LAB MANUAL

ELECTRONICS WORKSHOP

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Ahmedabad

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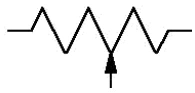
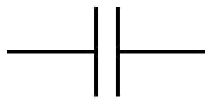
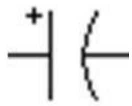
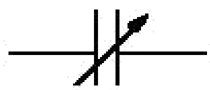
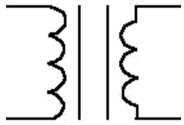
6		To Perform LED ON/OFF using Arduino.		

EXPERIMENT NO.: 1A **Date:**

AIM: To Understand & Draw the symbols of various electronic devices.

Sr. No.	Device Name	Symbol
1.	Resistor	
2.	Variable resistor	
3.	Capacitor	
4.	Electrolyte (polarized) Capacitor	
5.	Variable capacitor	
6.	Inductor	

7.	Transformer	
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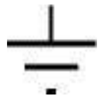
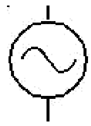
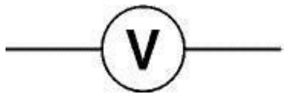
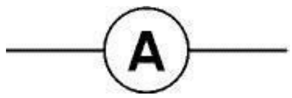
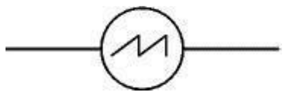
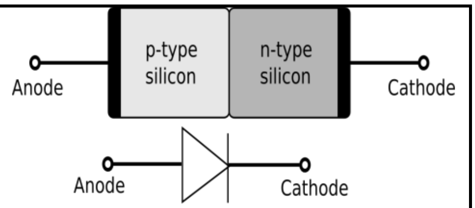
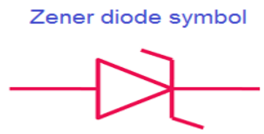
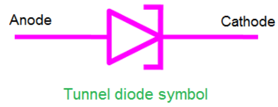
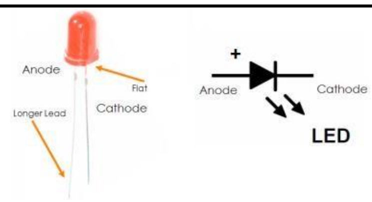
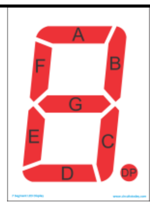
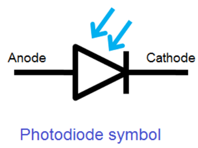
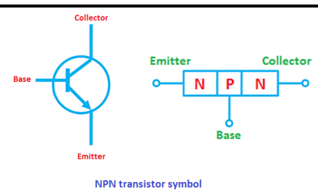
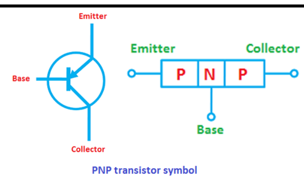
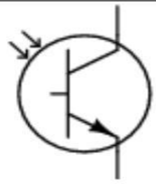
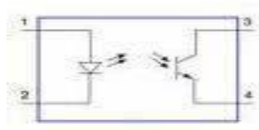
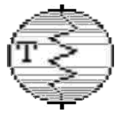
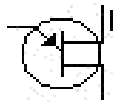
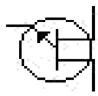
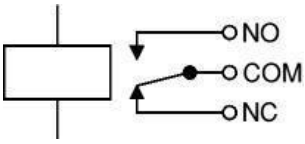
9.	Ground	
10.	AC supply	
11.	voltmeter	
12.	Current meter	
13.	CRO	
14.	ohm meter	

15.	PN junction diode	
16.	Zener diode	
17.	Tunnel diode	
18.	Light Emitting diode(LED)	
19.	Seven segment display	
20.	Photo diode	
21.	npn transistor	
22.	pnp transistor	

23.	Photo transistor	
24.	Optocoupler	
25.	Thermistor	
26.	LDR(Light Dependent Resistor)	
27.	UJT(Uni Junction Transistor) n-type	
28.	UJT(Uni Junction Transistor) p-type	
29.	SCR(Silicon Controlled Rectifier)	
30.	DIAC	

31.	TRIAC	
32.	n-channel JFET	
33.	p-channel JFET	
34.	n-channel depletion MOSFET	
35.	p-channel depletion MOSFET	
36.	n-channel enhance MOSFET	
37.	p-channel enhance MOSFET	

38.	Relay	
39.	DC Supply	
40.	AC Supply	

EXPERIMENT NO.: 1B

Date:

AIM: To Identify resistors, capacitors using Different codes.
To study different types of resistors and coding.

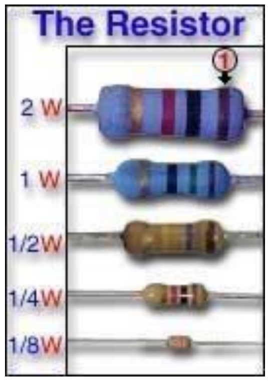
THEORY:

The resistor's function is to reduce the flow of electric current. This symbol is used to indicate a resistor in a circuit diagram. Resistance value is designated in units called the "Ohm." A 1000 Ohm resistor is typically shown as 1K-Ohm (kilo Ohm), and 1000 K-Ohms is written as 1M-Ohm (Mega ohm).

There are two classes of resistors; **fixed resistors** and the **variable resistors**. They are also classified according to the material from which they are made. The typical resistor is made of either carbon film or metal film. There are other types as well, but these are the most common.

The resistance value of the resistor is not the only thing to consider when selecting a resistor for use in a circuit. The "tolerance" and the electric power ratings of the resistor are also important. The tolerance of a resistor denotes how close it is to the actual rated resistance value. For example, a ±5% tolerance would indicate a resistor that is within ±5% of the specified resistance value.

The power rating indicates how much power the resistor can safely tolerate. The maximum rated power of the resistor is specified in Watts. Power is calculated using the square of the current (I^2) x the resistance value (R) of the resistor. If the maximum rating of the resistor is exceeded, it will become extremely hot and even burn. Resistors in electronic circuits are typically rated 1/8W, 1/4W, 1/2W, 1W and 2W. 1/8W is almost always used in signal circuit applications. When powering a light emitting diode, a comparatively large current flow through the resistor, so you need to consider the power rating of the resistor you choose.



Fixed Resistors:

A fixed resistor is one in which the value of its resistance cannot change. They are given below:

Carbon film resistors:

This is the most general purpose, cheap resistor. Usually the tolerance of the resistance value is ±5%. Power ratings of 1/8W, 1/4W and 1/2W are frequently used. Carbon film resistors have a disadvantage; they tend to be electrically noisy. Metal film resistors are recommended for use in analog circuits. The physical sizes of the different resistors are as follows.

Metal film resistors:

Metal film resistors are used when a higher tolerance (more accurate value) is needed. They are much more accurate in value than carbon film resistors. They have about ±0.05% tolerance. Resistors that are about ±1% are more than sufficient. Ni-Cr (Nichrome) seems to be used for the material of resistor. The metal film resistor is used for bridge circuits, filter circuits, and low-noise analog signal circuits.

Variable Resistors:

There are two general ways in which variable resistors are used. One is the variable resistor which value is easily changed, like the volume adjustment of Radio. The other is semi-fixed resistor that is not meant to be adjusted by anyone but a technician. It is used to adjust the operating condition of the circuit by the technician. Semi-fixed resistors are used to compensate for the inaccuracies of the resistors, and to fine-tune a circuit. The rotation angle of the variable resistor is usually about 300 degrees. Some variable resistors must be turned many times to use the whole range of resistance they offer. This allows for very precise adjustments of their value. These are called "Potentiometers" or "Trimmer Potentiometers."

In the photograph to the left, the variable resistor typically used for volume controls can be seen on the far right. Its value is very easy to adjust.

The four resistors at the center of the photograph are the semi-fixed type. These ones are mounted on the printed circuit board.

The two resistors on the left are the trimmer potentiometers.

Other Resistors:

There is another type of resistor other than the carbon-film type and the metal film resistors. It is the **wirewound resistor**. A wirewound resistor is made of metal resistance wire, and because of this, they can be manufactured to precise values. Also, high-wattage resistors can be made by using a thick wire material. Wirewound resistors cannot be used for high-frequency circuits. Coils are used in high frequency circuits. Since a wirewound resistor is a wire wrapped around an insulator, it is also a coil. Using one could change the behavior of the circuit. Still another type of resistor is the **Ceramic resistor**. These are wirewound resistors in a ceramic case, strengthened with special cement. They have very high power ratings, from 1 or 2 watts to dozens of watts. These resistors can become extremely hot when used for high power applications, and this must be taken into account when designing the circuit. These devices can easily get hot enough to burn you if you touch one.

The photograph on the left is of wirewound resistors.
The upper one is 10W and is the length of 45 mm, 13 mm thickness.
The lower one is 50W and is the length of 75 mm, 29 mm thickness.
The upper one is has metal fittings attached. These devices are insulated with a ceramic coating.

The photograph on left is a ceramic (or cement) resistor of 5W and the height is of 9 mm, 9 mm depth, 22 mm width.

CDS Elements

Some components can change resistance value by changes in the amount of light hitting them. One type is the Cadmium Sulfide Photocell. (Cd) The more light that hits it, the smaller its resistance value becomes.

There are many types of these devices. They vary according to light sensitivity, size, resistance value etc.

Pictured at the left is a typical CDS photocell. Its diameter is 8 mm, 4 mm high, with a cylinder form. When bright light is hitting it, the value is about 200 ohms, and when in the dark, the resistance value is about 2M ohms.

Thermistor (Thermally sensitive resistor):

The resistance value of the Thermistor changes according to temperature. This part is used as a temperature sensor. There are mainly three types of thermistor.

1. NTC(Negative Temperature Coefficient thermistor)

With this type, the resistance value decreases continuously as the temperature rises.

2. PTC(Positive Temperature Coefficient Thermistor)

With this type, the resistance value increases suddenly when the temperature rises above a specific point.

3.CTR(Critical Temperature Resister Thermistor)

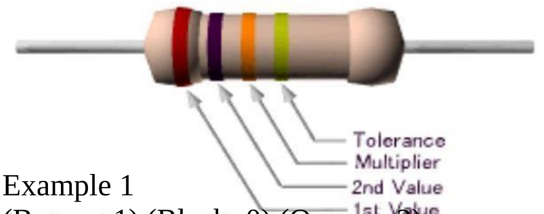
With this type, the resistance value decreases suddenly when the temperature rises above a specific point.

NTC type is used for the temperature control.

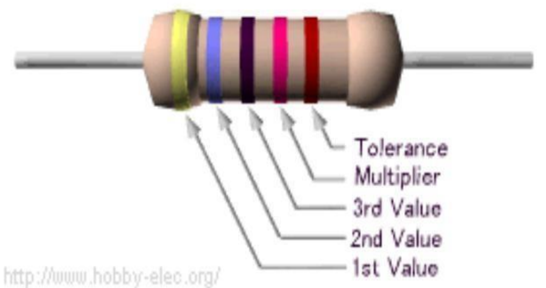
RESISTOR CODINGS:

Colour Coding:

There are main two types of codes used for the identification of value of the resistor. The resistance value is displayed using **<u>the color code</u>** (the colored bars/the colored stripes), because the average resistor is too small to have the value printed on it with numbers.



Example 1
(Brown=1),(Black=0),(Orange=3)
10×10^3 = 10k ohm
Tolerance(Gold) = ±5%



Example 2
(Yellow=4),(Violet=7),(Black=0),(Red=2)
470×10^2 = 47k ohm
Tolerance(Brown) = ±1%

Color	Value	Multiplier	Tolerance (%)
Black	0	10	-
Brown	1	10	±1
Red	2	10	±2
Orange	3	10	±0.05
Yellow	4	10	-
Green	5	10	±0.5
Blue	6	10	±0.25
Violet	7	10	±0.1
Gray	8	10	-
White	9	10	-
Gold	-	10-1	±5
Silver	-	10-2	±10
None	-	-	±20

Character Coding:

Characters are also used for coding the resistor. The characters used for coding are E, K, M, and R. When character comes in between two decimal numbers, it acts as a decimal point. The letter E indicates Ohms only, K indicates Kilo ohms and M indicates Mega ohms. e.g.

1. 2E5 = 2.5 Ω

2. 3K9 = 3.9 KΩ

3. 9M7 = 9.7 MΩ

4. 23E = 23Ω

5. 1K = 1 KΩ

6. 2M = 2MΩ

7. 22M3 = 22.3MΩ

8. R3 = 0.3 Ω

(b) To study different types of capacitors and coding.

THEORY:

The capacitor's function is to store electricity, or electrical energy. The capacitor also functions as a filter, passing alternating current (AC), and blocking direct current (DC). This symbol is used to indicate a capacitor in a circuit diagram. The capacitor is constructed with two electrode plates facing each other, but separated by an insulator. When DC voltage is applied to the capacitor, *an electric charge* is stored on each electrode. While the capacitor is charging up, current flows. The current will stop flowing when the capacitor has fully charged.

The capacitor has an insulator (the dielectric) between 2 sheets of electrodes. Different kinds of capacitors use different materials for the dielectric.

Breakdown voltage:

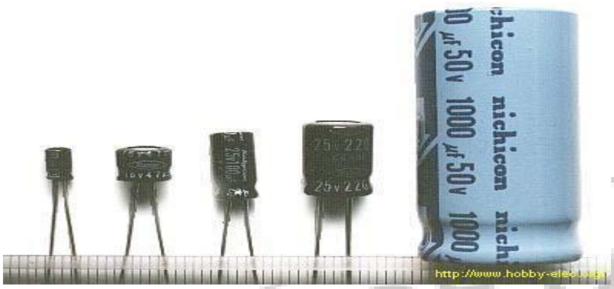
When using a capacitor, you must pay attention to the maximum voltage which can be used. This is the "breakdown voltage." The breakdown voltage depends on the kind of capacitor being used. You must be especially careful with electrolytic capacitors because the breakdown voltage is comparatively low. The breakdown voltage of electrolytic capacitors is displayed as Working Voltage. The breakdown voltage is the voltage that when exceeded will cause the dielectric (insulator) inside the capacitor to break down and conduct. When this happens, the failure can be catastrophic.

The different types of capacitors are given below:

Electrolytic Capacitors (Electrochemical type capacitors):

Aluminum is used for the electrodes by using a thin oxidization membrane. Large values of capacitance can be obtained in comparison with the size of the capacitor, because the dielectric used is very thin. The most important characteristic of electrolytic capacitors is that they have polarity.

They have a positive and a negative electrode [Polarized]. This means that it is very important which way round they are connected. If the capacitor is subjected to voltage exceeding its working voltage, or if it is connected with incorrect polarity, it may burst. It is extremely dangerous, because it can quite literally explode. Make absolutely no mistakes. Generally,



in the circuit diagram, the positive side is indicated by a "+" (plus) symbol. Electrolytic capacitors range in value from about 1µF to thousands of µF. Mainly this type of capacitor is used as a ripple filter in a power supply circuit, or as a filter to bypass low frequency signals, etc. Because this type of capacitor is comparatively similar to the nature of a coil in construction, it isn't possible to use for high-frequency circuits. (It is said that the frequency characteristic is bad.)

The photograph on the left is an example of the different values of electrolytic capacitors in which the capacitance and voltage differ.
From the left to right:
1µF (50V) [diameter 5 mm, high 12 mm]
47µF (16V) [diameter 6 mm, high 5 mm]
100µF (25V) [diameter 5 mm, high 11 mm]
220µF (25V) [diameter 8 mm, high 12 mm]
1000µF (50V) [diameter 18 mm, high 40 mm]

The size of the capacitor sometimes depends on the manufacturer. So the sizes shown here are just examples.

In the photograph to the right, the mark indicating the negative lead of the component can be seen.
You need to pay attention to the polarity indication so as not to make a mistake when you assemble the circuit.

Tantalum Capacitors

Tantalum Capacitors are electrolytic capacitors that use a material called tantalum for the electrodes. Large values of capacitance similar to aluminum electrolytic capacitors can be obtained. Also, tantalum capacitors are superior to aluminum electrolytic capacitors in temperature and frequency characteristics. When tantalum powder is baked in order to solidify it, A crack forms inside. An electric charge can be stored on this crack. These capacitors have polarity as well. Usually, the "+" symbol is used to show the positive component lead. Do not make a mistake with the polarity on these types. Tantalum capacitors are a little bit more expensive than aluminum electrolytic capacitors. Capacitance can change with temperature as well as frequency, and these types are very stable. Therefore, tantalum capacitors are used for circuits which demand high stability in the capacitance

values. Also, it is said to be common sense to use tantalum capacitors for analog signal systems, because the current-spike noise that occurs with aluminum electrolytic capacitors does not appear. Aluminum electrolytic capacitors are fine if you don't use them for circuits which need the high stability characteristics of tantalum capacitors.

The photograph on the left illustrates the tantalum capacitor.
The capacitance values are as follows, from the left:

0.33 µF (35V)
0.47 µF (35V)
10 µF (35V)

The "+" symbol is used to show the positive lead of the component. It is written on the

body. **Ceramic Capacitors**

Ceramic capacitors are constructed with materials such as titanium acid barium used as the dielectric. Internally, these capacitors are not constructed as a coil, so they can be used in high frequency applications.

Typically, they are used in circuits which bypass high frequency signals to ground. These capacitors have the shape of a disk. Their capacitance is comparatively small. The capacitor on the left is a 100pF capacitor with a diameter of about 3 mm. The capacitor on the right side is printed with 103, so 10 x 10^3pF becomes 0.01 µF. The diameter of the disk is about
6 mm. Ceramic capacitors have no polarity. Ceramic capacitors should not be used for analog circuits, because they can distort the signal

Variable Capacitors

Variable capacitors are used for adjustment etc.
of frequency mainly.

On the left in the photograph is a "trimmer," which uses ceramic as the dielectric. Next to it on the right is one that uses polyester film for the dielectric.

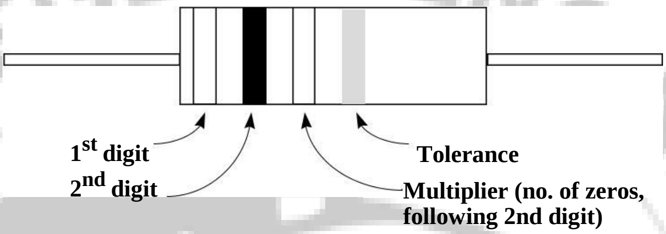
LAB ACTIVITY

EQUIPMENT REQUIRED

Electronic components (Resistor, capacitors, diode, Transistor)
Digital multimeter (DMM)

A1. Determining Resistor values

Resistor Colour Codes



Colour-code bands on a resistor.

Colour	Band 1	Band 2	Band 3	Band 4
Black	0	0	×1	–
Brown	1	1	×10	± 1%
Red	2	2	×100	± 2%
Orange	3	3	×1000	–
Yellow	4	4	×10000	–
Green	5	5	×100000	± 0.5%
Blue	6	6	×1000000	± 0.25%
Violet	7	7	×10000000	± 0.1%
Grey	8	8	–	–
White	9	9	–	–
Gold	–	–	×0.1	±5%
Silver	–	–	×0.01	±10%

Resistance measurement

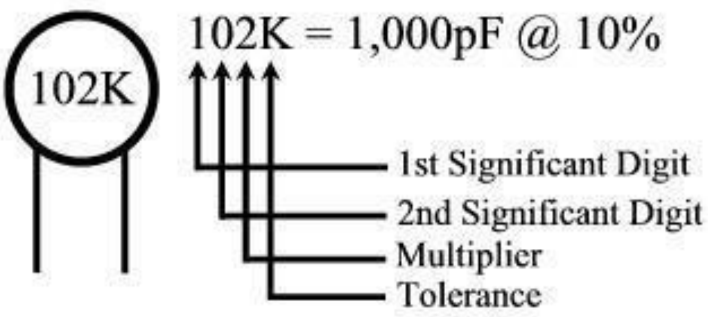
Procedure

1. Connect probes: black probe to COM terminal and red probe to terminal marked with 'Ω'
   Set function to resistance measurement
   Set to the appropriate range (refer to above)
   Connect the two probes' crocodile clips to the resistor (or to the resistor circuit via jumper wires) to make measurement
   Note the reading, adjust range if necessary
   Take the more accurate reading.

Determine the value for the given data

No.	Colour code	Actual Value	Measured Value (DMM)
1	Red, red, black		
2	Red, black, orange		
3	Blue, gray, green		
4		10M	
5		33K	

A2. Determining capacitor values



Code	Tolerance
C	±0.25pF
J	±5%
K	±10%
M	±20%
D	±0.5pF
Z	80% / -20%

Determine the value of the ceramic capacitors

No.	Code Number	Actual Value
1	104	
2	223	
3	68	
4		0.47μF
5		33nF

A3. Diode Testing

Draw the schematic symbol of a 1N4001 diode and identify the leads (Anode and Cathode) in the box below.

3. Set the Lab DMM to *Diode Testing* mode.
b. Measure the forward and reverse bias voltages of the given diodes and record them

Forward bias voltage:
Place the RED probe on the Anode. Touch the BLACK probe to the Cathode and record the reading

Reverse bias voltage:
Place the RED probe on the Cathode. Touch the BLACK probe to the Anode and record the reading

No.	Diode Number	Forward Bias Voltage	Reverse Bias Voltage
1	1N4001		
2	1N914		

EXPERIMENT NO.: 2 **Date:**

AIM: To study about different electronics components.

TRANSFORMERS

A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (emf) or voltage in the secondary winding.

Transformers are normally pretty easy to identify by sight, and many have their specs printed on them. They are typically marked with an "T" on a circuit board.

FUSES

In electronics and electrical engineering, a fuse is a type of low resistance resistor that acts as a sacrificial device to provide overcurrent protection, of either the load or source circuit. Its essential component is a metal wire or strip that melts when too much current flows, which interrupts the circuit in which it is connected. Short circuit, overloading, mismatched loads or device failure are the prime reasons for excessive current. A fuse interrupts excessive current (blows) so that further damage by overheating or fire is prevented.

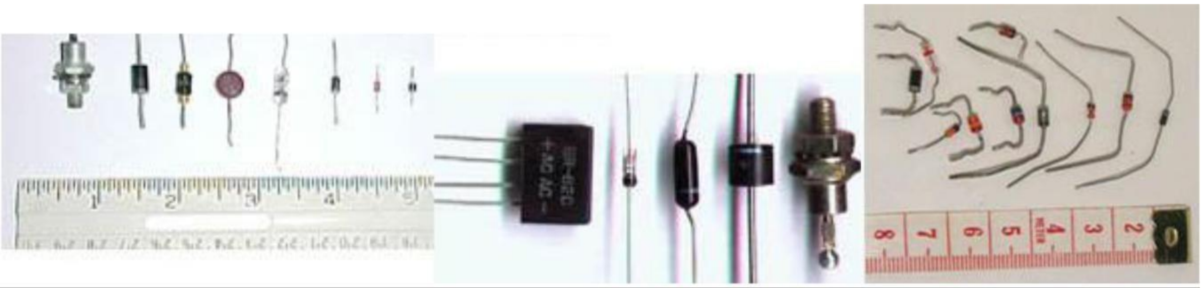
Fuses can be easy to identify, and typically have their voltage and amperage rating marked on them.

SEMICONDUCTORS

DIODES

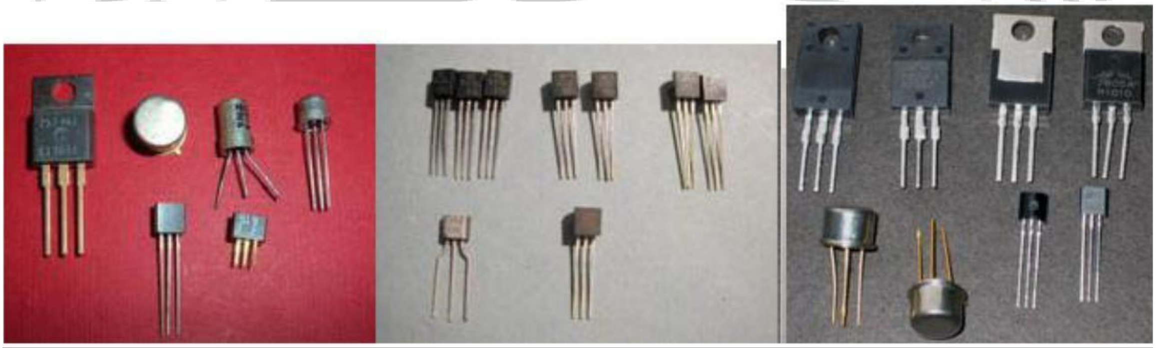
In electronics, a diode is a two-terminal electronic component with asymmetric conductance, it has low (ideally zero) resistance to current flow in one direction, and high (ideally infinite) resistance in the other.

Semiconductors, such as Diodes (typically marked with an “D” on a circuit board).



TRANSISTORS

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.
Transistors (typically marked with an “Q” on a circuit board).



BRIDGE RECTIFIERS

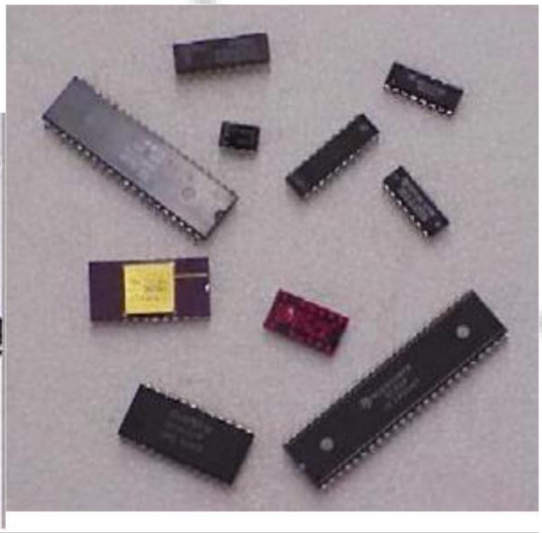
A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating current (AC) input into a direct current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.

Bridge Rectifiers (typically marked with an “BR” on a circuit board)

INTEGRATED CIRCUITS

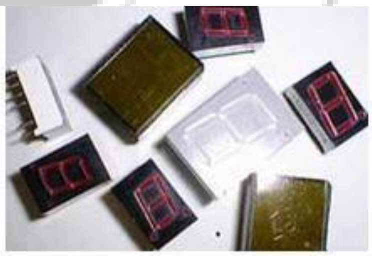
An integrated circuit or monolithic integrated circuit (also referred to as an IC, a chip, or a microchip) is a set of electronic circuits on one small plate ("chip") of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from independent components. Integrated circuits are used in virtually all electronic equipment today and have revolutionized the world of electronics. Computers, mobile phones, and other digital home appliances are now inextricable parts of the structure of modern societies, made possible by the low cost of producing integrated circuits.

Integrated Circuits (typically marked with an “U” or “IC” on a circuit board)



LED AND LED DISPLAY

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.



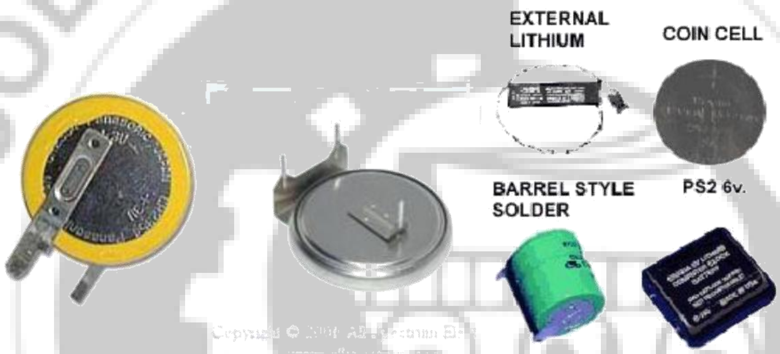
SWITCHES

In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is nonconducting.

BATTERIES

In electricity, a battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy.

Batteries are also pretty easy to identify, and are well marked with their specification.



RELAYS

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Relays are typically enclosed in plastic, and many have their specs printed on them. They are typically marked with a “K” on a circuit board.

EXPERIMENT NO.: 3 **Date:**

AIM: To study Cathode Ray Oscilloscope and perform measurements.

APPARATUS:

1. CRO
2. CRO probes

THEORY:

An oscilloscope is a test instrument which allows you to look at the 'shape' of electrical signals by displaying a graph of voltage against time on its screen. It is like a voltmeter with the valuable extra function of showing how the voltage varies with time.

The graph, usually called the trace, is drawn by a beam of electrons striking the phosphor coating of the screen making it emit light, usually green or blue. This is similar to the way a television picture is produced.

Oscilloscopes contain a vacuum tube with a cathode (negative electrode) at one end to emit electrons and an anode (positive electrode) to accelerate them so they move rapidly down the tube to the screen. This arrangement is called an electron gun. The tube also contains electrodes to deflect the electron beam up/down and left/right.

The electrons are called cathode rays because they are emitted by the cathode and this gives the oscilloscope its full name of cathode ray oscilloscope or CRO.

A dual trace oscilloscope can display two traces on the screen, allowing you to easily compare the input and output of an amplifier for example. It is well worth paying the modest extra cost to have this facility.

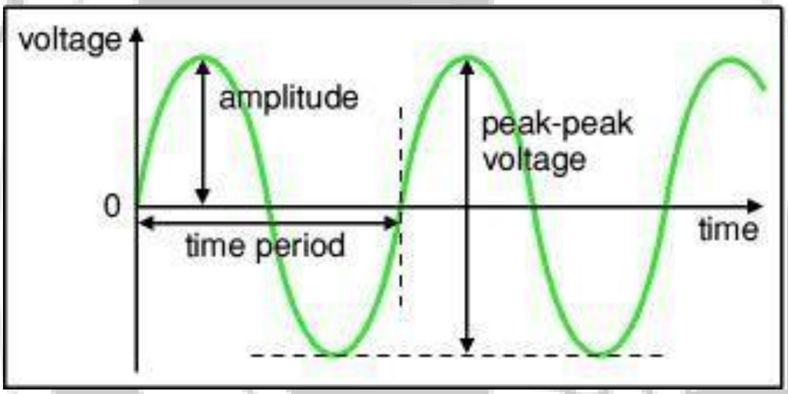
Setting up an oscilloscope

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully. It is quite easy to 'lose' the trace off the screen if controls are set wrongly.

There is some variation in the arrangement and labeling of the many controls so the following instructions may need to be adapted for your instrument.

1. Switch on the oscilloscope to warm up (it takes a minute or two).
2. Do not connect the input lead at this stage.
3. Set the AC/GND/DC switch (by the Y INPUT) to DC.
4. Set the SWP/X-Y switch to SWP (sweep).
5. Set Trigger Level to AUTO.
6. Set Trigger Source to INT (internal, the y input).
7. Set the Y AMPLIFIER to 5V/cm (a moderate value).
8. Set the TIMEBASE to 10ms/cm (a moderate speed).
9. Turn the time base VARIABLE control to 1 or CAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace across the middle of the screen, like the picture.
11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharp trace.
12. The oscilloscope is now ready to use.

Measuring voltage and time period



The trace on an oscilloscope screen is a **graph of voltage against time**. The shape of this graph is determined by the nature of the input signal.

In addition to the properties labelled on the graph, there is frequency which is the number of cycles per second.

The diagram shows a **sine wave** but these properties apply to any signal with a constant shape.

Amplitude is the maximum voltage reached by the signal.
It is measured in **volts**, **V**.

Peak voltage is another name for amplitude.

Peak-peak voltage is twice the peak voltage (amplitude). When reading an oscilloscope trace it is usual to measure peak-peak voltage.

Time period is the time taken for the signal to complete one cycle.
It is measured in **seconds (s)**, but time periods tend to be short so **milliseconds (ms)** and **microseconds (µs)** are often used. 1ms = 0.001s and 1µs = 0.000001s.

Frequency is the number of cycles per second.
It is measured in **hertz (Hz)**, but frequencies tend to be high so **kilohertz (kHz)** and **megahertz (MHz)** are often used. 1kHz = 1000Hz and 1MHz = 1000000Hz.

$$\text{Frequency} = \frac{1}{\text{Time Period}} \text{ and Time Period} = \frac{1}{\text{Frequency}}$$

Voltage

Voltage is shown on the **vertical y-axis** and the scale is determined by the Y AMPLIFIER (VOLTS/CM) control. Usually **peak-peak voltage** is measured because it can be read correctly even if the position of 0V is not known. The **amplitude** is half the peak-peak voltage.

If you wish to read the amplitude voltage directly you must check the position of 0V (normally halfway up the screen): move the AC/GND/DC switch to GND (0V) and use Y-SHIFT (up/down) to adjust the position of the trace if necessary, switch back to DC afterwards so you can see the signal again.

Voltage = distance in cm × volts/cm

Time period

Time is shown on the **horizontal x-axis** and the scale is determined by the TIMEBASE (TIME/CM) control. The **time period** (often just called **period**) is the time for one cycle of the signal. The **frequency** is the number of cyles per second, frequency = 1/time period

Ensure that the variable timebase control is set to 1 or CAL (calibrated) before attempting to take a time reading.

Time = distance in cm × time/cm

Precautions

An oscilloscope should be handled gently to protect its fragile (and expensive) vacuum tube.
Oscilloscopes use high voltages to create the electron beam and these remain for some time after switching off - for your own safety do not attempt to examine the inside of an oscilloscope.

CONCLUSION:

EXPERIMENT NO.: 4 **Date:**

AIM: To study digital multimeter and perform testing of various components.

APPARATUS:

1.digital multimeter
2.resistors
3. diode
4.P-n-p and n-p-n transistors.

Typical Voltage/Current Test

Voltmeters are usually connected across a circuit. You can perform two types of tests with a voltmeter. If you connect it from the positive terminal of a component to ground, you will read the amount of voltage there is to operate the component. It will usually read 0 volts or full voltage. If you test a component that is supposed to have 12 volts, but there is 0 volts, there is an open in the circuit. This is where you will have to trace back until you locate the open.

Using digital multimeter, we can measure voltage across any electronic component. We have to connect the multimeter probes across that component. We can measure ac or dc voltage. The switch position must be kept at particular position to ensure correct readings. To measure ac voltage/current, the switch should be kept on V~ / A~ range. Same way, to measure dc voltage/current, the switch should be kept on V- / A- range.

Typical Resistance Test

Another useful function of the DMM is the ohmmeter. An ohmmeter measures the electrical resistance of a circuit. The switch should be kept on Ω range. If you have no resistance in a circuit, the ohmmeter will read 0. If you have an open in a circuit, it will read infinite.

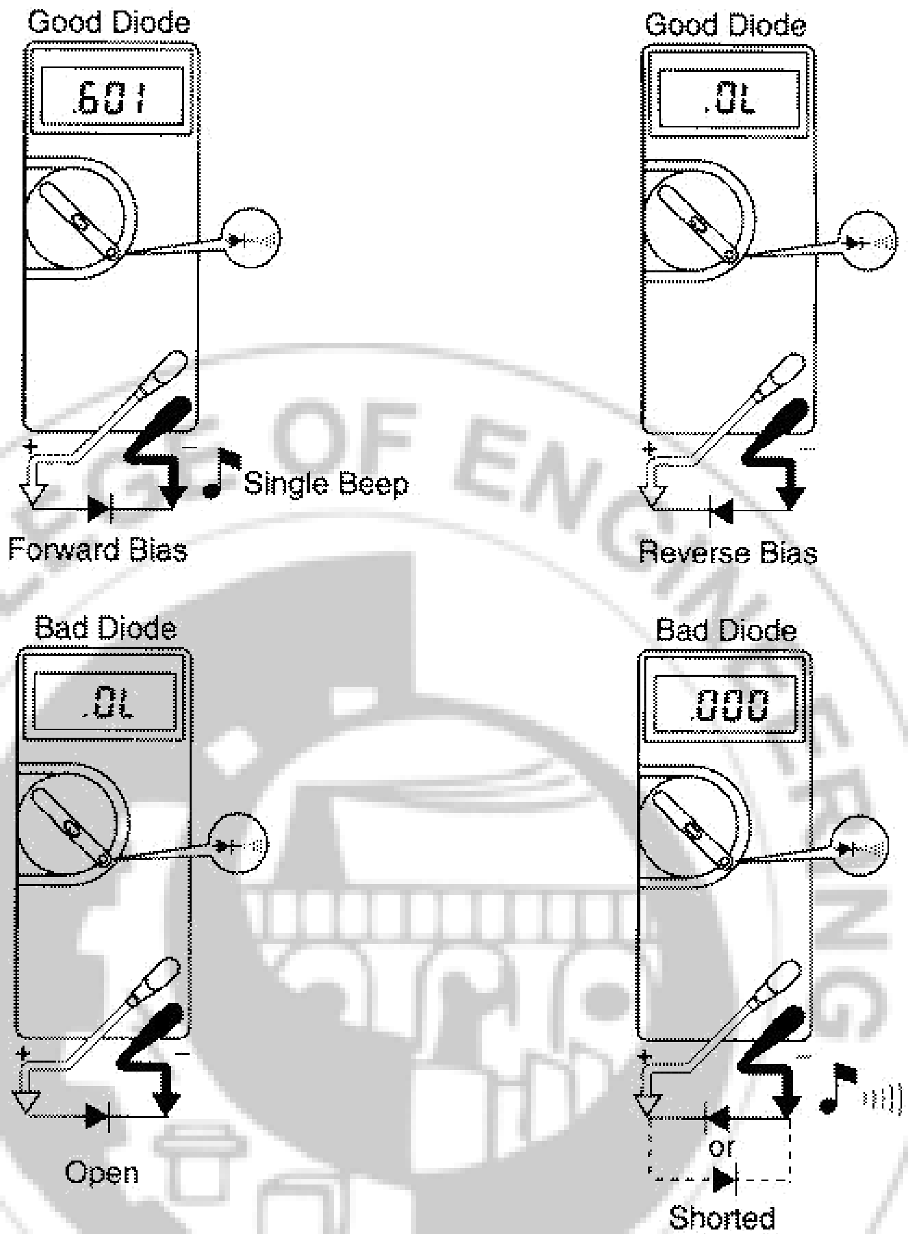
An ohmmeter uses its own battery to conduct a resistance test. Therefore there must be no power in the circuit being tested or the ohmmeter will become damaged.

When you test a component you put the red lead on the positive side and the black lead on the negative side. Current from the battery will flow through the component and the meter will determine the resistance by how much the voltage drops. If the component has an open the meter will flash "1.000" or "OL" to show an open or infinite resistance. A reading of 0 ohms indicates that there is no resistance in the component and it is shorted. If a component is supposed to have 1,000 ohms of resistance and a test shows it has 100 ohms of resistance, which indicates a short. If it reads infinite, then it is open.

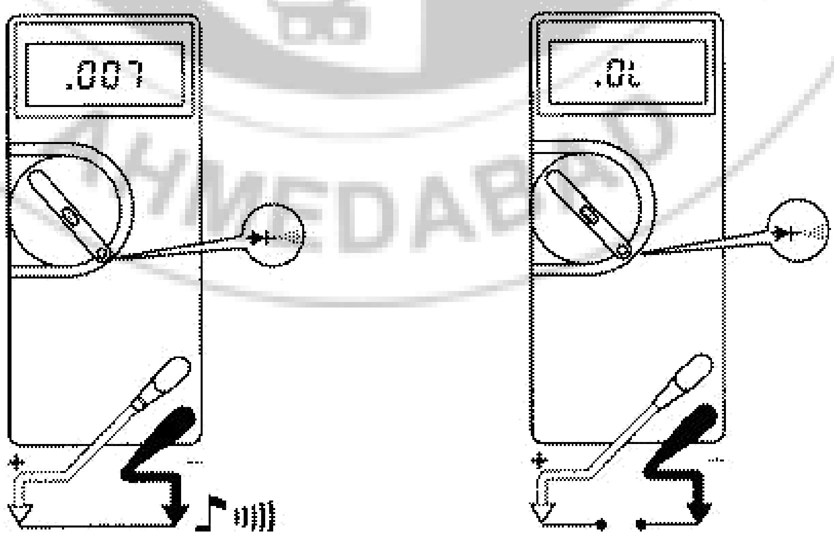
On a (digital) DMM, there will usually be a diode test mode. Using this, a silicon diode should read between .5 to .8 V in the forward direction and open in reverse. For a germanium diode, it will be lower, perhaps .2 to .4 V or so in the forward direction. Using the normal resistance ranges

- any of them - will usually show open for any semiconductor junction since the meter does not apply enough voltage to reach the value of the forward drop. Note, however, that a defective diode may indeed indicate a resistance lower than infinity especially on the highest ohms range. So, any reading of this sort would be an indication of a bad device but the opposite is not guaranteed.

Testing Diode



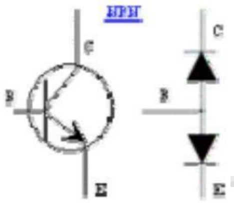
Continuity test



This mode is used to check if two points are electrically connected. It is often used to verify connectors. If continuity exists (resistance less than 210 ohms), the beeper sounds continuously.

Testing bipolar transistors

The assumption made when testing **transistors** is that a transistor is just a pair of connected diodes. Therefore it can be tested for shorts, opens or leakage with a simple digital multimeter.



To test a bipolar transistor with a digital multimeter, take it out of circuit and make the following measurements using the diode test mode:

Connect the red (positive) lead to the base of the transistor. Connect the black (negative) lead to the emitter. A good NPN transistor will read a **junction drop voltage** of 0.4V to 0.9V. A good PNP transistor will read **open**.
Leave the red meter lead on the base and move the black meter lead to the collector - the reading should be *almost the same as the previous test*, open for PNP and a *slightly lower voltage drop* for NPN transistors.
Reverse the meter leads and repeat the test. This time, connect the black meter lead to the base of the transistor and the red lead to the emitter. A good PNP transistor will read a **junction drop voltage** of 0.4V to 0.9V. A good NPN transistor will read **open**.

Leave the black meter lead on the base and move the red lead to the collector - the reading should be *almost the same as the previous test*, open for NPN and a *slightly lower voltage drop* for PNP transistors.
Place one meter lead on the collector, the other on the emitter, then reverse. Both tests should read **open** for both NPN and PNP transistors.

If you read a short circuit (zero ohms or a voltage drop of zero) between two leads, or the transistor fails any of the tests described above, it is bad and must be replaced.

If you get readings that do not make sense, try to compare them with measurements done on a good transistor of the same type.

CONCLUSION:

EXPERIMENT NO.: 5 **Date:**

AIM: To study function generator & Power Supply and perform measurements.

APPARATUS:

1.function generator
2.CRO probes
3.DC Regulated Power Supply

THEORY:

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Most function generators allow the user to choose the shape of the output from a small number of options.

Square wave - The signal goes directly from high to low voltage.
Sine wave - The signal curves like a sinusoid from high to low voltage.
Triangle wave - The signal goes from high to low voltage at a fixed rate.

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal.

The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.

The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls. One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

The duty cycle of a signal refers to the ratio of high voltage to low voltage time in a square wave signal.

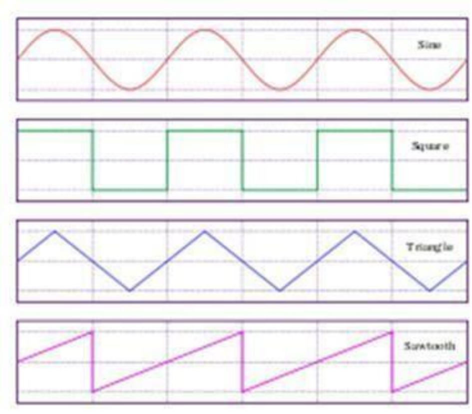
Using a function generator

After powering on the function generator, the output signal needs to be configured to the desired shape. Typically, this means connecting the signal and ground leads to an oscilloscope to check the controls. Adjust the function generator until the output signal is correct, then attach the signal and ground leads from the function generator to the input and ground of the device under test. For some applications, the negative lead of the function generator should attach to a negative input of the device, but usually attaching to ground is sufficient.

FUNCTION GENERATOR

A simple analog function generator, circa 1990

A DDS function generator



Sine, square, triangle, and sawtooth waveforms

A **function generator** is usually a piece of electronic test equipment or software used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular and sawtooth shapes. These waveforms can be either repetitive or single-shot (which requires an internal or external trigger source).Integrated circuits used to generate waveforms may also be described as function generator ICs.

Although function generators cover both audio and RF frequencies, they are usually not suitable for applications that need low distortion or stable frequency signals. When those traits are required, other signal generators would be more appropriate.

Some function generators can be phase -locked to an external signal source (which may be a frequency reference) or another function generator.

Function generators are used in the development, test and repair of electronic equipment. For example, they may be used as a signal source to test amplifiers or to introduce an error signal into a control loop.

Working

Simple function generators usually generate triangular waveform whose frequency can be controlled smoothly as well as in steps. This triangular wave is used as the basis for all of its other outputs. The triangular wave is generated by repeatedly charging and discharging a capacitor from a constant current source.

This produces a linearly ascending or descending voltage ramp. As the output voltage reaches upper and lower limits, the charging and discharging is reversed using a comparator, producing the linear triangle wave. By varying the current and the size of the capacitor, different frequencies may be obtained. Saw tooth waves can be produced by charging the capacitor slowly, using a current, but using a diode over the current source to discharge quickly

- the polarity of the diode changes the polarity of the resulting saw tooth, i.e. slow rise and fast fall, or fast rise and slow fall.

A 50% cycle square is easily obtained by noting whether the capacitor is being charged or discharged, which is reflected in the current switching comparator output. Other duty cycles (theoretically from 0% to 100%) can be obtained by using a comparator and the saw tooth or triangle signal. Most function generators also contain a non-linear diode shaping that can convert the triangle wave into a reasonably accurate sine wave by rounding off the corners of the triangle wave in a process similar to clipping in audio systems.

A typical function generator can provide frequencies up to 20 MHz RF generators for higher frequencies are not function generators in the strict sense since they typically produce pure or modulated sine signals only.

Function generators, like most signal generators, may also contain an attenuator, various means of modulating the output waveform, and often the ability to automatically and repetitively "sweep" the frequency of the output waveform (by means of a voltage-controlled oscillator) between two operator-determined limits. This capability makes it very easy to evaluate the frequency response of a given electronic circuit.

Some function generators can also generate white or pink noise.

More advanced function generators are called arbitrary waveform generators (AWG). They use direct digital synthesis (DDS) techniques to generate any waveform that can be described by a table of amplitudes.

POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:

Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage. s

CONCLUSION:

LAB Activity

2A DIGITAL MULTI METER

observation

Description	**Value**
Measurement of line voltage (ac)	
Measurement of resistance	
Measurement of continuity	

Self test of CRO	
Description	**Value**
Measurement of voltage	
Measurement of Time	
Calculated frequency	

Description	**Sine wave**	**Square Wave**
Measurement of voltage		
Measurement of Time		
Calculated frequency		

EXPERIMENT NO.: 6 **Date:**

AIM: To perform LED on/OFF USING arduino.

Study of Arduino Board

Introduction of Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Why Arduino?

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

- Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50
- Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

- Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
- Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

How to use Arduino?

Getting Started with Arduino products

The Arduino Software (IDE) allows you to write programs and upload them to your board. In the Arduino Software page you will find two options:

1. If you have a reliable Internet connection, you should use the online IDE (Arduino Web Editor). It will allow you to save your sketches in the cloud, having them available from any device and backed up. You will always have the most up-to-date version of the IDE without the need to install updates or community generated libraries.

2. If you would rather work offline, you should use the latest version of the desktop IDE.

Code online on the Arduino Web Editor
To use the online IDE simply follow these instructions. Remember that boards work out-of-the-box on the Web Editor, no need to install anything.
Install the Arduino Desktop IDE
To get step-by-step instructions select one of the following link accordingly to your operating system.

Windows
Mac OS X
Linux
Portable IDE (Windows and Linux)

Choose your board in the list here on the right to learn how to get started with it and how to use it on the Desktop IDE.

Learn Arduino

- Read an introduction on what is Arduino and why you'd want to use it.
- What is the Arduino Software (IDE) and how do I change the default language?
- Libraries: Using and installing Arduino Libraries.
- Cores: Need to add a new board to your Arduino Software?
  Install the relate core and manage it.

- Troubleshooting: Advice on what to do if things don't work.

For a complete list of Guides visit the Foundations section, where you will find in-depth knowledge about the principles and techniques behind the Arduino platform.

Making the Arduino StarterKit projects and reading the book 'Getting Started with Arduino' are great ways to start learning and tinkering with coding and electronics.

LED ON/OFF USING ARDUINO.

It requires

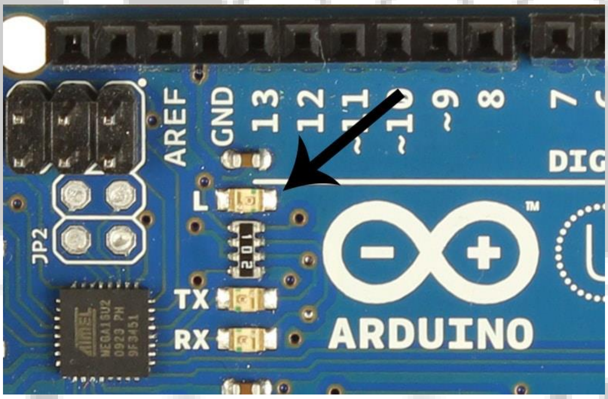
- LED
- Resistor
- Connecting wires

ELECTRICAL SIGNALS

The Arduino communicates with modules and sensors by switching on and off electrical current. It’s very similar to the one’s and zero’s in binary code. When current is switched on, it’s known as a “HIGH signal”. That’s comparable to the “one” in binary code. When the current is switched off, that’s a “LOW signal”, which is similar to the zero in binary code. The length of time the current stays on or off can be changed from a microsecond up to many minutes.

(A) TO PERFORM CONTROLLING OF ARDUINO’S LED

To turn on an LED, the Arduino needs to send a HIGH signal to one of it’s pins. To turn off the LED, it needs to send a LOW signal to the pin. You can make the LED flash by changing the length of the HIGH and LOW states.
The Arduino has an on-board surface mount LED that’s hard wired to digital pin 13. It’s the one with an “L” next to it:



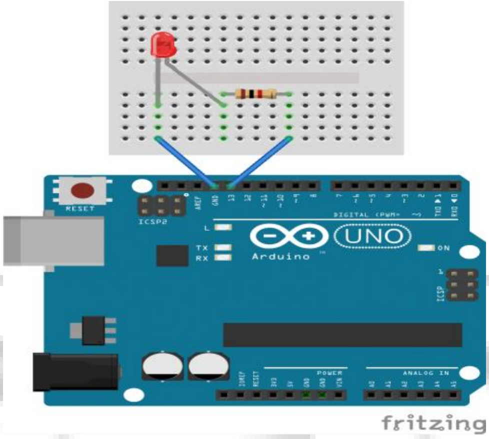
To get this LED flashing, upload the “Blink” program to your Arduino:

```
void setup() {
pinMode(13, OUTPUT);
}
void loop() {
digitalWrite(13, HIGH);
delay(1000);
digitalWrite(13, LOW);
delay(1000);
}
```

The LED should now be blinking on and off at a rate of 1000 milliseconds (1000 milliseconds = 1 second).
The delay() function on line 6 tells the Arduino to hold the HIGH signal at pin 13 for 1000 ms.
The delay() function on line 8 tells it to hold the LOW signal at pin 13 for 1000 ms. You can change

the blinking speed by changing the number inside the parentheses of the delay() functions.

(B)TO PERFORM CONTROLLING OF AN EXTERNAL LED



An external LED or any other powered module can be controlled in a similar way.
LEDs need to have a resistor placed *in series* (in-line) with it. Otherwise, the unrestricted current will quickly burn out the LED. The resistor can be any value between 100 Ohms and about 10K Ohms. Lower value resistors will allow more current to flow, which makes the LED brighter. Higher value resistors will restrict the current flow, which makes the LED dimmer.
Also, most LED's have polarity, which means that they need to be connected the right way around. Usually, the LED's shortest lead connects to the ground side.
If you connect the LED to pin 13 as shown in the image below, you can use the same code we used above to make the LED flash on and off.

CHANGING THE PIN

If you want to use a different pin to power the LED, it's easy to change it. For example, say you want to use pin 8 instead of pin 13. First move the signal wire from pin 13 over to pin 8:

Now you'll need to edit a line of code in the program so the Arduino knows which pins to use as output pins. That's done on line 2, where it says:

pinMode(13, OUTPUT);

To use pin 8, you just have to change the 13 to an 8:

pinMode(8, OUTPUT);

Next you'll need to change the code that tells the Arduino which pins will get the HIGH and LOW output signals. That's done everywhere there's a digitalWrite() function.

digitalWrite(13, HIGH);

digitalWrite(13, LOW);

To specify that pin 8 should get the HIGH and LOW signals, you just need to change the 13's to 8's:

digitalWrite(8, HIGH);

digitalWrite(8, LOW);

The finished program should look like this:

void setup() {

pinMode(8, OUTPUT);

```
}
void loop() {
  digitalWrite(8, HIGH);
  delay(1000);
  digitalWrite(8, LOW);
  delay(1000);
}
```

After uploading, the LED should flash just like it did when it was connected to pin 13.