Lab 1

Course:	**Digital Logic Design**	Instructor:	**Sidra Rafique**
Topic:	**Introduction to Digital Laboratory Equipment & ICs**		

Objective:

The objective of this lab session is to introduce students to various digital laboratory equipment and integrated circuits (ICs) commonly used in digital logic and design experiments. By the end of this session, students should be able to understand the functions and operations of each component in detail.

Equipment and ICs:

- **Digital Multimeter (DMM)**

Description: A digital multimeter is a versatile electronic instrument used to measure voltage, current, and resistance in digital circuits.

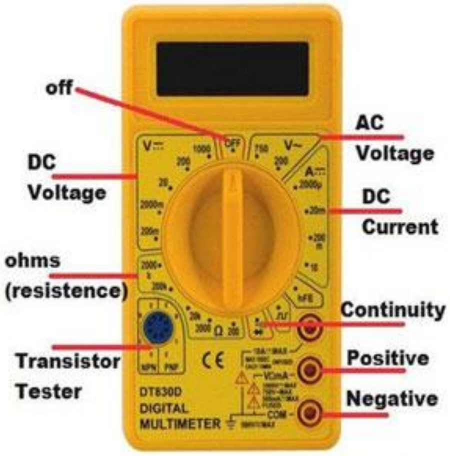

Figure 1. Digital Multimeter

Operations

I. Voltage Measurement:

Procedure:

a) Set the DMM to the voltage measurement mode. Choose the appropriate range based on the expected voltage level.
b) Connect the red probe to the positive terminal and the black probe to the negative terminal of the circuit or component being measured.
c) Read the displayed voltage value on the DMM's digital screen.

Usage:

a) Voltage measurement is crucial for determining the potential difference across components, power sources, or nodes in a circuit.

II. Current Measurement:

Procedure:

a) Ensure the circuit is powered off.
b) Set the DMM to the current measurement mode.
c) Break the circuit and connect the DMM in series with the load (component or part of the circuit) where current needs to be measured.
d) Resume power to the circuit and read the displayed current value on the DMM.

Usage:

a) Current measurement helps in understanding how much electric current flows through a component or a portion of the circuit, aiding in troubleshooting and analysis.

III. Resistance Measurement:

Procedure:

a) Set the DMM to the resistance measurement mode.
b) Choose an appropriate range that covers the expected resistance value.
c) Ensure the circuit or component under test is powered off and isolated from other sources.
d) Connect the probes to the ends of the resistor or the component being measured.
e) Read the displayed resistance value on the DMM's screen.

Usage:

a) Resistance measurement helps in determining the resistance value of resistors, potentiometers, or any other resistive component in a circuit. It is crucial for verifying component values and circuit integrity.

- **Power Supply**

Description: A power supply is an electronic device that converts AC (alternating current) voltage from a wall outlet or other power source into stable DC (direct current) voltage suitable for powering digital circuits and other electronic devices. It provides a reliable and regulated voltage output to ensure proper functioning and protection of connected circuits and components.

Figure 2. Power Supply

Operations:

I. Adjusting Voltage Output:

Procedure:

a) Locate the voltage adjustment knob or control on the power supply unit.
b) Rotate the knob to set the desired output voltage level. Many power supplies have a variable voltage output range that can be adjusted within specific limits.
c) Monitor the voltage display (if available) on the power supply to ensure the desired voltage level is reached.

Usage:

a) Adjusting the voltage output allows for supplying the required voltage level to match the specifications of the connected digital circuit or component. It enables experimentation with different voltage levels and ensures compatibility with the circuit's operating requirements.

II. Connecting and Disconnecting Circuits:

Procedure:

b) Identify the positive (+) and negative (-) terminals or binding posts on the power supply.
c) Use appropriate cables and connectors to make secure connections between the power supply terminals and the circuit being powered.
d) Ensure proper polarity alignment, matching positive and negative terminals between the power supply and the circuit.
e) After making connections, switch on the power supply using the power switch or button.
f) To disconnect the circuit, switch off the power supply first and then disconnect the cables from the terminals.

Usage:

a) Connecting circuits to the power supply enables the application of power to the circuits for testing, operation, and analysis. Proper connection and disconnection procedures ensure safety and prevent damage to both the power supply and the connected circuits.

- ## Breadboard

Description: A breadboard is a reusable platform for prototyping and connecting electronic circuits without soldering.

Operations:

I. **Placing Components:** Insert electronic components (e.g., resistors, ICs, LEDs) into the breadboard's holes.
II. **Making Connections:** Use jumper wires to connect components by inserting them into the breadboard's holes according to the circuit diagram.
III. **Understanding the Layout:** Familiarize yourself with the breadboard's layout, including rows, columns, and power rails (positive and negative).

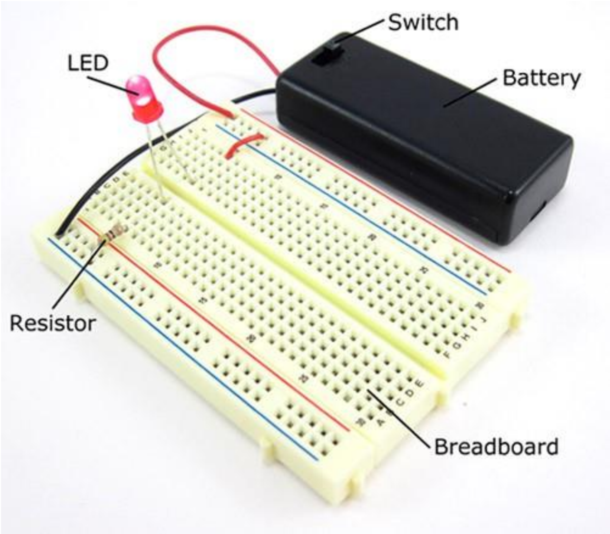

Figure 3. Breadboard

- **Logic Gates ICs**

Description: Logic gates ICs are integrated circuits that contain multiple logic gates within a single package. These gates perform basic logical operations on binary input signals and produce corresponding output signals based on predefined truth tables. Common types of logic gates include AND, OR, NOT, NAND, NOR, XOR, and XNOR gates.

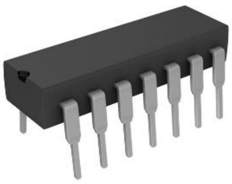

Figure 4. Logic Gates ICs

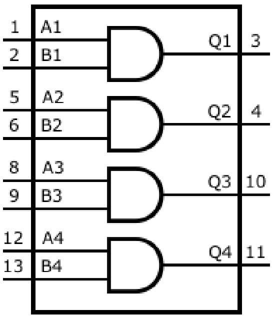

Figure 5. Internal structure of Logic Gates ICs

Operations:

I. **Connecting Inputs and Outputs:** Connect the inputs and outputs of the logic gates ICs to other components on the breadboard.

Procedure:

a) Identify the pins of the logic gate IC corresponding to the input and output terminals.

b) Connect the input terminals of the logic gate IC to the appropriate signal sources (e.g., switches, other logic gates, or power supply outputs) using jumper wires on the breadboard.
c) Connect the output terminal of the logic gate IC to the input terminals of other components or logic gates as needed.
d) Ensure proper alignment of input and output signals according to the logic gate's functionality (e.g., connecting the output of an AND gate to the input of another gate).

Usage:

a) Connecting inputs and outputs of logic gates ICs allows for the creation of complex logic circuits by combining multiple gates to achieve desired logical functions.

II. **Observing Truth Tables:** Apply different input combinations and observe the corresponding output states to understand the behavior of each logic gate.

Procedure:

a) Prepare a truth table listing all possible combinations of input signals for the logic gate(s) under test.
b) Apply each input combination to the corresponding inputs of the logic gate IC(s) connected on the breadboard.
c) Observe and record the resulting output states produced by the logic gate IC(s) for each input combination.
d) Compare the observed output states with the expected output states derived from the truth table.

Usage:

a) Observing truth tables helps in understanding the behavior and functionality of each logic gate IC. It allows verification of the gate's operation and aids in circuit analysis and troubleshooting.

- **Flip-Flops (e.g., D Flip-Flop)**

Description: Flip-flops are sequential logic circuits used in digital electronics to store binary data. They are fundamental building blocks in sequential logic circuits and are widely used in applications such as memory units, counters, and registers. Flip-flops have two stable states, typically represented as "0" and "1", which can be changed in response to input signals.

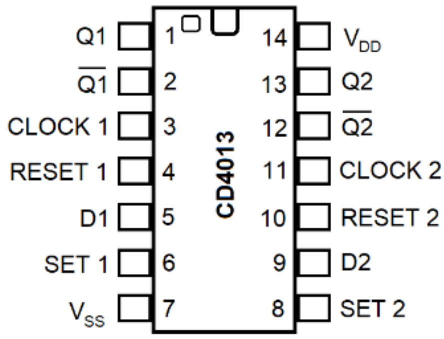

Figure 6. D Flip-Flop

Operations:

I. **Clocking Inputs:**

Procedure:

- Locate the clock input pin of the flip-flop IC.
- Apply clock signals to the clock input using an external signal source such as a square wave generator or another logic gate output.
- Ensure the clock signal meets the timing requirements specified in the flip-flop's datasheet, including pulse width and frequency.
- The rising or falling edge of the clock signal triggers the flip-flop to capture and store the input data at the designated clock cycle.

Usage:

- Clocking inputs control the timing of data transfer and state changes in flip-flops, enabling synchronous operation in sequential logic circuits.

II. **Setting and Resetting:**

Procedure:

- Identify the set (S) and reset (R) input pins of the flip-flop IC.
- Apply appropriate signals to the set and reset inputs to change the output state of the flip-flop.
- Depending on the flip-flop type and configuration, activating the set or reset input forces the output to a predetermined state, overriding the normal operation.
- Ensure proper timing and sequencing of set and reset signals to prevent unintended state transitions or glitches.

Usage:

- Setting and resetting inputs allow for initializing or forcing specific states in flip-flops, enabling control over their behaviour in sequential logic circuits.

III. **Observing Output Changes:**

Procedure:

- Monitor the output of the flip-flop using an oscilloscope, logic analyser, or LEDs connected to the output pins.
- Apply input signals (clock, set, reset) to the flip-flop and observe how the output changes in response.
- Record the output states at different clock cycles or input conditions to analyse the flip-flop's behaviour and functionality.
- Verify that the observed output changes align with the expected behaviour based on the flip-flop's truth table or datasheet.

Usage:

- Observing output changes provides insights into the operation and functionality of flip-flops, aiding in circuit analysis, testing, and troubleshooting.

- **LEDs (Light Emitting Diodes)**

Description: LEDs are semiconductor devices that emit light when current flows through them.

Operations:

I. **Connecting to Power Supply:** Connect the LEDs to the power supply through current-limiting resistors to prevent damage.
II. **Observing Behaviour in Circuits:** Include LEDs in digital circuits to observe their behaviour as indicators of the circuit's state.

- ### Resistors, Capacitors, and Connecting Wires

Resistors: Resistors are passive electronic components that resist the flow of electric current. They are commonly used to limit current flow, adjust signal levels, divide voltages, and provide biasing in electronic circuits.

Capacitors: Capacitors are passive electronic components used to store and release electrical charge. They consist of two conductive plates separated by an insulating material (dielectric). Capacitors are widely used in timing circuits, filtering, decoupling, and energy storage applications.

Connecting Wires: Connecting wires are essential components that provide electrical connections between various components on the breadboard or in electronic circuits. They come in different lengths, gauges, and colours and are used to establish electrical paths between components, facilitating circuit connections and experimentation.

Operations:

I. Resistors:

Limiting Current Flow: Resistors are often used to limit the amount of current flowing through a circuit component or part of a circuit. By restricting current flow, resistors help protect components from damage due to excessive current.

Adjusting Signal Levels: Resistors can be used to adjust signal levels in electronic circuits. They act as voltage dividers, attenuating or scaling down input voltages to desired levels.

II. Capacitors:

Storing and Releasing Electrical Charge: Capacitors store electrical charge when voltage is applied across their terminals. This stored charge can be released when needed, making capacitors useful for energy storage and time-delay applications.

Timing Circuits: Capacitors are commonly used in timing circuits to control the timing of signal transitions or generate precise time delays.

Filtering: Capacitors are employed in filter circuits to remove unwanted signals or noise from electrical signals, resulting in smoother, cleaner waveforms.

III. Connecting Wires:

Establishing Electrical Connections: Connecting wires serve as conductive paths to establish electrical connections between various components on the breadboard or in electronic circuits.

Breadboard Usage: In breadboard-based prototyping, connecting wires are used to create circuits by connecting different components and nodes on the breadboard, enabling experimentation and testing.

- ## Precautions:

1. Ensure proper connections and polarity while connecting components.
2. Avoid short circuits by double-checking connections.

3. Handle ICs carefully to prevent damage due to static electricity.
4. Use appropriate resistor values to limit current flow through LEDs.
5. Do not exceed the maximum ratings of components (voltage, current).
6. Follow safety guidelines provided by the instructor.