LOGIC GATES

1. What are Logic gates?

Logic gates are electronic circuits that perform logical operations. Logic gates are circuit made of Transistor, Diode and Resistor.A logic gate can have more than one input but only one output.

2. Derive basic/simple logic gates with its definition, logic symbol, truth table and expression?
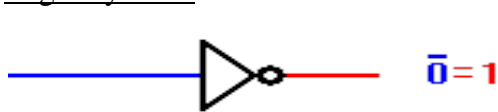
The three basic logic operations are **NOT**, **AND** and **OR**

NOT Gate (Inverter)

Definition: NOT gate is a logic gate that changes a 0 input to 1 and a 1 input to 0. NOT gate also called the Inverter performs the operation called Inversion or Complement or Negation.

Truth Table
Logic Symbol:

$$\bar{0} = 1$$
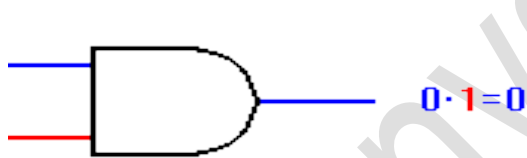
Y	$\bar{A}$
0	1
1	0

Expression: $Y= \bar{A}$

Application:

NOT gate can be used to find 1's complement of an 8-bit binary number (byte of data).

AND Gate (Multiplication)

Definition: AND gate is a logic gate which performs logical multiplication. The output is HIGH (1) only if both inputs are HIGH (1). Otherwise, output is LOW (0).

$$0 \cdot 1 = 0$$

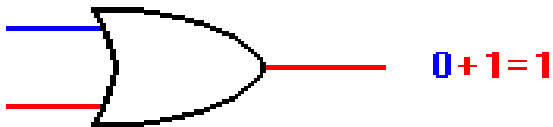| A	B	Y=A.B
0	0	0
0	1	0
1	0	0
1	1	1

Expression: **Y= A.B**

Application: AND gate is commonly used to enable Passage of signal (pulse waveform) from one point toanother.

OR Gate (Addition)

Definition: OR gate is a logic gate which performs logical addition. The output is HIGH (1) if any one of its inputs is HIGH (1). The output will be low only if both the inputs are low.

A	B	Y=A+B
0	0	0
0	1	1
1	0	1

|		
1	1	1

$$0+1=1$$

Expression: **Y= A+B**

Application: OR gate is used in intrusion detection and alarm system.

3. Derive compound logic gates with its definition, logic symbol, truth table and expression?

NAND and NOR are compound logic gates.

NAND Gate

Definition: NAND is a combination of both AND and NOT gate. It operates the same as an AND gate but the output will be opposite. The output is HIGH (1) only if both inputs are LOW (0).

$$\overline{0 \cdot 1} = 1$$
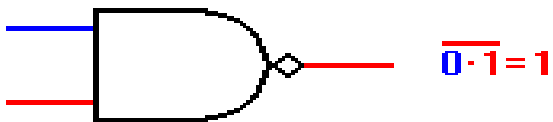
A	B	$Y=\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Expression: **Y= $\overline{A.B}$**

NOR Gate

Definition: NOR is a combination of both OR and NOT gate. It operates the same as an OR gate but the output will be opposite. The output is HIGH (1) if all its inputs are LOW (0), the output is LOW (0) if either of the inputs or all its inputs are HIGH (1).

$$\overline{0+1} = 0$$

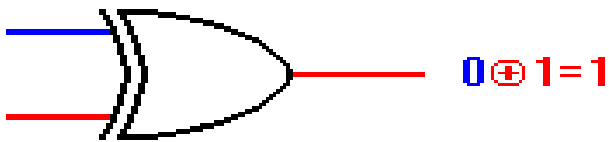| A	B	$Y=\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Expression: **Y= $\overline{A+B}$**

4. Explain XOR and XNOR logic gates with its definition, logic symbol, truth table and expression?

XOR Gate

Definition: The exclusive OR gate is a modified OR gate. The XOR gate produces a high output when both its inputs are *different*. If the inputs are the same, the output is a low.

A	B	$Y=A\oplus B$

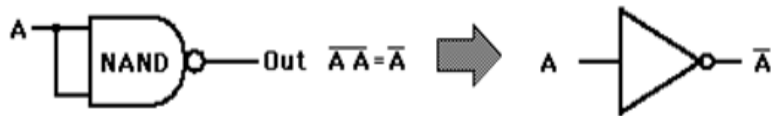|		
0	0	0
0	1	1
1	0	1
1	1	0

Expression:

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

Universal property of NAND and NOR Gates
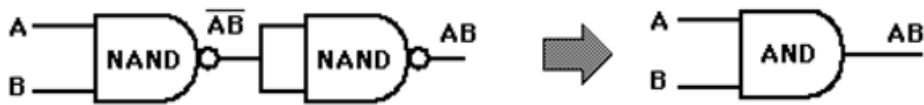
Universal property of NAND Gate

NAND as NOT Gate

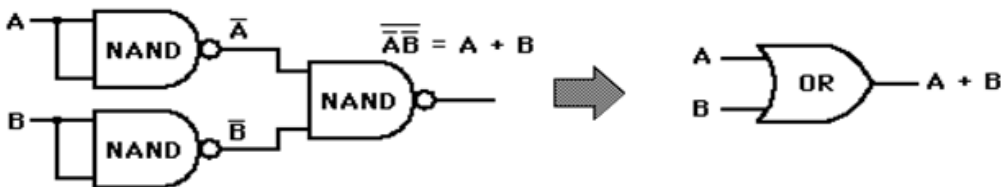All NAND input pins connect to the input signal A which gives an output $\overline{A}$

NAND as AND Gate

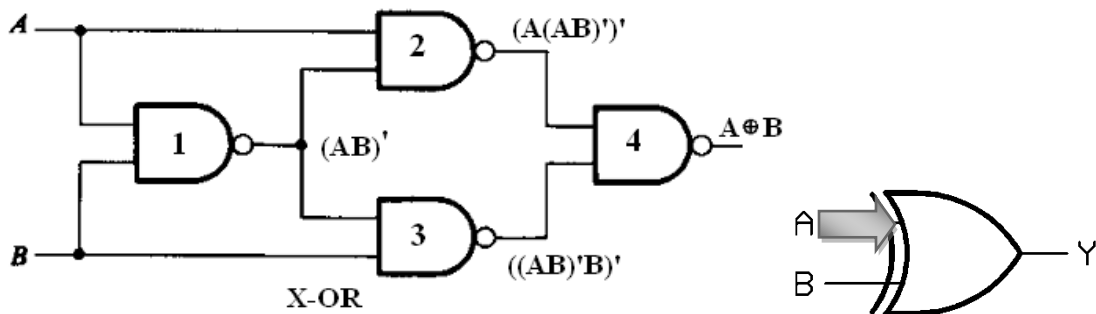The AND is replaced by a NAND gate with its output complemented by a NAND gate inverter

NAND as OR Gate

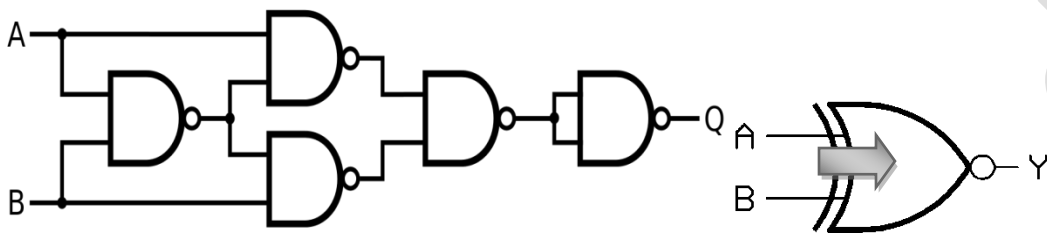The OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter

NAND as X-OR Gate

The X-OR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter

X-OR

NAND as X-NOR Gate
The X-NOR gate is replaced by a NAND gate with all its inputs complemented by NAND gate inverter
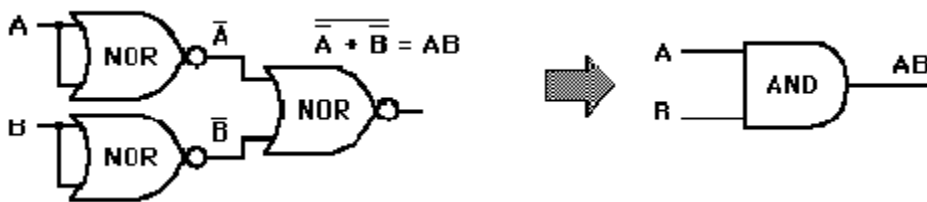

Universal property of NOR Gate

NOR as NOT Gate
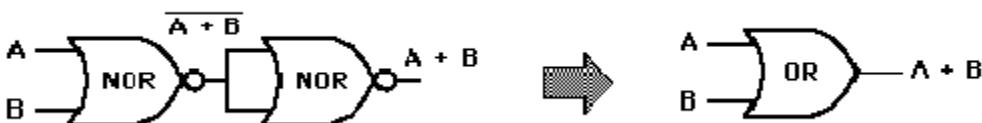A NOT gate is equivalent to an inverted-input NOR gate.

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

NOR as AND Gate
The AND is replaced by a NOR gate with its output complemented by a NOR gate inverter

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

NOR as OR Gate
The OR is replaced by a NOR gate with its output complemented by a NOR gate inverter
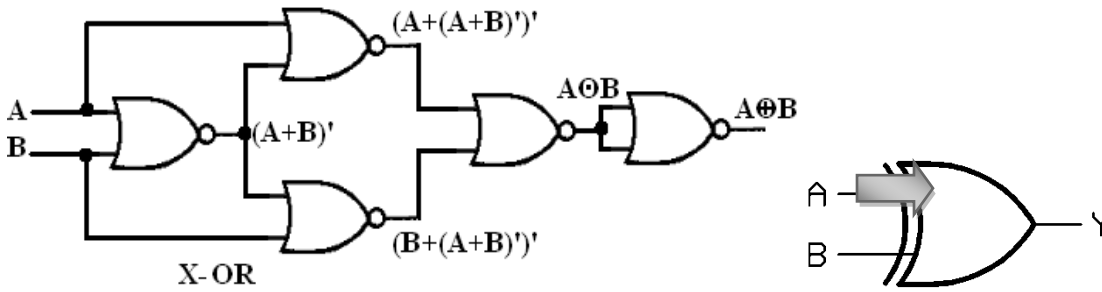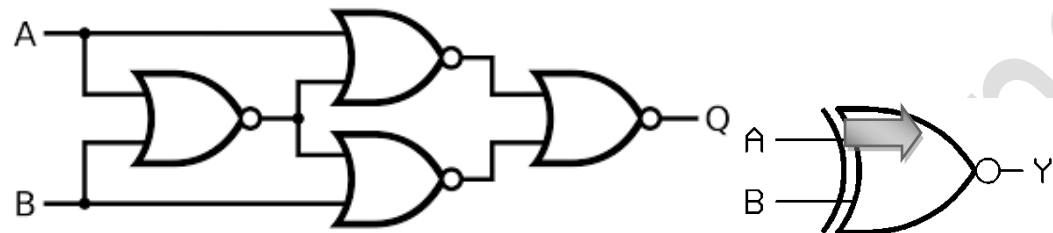

$$\overline{A + B}$$

NOR as X-OR Gate

The X-OR gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverter

NOR as X-NOR Gate

The X-NOR gate is replaced by a NOR gate with all its inputs complemented by NOR gate inverter