

# Digital Logic Design

**(EL-1005)**

**LABORATORY MANUAL**

**Spring 2024**



**LAB 01**

## Introduction to Lab Equipment

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**MARKS AWARDED:**

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## Lab Session 01: Introduction to Lab Equipment

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### **OBJECTIVES:**

The objective of this lab is:

- To get familiar with the apparatus that would be used in rest of the semester for the implementation and testing of logic circuits.
- Explain basic Circuit connection procedure and function usage of logic probe.

### **APPARATUS:**

- Logic trainer
- Logic probe

### **Introduction:**

#### **IC (Integrated Circuit)**

Integrated Circuit usually called a **chip** or **microchip** is a small electronic device made up of semiconductor material. IC's contain the electronic components for the digital gates. The chip is mounted in a ceramic or plastic container and connections are welded to external pins to form the IC. The number of pins may range from 14 in a small IC package to 64 or more in a larger IC.

The following figures show an IC with 14 pins, both the Device package and the pin layout in its top view. If you are looking at the IC from above, you will see a circle or notch. This is the top of the chip. The top-left pin is almost always Pin 1:

### **Basic Diagram:**

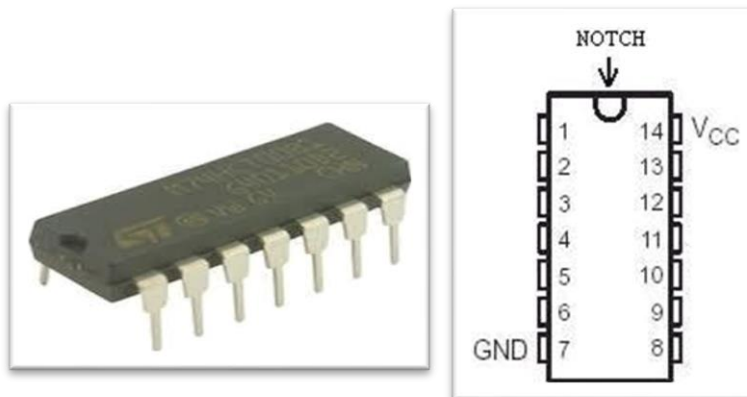


Figure 1: Left is the 3D view of IC and right one is the top view of IC.

In coming labs, we will be using various series of ICs for the self-learning, and the functionality of all kinds of gates like NOT, AND, OR gates, etc. Later on, we will implement the circuitry of Binary Adder, Subtractor, and Multiplexers, which help us to build the concepts needed for further courses upcoming in the next semester.

### **Analogue & Digital Electronic Trainer (ETS-7000):**

ETS-7000 logic trainer is a low cost, high performance complete digital electronics workstation and have a huge number of features in one compact unit. It is designed to provide all the basic tools necessary to conduct logic experiments. This trainer is housed in a compact and robust casing and is equally ideal for constructing and testing

both analogue and digital electronics circuits. It is also ideally suited for developing, debugging, integrating and testing digital systems. Figure 1-1 shows the front panel of ETS-7000 logic trainer. It has DC Power Supplies, Function Generators for generating various types of Waves with different frequencies, Logic & Pulse Switches, 7-Segment Display and Breadboard etc.



Figure 2: Front Panel of Digital Training System ETS-7000

#### Components of ETS-7000 Trainer:

1. **Power Switch:** A switch to turn ON/OFF the logic trainer.
2. **Variable Positive Power:** A variable DC power supply with DC output from 3V to 15V, 500mA.
3. **Variable Negative Power:** A variable DC power supply with DC output from -3V to -15V, 500mA.
4. **Pulse Switches:** Two pulse switches (push buttons) A and B along with their complements  $\bar{A}$  and  $\bar{B}$
5. **Frequency Range:** A knob to select one of the frequency ranges which are as follows:
  - a) 1Hz – 10Hz
  - b) 10Hz – 100Hz
  - c) 100Hz – 1kHz
  - d) 1kHz – 10kHz
  - e) 10kHz – 100kHz
  - f) 100kHz – 1MHz
6. **Mode Selector:** Using mode selector switch the mode can be selected between TTL logic and CMOS logic. TTL logic will be used throughout in this manual.
7. **Bits Data Switches:** Eight binary switches from SW0 -- SW7 are available to provide binary input to the logic circuit. The output level of a switch in correspondence to the logic level will be as follows:

Logic Level	Output Level
LO	0V
HI	5V

8. **Digital Displays:** Two digits of BCD to 7-segment LED display are available on the logic trainer. The output on 7-segment display in correspondence to the BCD input applied at the input connections will be as follows:

DECIMAL	BCD INPUT			
	D	C	B	A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

H= Logic High, L= Logic Low

### **Breadboard:**

A breadboard is used to make up temporary circuits for testing or to try out an idea. No soldering is required so it is easy to change connections and replace components. Parts will not be damaged so they will be available to re-use afterwards. The photograph shows a circuit on a typical small breadboard which is suitable for beginners building simple circuits with one or two ICs.

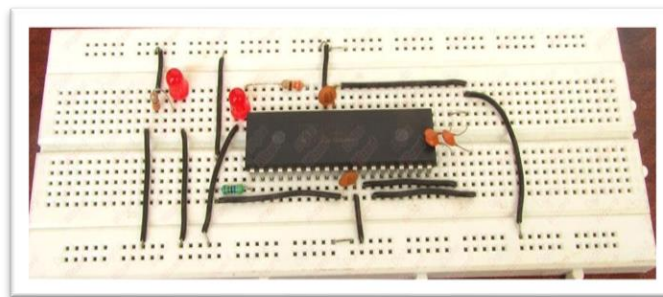


Figure 3: Breadboard Connection

### **Connections on Breadboards:**

Breadboards have many tiny sockets (called 'holes') arranged on a 0.1" grid. The leads of most components can be pushed straight into the holes. ICs are inserted across the central gap with their notch or dot to the left. Wire links can be made with single-core plastic-coated wire of 0.6mm diameter (the standard size). Stranded wire is **not** suitable because it will crumple when pushed into a hole and it may damage the board if strands break off. The diagram shows how the breadboard holes are connected.

The top and bottom rows are linked **horizontally** all the way across. The other holes are linked **vertically** in blocks of 5 with no link across the center. Notice how there is separate blocks of connections to each pin of ICs.

### **Logic Probe:**

A logic probe can be very handy for troubleshooting and analysis of a digital logic circuit. As compared to a DC voltmeter or an oscilloscope, it needs to distinguish between the states of LOW and HIGH, and so it can be very simple and inexpensive. Its features include two LED indicators: HI (red LED) and LO (green LED).



Figure 4: Logic Probe

### **Operation:**

1. Connect the black alligator clip to ground or common of the circuit under test.
2. Connect the red alligator clip to VCC (4V DC minimum to 18V DC maximum) of the circuit under test.
3. Touch the probe tip to the circuit point under test. The LEDs on probe indicate the logic level or signals present when the circuit node is probed.
4. The LED response is noted below:

Input signal	LEDs
Logic "1" Logic "0" Bad Logic Level or Open circuit Square Wave < 200kHz Square Wave > 200kHz	HI (Red) ON LO (Green) ON Amber LED indicates a pulse. HI and LO blinking at frequency rate. HI and LO may or may not be ON.

### **Basic Circuit Connection Procedure:**

The components used to build digital circuits are very delicate and can easily be damaged if not handled properly. Following are the steps to build a digital circuit:

- Turn power switch OFF.
- Place diode / transistor / IC chip on the breadboard. Make sure their pins are not short circuited.
- Connect the GND pins of all IC chips to ground.
- Connect the VCC pins of all chips to +5V on your trainer.
- Connect all other input and output signals.
- Turn power ON.

**Precautions:**

- Be careful not to connect any circuit output to VCC or any other output.
- Check IC diagram before making any connections.
- Turn power OFF before you modify the circuit.
- Handle components from their top plastic part. Avoid touching the pins.

**LAB TASK:**

**LAB TASK #1:**

Display the number 39 on the two BCD-to-seven segment displays available on logictrainer. What BCD input should be applied to the two BCD-to-seven segment displays?