

**SCR 1013 : Digital Logic**

# **Module 3: LOGIC GATES**

NOT Gate (Inverter)

AND Gate

OR Gate

NAND Gate

NOR Gate

Exclusive-OR (XOR) Gate

Exclusive-NOR (XNOR) Gate



# Outline

- NOT Gate (Inverter)
- AND Gate
- OR Gate

Basic building block

- NAND Gate
- NOR Gate

Universal gate using  
2 of the basic gates

- Exclusive-OR (XOR) Gate
- Exclusive-NOR (XNOR) Gate

Universal gate using  
2 of the basic gates



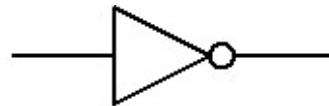
# NOT Gate (Inverter)

- **Characteristics**

Performs inversion or complementation

- Changes a logic level to the opposite
- 0 (LOW)  $\rightarrow$  1 (HIGH) ; 1  $\rightarrow$  0

- **Symbol**



- **Truth Table**

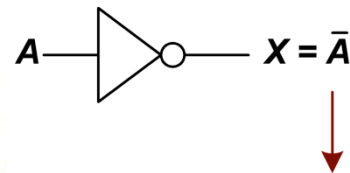
Input	Output
1	0
0	1

# NOT Gate (Inverter)

- **Operator**
  - NOT Gate is represented by overbar

$\bar{A}$   
↓  
"A bar"  
"not A"

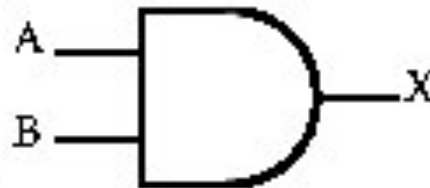
- **Logic expression**



↓  
**X is the complement of A**  
**X is the inverse of A**  
**X is NOT A**

# AND Gate

- **Characteristics**
  - Performs ‘logical multiplication’
    - If all of the input are HIGH, then the output is HIGH.
    - If any of the input are LOW, then the output is LOW.
      - *AND gate must at least have two (2) INPUTs, and must always have 1 (one) OUTPUT. The AND gate can have more than two INPUTs*
- **Symbols**



# OR Gate

- **Characteristics**

- Performs ‘logical addition’.

- If any of the input are HIGH, then the output is HIGH.
- If all of the input are LOW, then the output is LOW.

- **Symbols**



# NAND Gate

- NAND → NOT-AND ⇨ combines the AND gate and an inverter
- Used as a universal gate
  - Combinations of NAND gates can be used to perform AND, OR and inverter operations
  - If all or any of the input are **LOW**, then the output is **HIGH**.
  - If all of the input are **HIGH**, then the output is **LOW**.
- Symbol used:



# NOR Gate

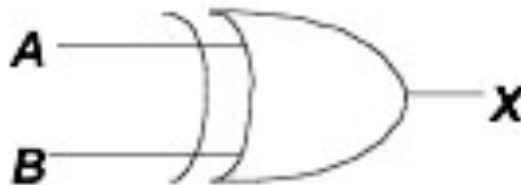
- NOR  $\rightarrow$  NOT-OR  $\Rightarrow$  combines the OR gate and an inverter
- Used as a universal gate
  - Combinations of NOR gates can be used to perform AND, OR and inverter operations
  - If all or any of the input are **HIGH**, then the output is **LOW**.
  - If all of the input are **LOW**, then the output is **HIGH**.
- Symbol used:





# XOR Gate

- **Characteristics**
  - Combines basic logic circuits of AND, OR and Inverter.
  - Has only 2 inputs
  - Used as a universal gate
    - Can be connected to form an adder that allows a computer to do perform addition, subtraction, multiplication and division in ALU (Arithmetic and Logic Unit).
    - If both of the input are at the same logic level, then the output is **LOW**.
    - If both of the input are at opposite logic levels, then the output is **HIGH**
- **Symbol**



# XNOR Gate

- **Characteristics**
  - Has only 2 inputs, but output of XNOR is the opposite of XOR
    - If both of the input are at the same logic level, then the output is **HIGH**.
    - If both of the input are at opposite logic levels, then the output is **LOW**.
- **Symbol**

