together. Now it will work as a NOT gate. Its output is

$$Y = (A + A)'$$

$$Y = A'$$

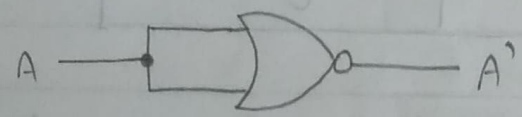
Input A	Output A'
0	1
1	0

2. NOR gates as OR gate - A NOR produces complement of OR gate. So, if the output of a NOR gate is inverted, overall output will be that of an OR gate.

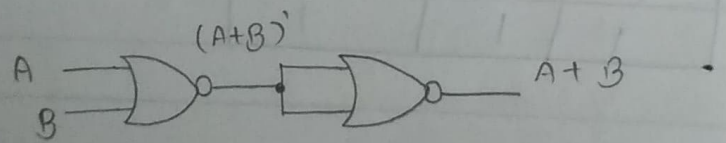
$$Y = ((A + B)')'$$

$$Y = A + B$$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1



1. NOR gates as NOT gate



2. NOR gates as OR gate

Experiment :

Date

Page No.

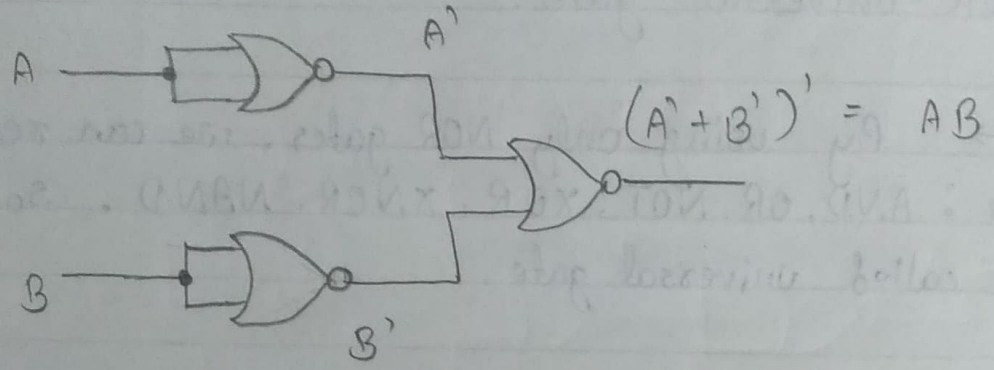
3. NOR gates as AND gate -
from DeMorgan's theorems -
$(A+B)' = A'B'$
$(A'+B')' = A''B'' = AB$ So, give the invested inputs to a NOR gate., obtain AND operation at output.

A	B	Y = A.B
0	0	0
0	1	0
1	0	0
1	1	1

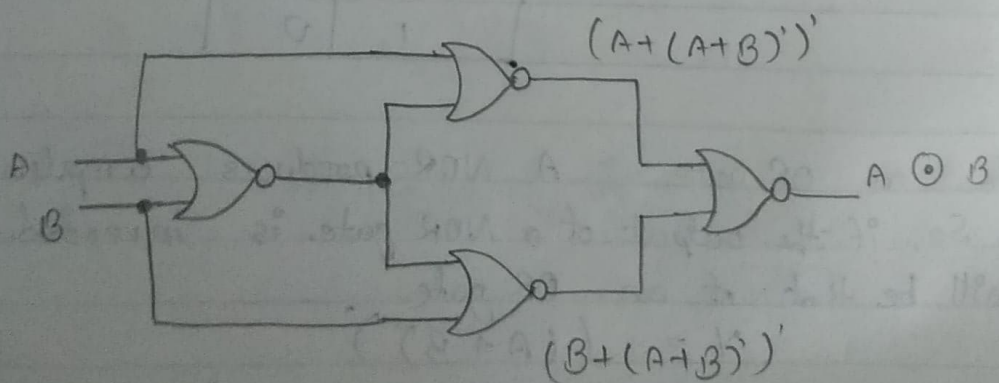
4. NOR gates as Ex-NOR gate - The output of a two input Ex-NOR gate is shown by $Y = AB + A'B'$.
(This can be achieved with the logic diagram shown in the left side.)

$$Y = ((A+(A+B)')' \cdot (B+(A+B)')')'$$
$$= (A+(A+B)')'' . (B+(A+B)')''$$
$$= (A+(A+B')') . (B+(A+B)')$$
$$= (A+A'B') . (B+A'B')$$
$$= (A+A').(A+B').(B+A)'(B+B')$$
$$= 1.(A+B').(B+A').1$$
$$= A.(B+A') + B'.(B+A')$$
$$= AB + AA' + B'B + B'A'$$
$$= AB + 0 + 0 + A'B'$$
$$Y = AB + A'B'$$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1



3. NOR gates as AND gate.



4. NOR gates as Ex-NOR gate.

Experiment :

Date

Page No.

5. NOR gates as Ex-OR gate - Ex-OR gate is actually XNOR gate followed by NOT gate. So give the output of XNOR gate to a NOT gate, overall output is that of an XOR gate.

$$Y = A'B + AB'$$

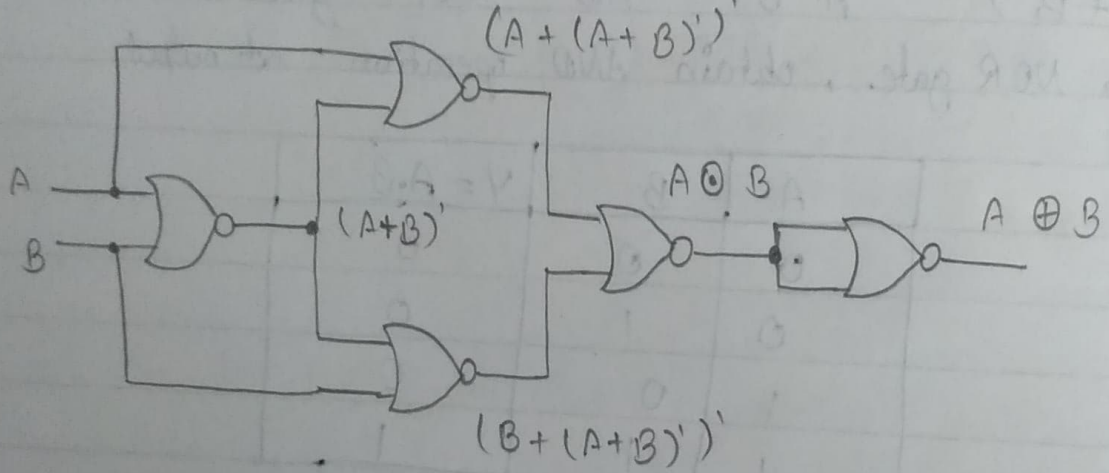
A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0

Procedure -

1. Select and drag " ● " for generate wire of the circuit.
2. Join the wire to perform the require logic.

Note :- Follow these steps for all experiments.

Result → We've implemented the logic functions i.e. AND, OR, NOT, Ex-OR, Ex-NOR with the help of NOR universal gate.



5 NOR gates as Ex- OR gate

Experiment : 4

Date

Page No.

Aim - To verify the truth table of half adder using XOR and NAND gates.

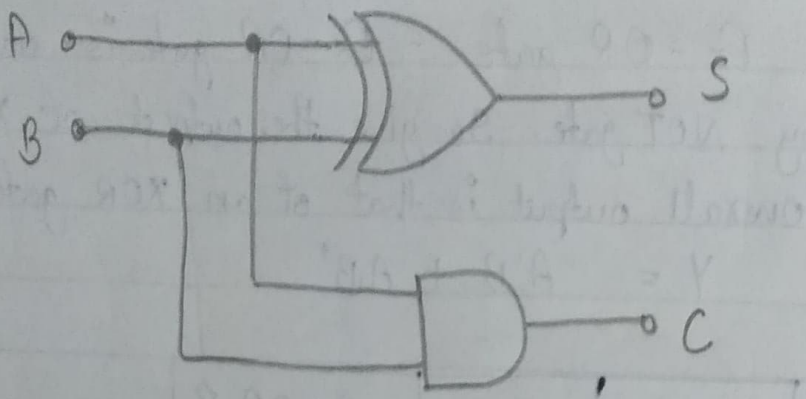
Theory →

Half adder is a combinational circuit that performs simple addition of two binary no.s.

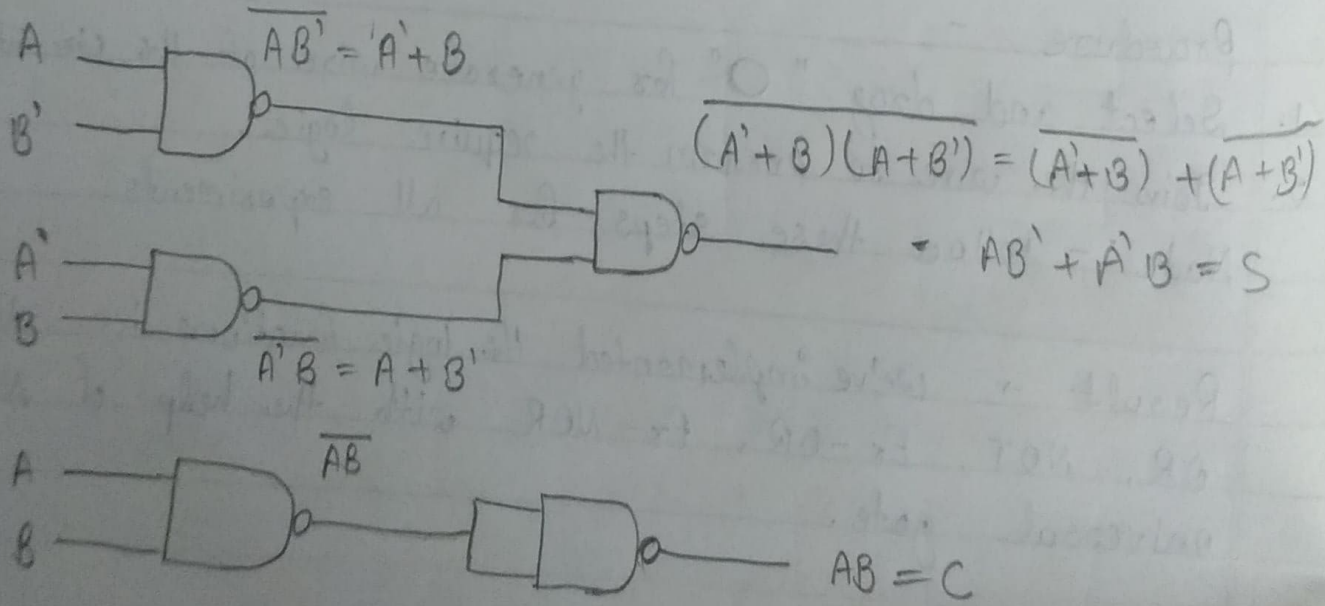
Half adder Truth table - The sum output of the binary addition carried out above is similar to that of an XOR operation while the carry output is similar to that of an AND operation.

INPUT		OUTPUT	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

As we know that NAND and NOR are called universal gates as any logic system can be implemented using these two, the half adder circuit can also be implemented using them. We know that a half adder circuit has one XOR gate and one AND gate.



Half Adder Logic Diagram



Half adder using NAND gates

Experiment :

Date

Page No.

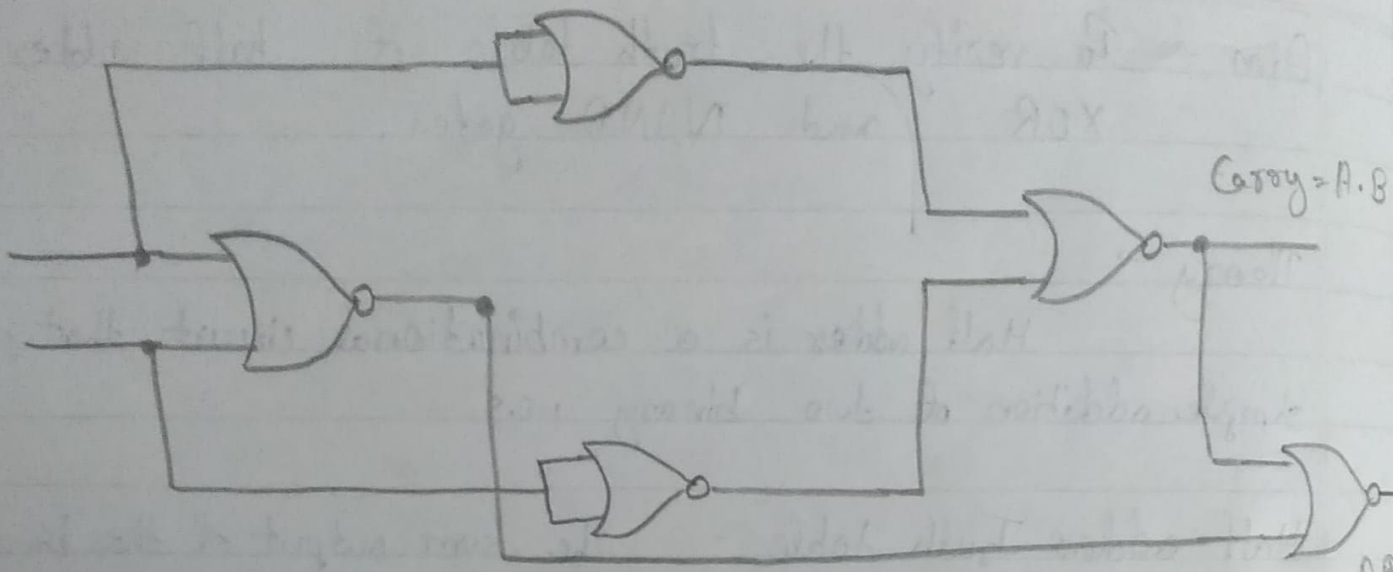
Half adder using NAND gates - five NAND gates are required in order to design a half adder. The circuit to realize half adder using NAND gates is shown ~~left side~~

Half adder using NOR gates - Five NOR gates are required in order to design a half adder. The circuit to realize half adder using NOR gates is shown.

Procedure -

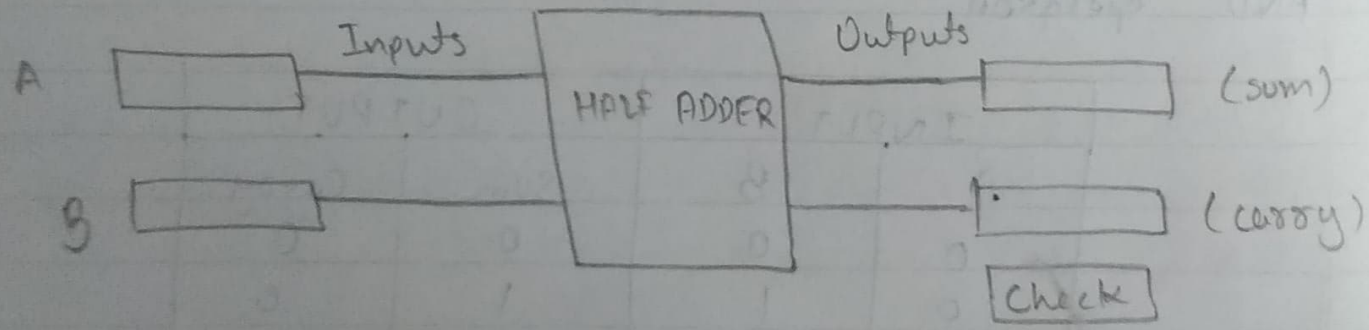
* Connect the supply (+5 v) to the circuit.
* First press "ADD" button to add basic state of your output in the given table.
* Press the switches to select the required inputs "A" and "B".
* Press "ADD" button to add your inputs and outputs in the given table.
* Repeat steps 3 & 4 for next state of inputs and their corresponding outputs.

Result - Truth table of half adder is verified using Ex-OR and NAND gate.



Half adder using NOR gates.

Simulator →



Truth Table

Print

S. no.	A	B	Sum	Carry	Remarks
1.	0	1	1	0	✓
2.	0	0	0	0	✓
3.	1	1	1	0	✗
4.	1	0	0	1	✗
5	1	1	0	1	✓
6	1	0	1	0	✓