1. General Information

1.1 Introduction to the Lab :

Location of the Lab: Engineering Building , 2nd Floor , Room # : 2151

Lab Instructor: Eng. Ahmad A. Al-Zahrani

Course Coordinator: Eng. Mohammed H. Sinky

Sessions: 3 hours/session (There are at least 10 sessions Hands-on Experiments)

Objective: This lab will introduce the student to the practical world of digital system design and the various digital components, this includes how to construct a digital circuit using the standard integrated circuits (ICs) and other hardware that are readily available commercially, also the student will be familiarized with the procedure of designing, simplifying, implementing and checking many combinational and sequential circuits that explained and presented in lectures.

1.2 Lab Rules:

- Regular and Disciplined , attend the lab sessions regularly.
- Come to the lab sessions on time . Action may be taken to the Late Comers.
- Submit your lab reports on time, any lateness report for no valid reason will not be accepted.
- Lab is yours, so help to keep it clean . Bringing foods, water or newspaper are forbidden.
- You should come prepared. Read the background information and discuss the experiment with your colleagues.
- You should bring the Lab manual on every time you come to the laboratory.
- Do not make walking around, chatting or noise during lab period.
- Please do not change your lab group or bench without taking a permission from the Lab instructor.
- Do not do anything in a hurry. Ask the Instructor if you don't understand any point or step.
- After finishing the experiment, disconnect the connection wires that you have connected during the experiment, and but them in the wire kit, take out all IC chips from the breadboard and but them back in the IC Cabinet, be sure to return all materials you have used and clean your table, and inform the Lab instructor and when you depart.

The student's mark will be affected if these rules are not obeyed.

1.3 Grading :

The Lab weights 30% of the course grade, the following grading scheme will be used :

Technical Reports	10%
Participation and Activities	6%
Attendance	4%
Final Project	10%

- Discipline and preparedness will be taken into account when assessing the student .
- Two marks will be discarded for each unexcused absence.
- A student who has more than two unexcused absence will receive final grade of zero.
- Students have to discuss their lab experiment and results with each others, but every student should write his report by himself . No marks will be given If any cheating in way of copying is noticed .

1.4 Requirements for Lab Reports :

Lab reports should be submitted in a week from the date the lab is performed and should include all of the following sections :

Cover Page: The cover page of your lab report should include experiment's name and number, your name and number, your bench order and the submission date.

Discussion and Conclusions: In this section, you present your results , observations , comments and discuss your conclusions .
Questions' answers : if your lab manual includes questions to be answered, you should answer all the questions completely and accurately.

When writing the lab report, ensure that all sentences are grammatically correct & without mistakes in spelling . You can use computer to make your report , the following powerful software may help you :

SmartDraw or Microsoft Visio to create diagrams.
Circuit Maker Pro to draw and simulate the logic circuits.

Please ask the instructor if any point here is not clear to you.

2. Introduction to Lab Equipments

In this section will present a brief description on the equipments available in the lab, the student have to acquire the way to use them in performing various lab experiments.

2.1 Integrated Circuits (IC)

An integrated circuit (IC) is a thin chip consisting of at least two interconnected semiconductor devices, mainly transistors, as well as passive components like resistors . Sometimes we called it 'Chip' . The IC chip may contains millions of components and measure only 5 mm/0.2 in square and 1 mm/0.04 in thick .

IC chips are supplied in many different packages. The most common are the Dual In-line Package, or DIP. The DIP is made from plastic or ceramic (see the following figure). DIPs may have 4 to about a hundred pins.

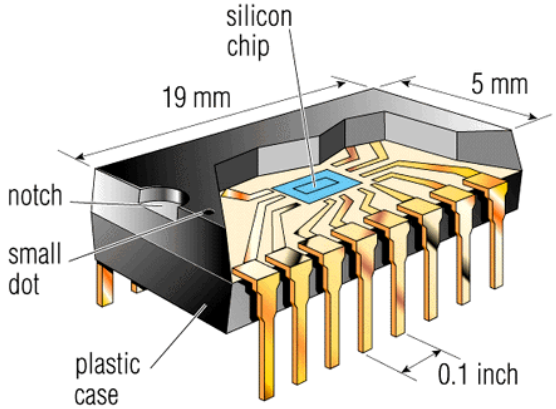


Figure 2.1 DIP integrated circuit (IC) *(Image © Research Machines plc)

Nowadays, Integrated circuits are used in electronic devices, computer, calculators and almost in all digital applications. Integrated circuits are classified by the number of gates as following :

Type	Number of Gates
Small-scale integration (SSI)	Fewer than 12
Medium-scale integration (MSI)	12 to 99
Large-scale integration (LSI)	100 to 9999
Very large-scale integration (VLSI)	10,000 to 99,999
Ultra large-scale integration (ULSI)	100,000 or more

IC chip contains a specific logic arrangement of various logic functions called 'Logic Family'. Each IC chip are numbered according to its logic family and function . The major logic families for our use are :

1- **TTL** (Transistor-Transistor Logic):

- Made of bipolar transistors .
- Numbered in the "74XX" & "54XX" format .
- Require a supply voltage = 5 V ± 0.5 .
- For TTL circuit , logic "1" is usually defined as a signal of about 2.4 V, logic "0" is about 0.5V above ground.
- Have some subfamilies like :

  74LXX (low-power TTL)
  74HXX (high-speed TTL)
  74SXX (Schottky TTL)

74LSXX (low-power & Schottky)

2-**CMOS** (Complimentary Metal Oxide Semiconductor):

- Made from MOSFETs.
- Much lower in power requirements than TTL.
- Comes in two schemes : metal gate CMOS "40XX", and silicon gate CMOS '74CXX".
- 40XX has a rated working voltage of 3 – 15 .
- Silicon gate CMOS (74CXX) logic has a working voltage range of 2 -6V.

In this lab we will use only the first Logic family (TTL ICs). You may use the second type in the final project.

In order to use IC's in building a circuit, we must have the chip's datasheet. Datasheet offers the detailed information about chip's pinout diagram, functions, rating and the internal logic circuit. Datasheets are usually available in Databooks supplied by the chip's manufacture or via internet. in this Lab, all we need to deal with IC are chip's pinout diagrams and its function table, copy of these are available at the end of this manual.

It is very important to know pin numbering method for IC, Figure2.2 illustrates the principle, the pins are numbered anti-clockwise around the IC (chip) starting from pin1 at upper left-hand near the notch or dot.

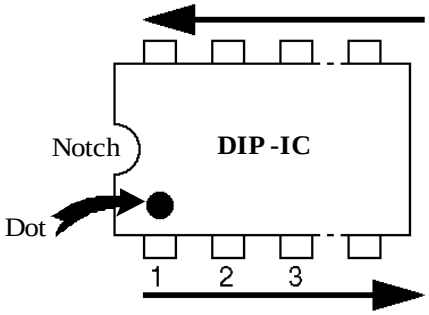


Figure 2.2 IC Pin Numbering

2.2 Bread board

A breadboard is a device used to build a prototype of an electronic circuit. Figure2.3 show some of the breadboards that are commercially available.

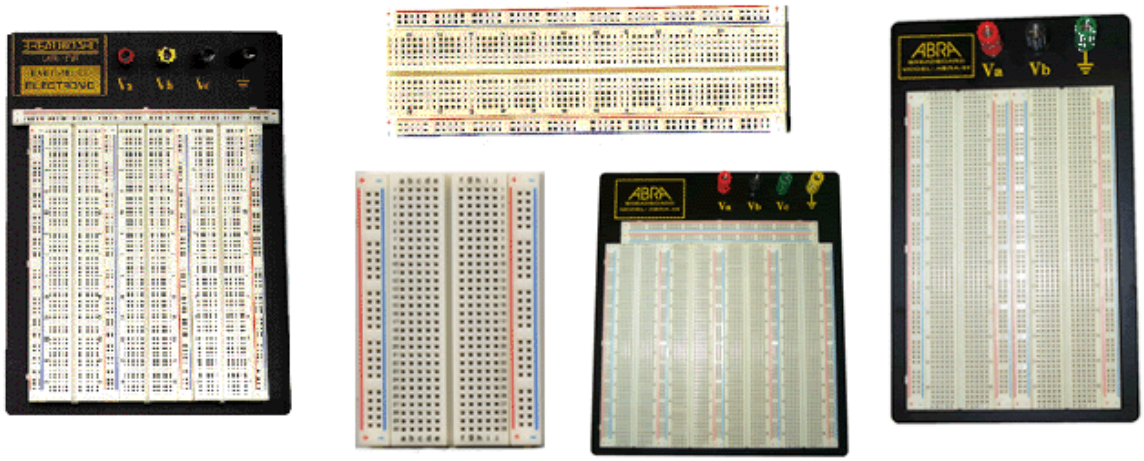


Figure2.3 Samples of Breadboards

The type which is available at the lab is shown in Figure2.4. This type (PP-272) comes with Built-In Power Supply.

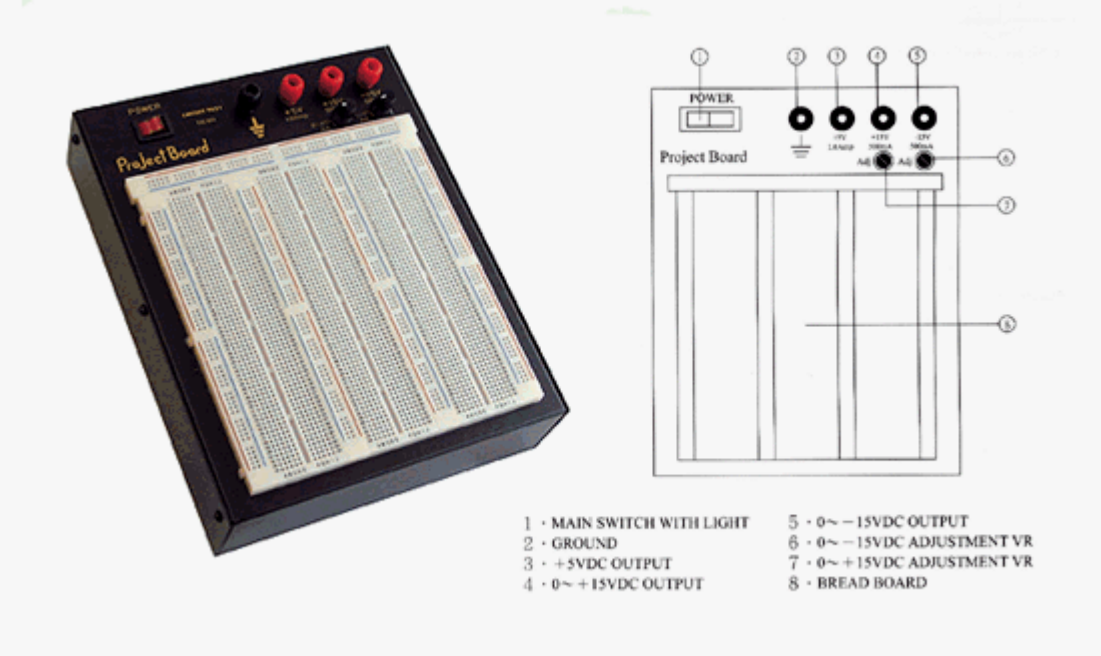


Figure2.4 PP-272 Breadboard

When you physically see a breadboard, you observe that there are many strips of metal (or copper) which run underneath the board. The metal strips are arranged as shown in Figure2.5.

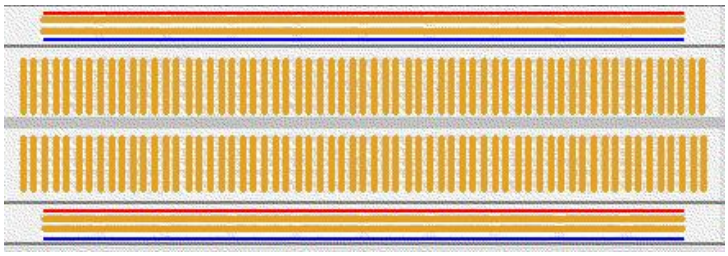


Figure2.4 Arrangement of Metal Strip

These strips connect the holes on the top of the breadboard. To build a circuit we place the legs of components (ICs, switches, resistors …, etc) in the holes and connect these holes together to construct the circuit (see Figure2.6).

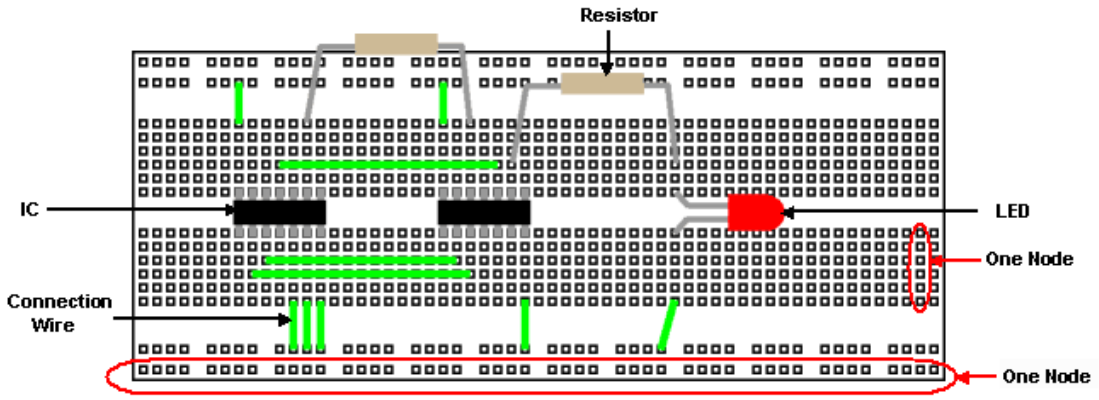


Figure 2.6 Using Breadboard

2.3 *Light Emitting Diodes (LEDs)*

LED is a special type of diodes that emit light when connected in a circuit. I t used to indicate the status of the outputs in the digital circuits. Figure2.7 shows a samples of LEDs, the circuit symbol and how to recognize the polarity of the LED.

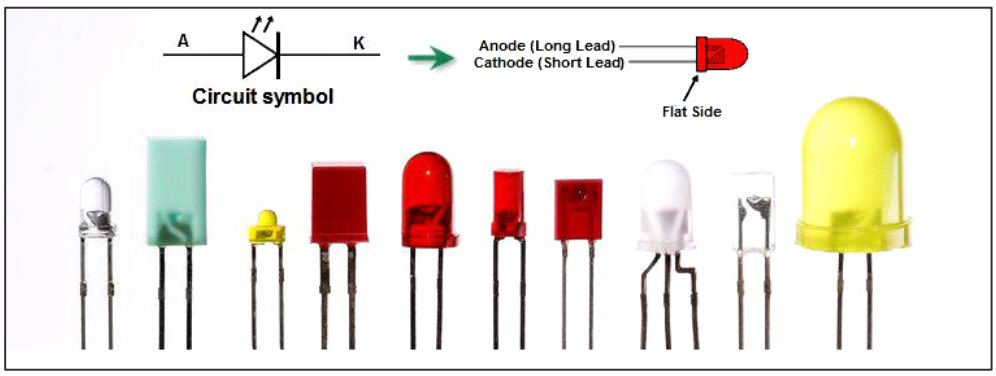


Figure2.7 Light Emitted Diodes

The most important things when using a LED in the circuit are:

1- The Anode and Cathode must be connected correctly to enable the LED to emit light.
2- The current through the LED must be limited by a series resistor, we often use 470Ω for that purpose in the lab, this is because any LED has a specified maximum current rating. Most LEDs can pass 20 mA continuously without damage but it is not necessary to use the maximum rated current. An LED will light with less current. The value of the current passing through the led control only the brightness of the LED.

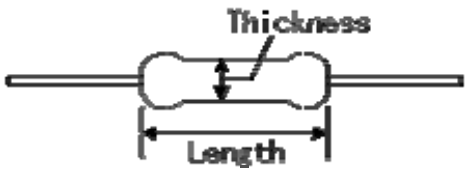
2.3 *Resistors*

A resistor is a two-terminal electrical component that creates a potential difference across its terminals that is proportional to the current passing through it, it is used in circuits to limit current flow or to provide a voltage drop. I suppose you took this electric element in Circuit(I), so I will not go through more theoretical details here.

There are two main classes of resistors; fixed resistors and the variable resistors, also there is another classification of resistors based on the material from which they are made. The typical resistors is made of either carbon-film or metal-film. There are other types, but these are the most common.

Before using any resistor in your circuit, you must know two ratings or values:

1. The resistance value itself in ohm, this is can be recognized by using an ohmmeter or the color bands that painted around the resistor's body (see Figure2.8).
2. The maximum rated power of the resistor. The common ratings are: 1/8w, 1/4w, 1/2w, 1w, 2w, 3w, 5w and 10w. The size of a resistor indicate its power rating (see table2.1). For digital circuits, where the current rating is small, we usually use 1/8w or 1/4w resistors.



Rating power (W)	Thickness (mm)	Length (mm)

1/8	**2**	**3**
1/4	**2**	**6**
1/2	**3**	**9**
1	**3.5**	**12**
2	**5**	**15**

Table2.1 Power Rating vs. Resistor's Size

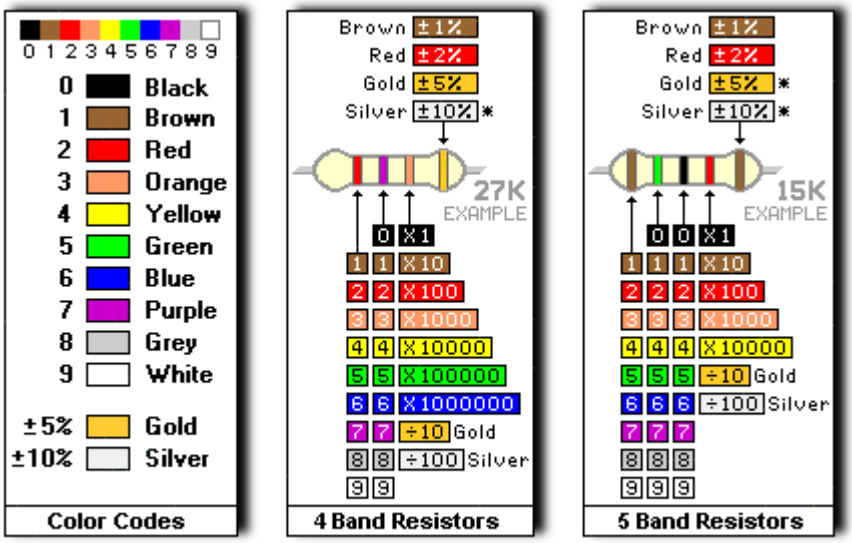


Figure2.8 Resistor Color Codes (http://hibp.ecse.rpi.edu)