LAB MANUAL

1st SEMESTER

D.Voc Industrial Electronics

Haryana Vishwakarma Skill University

Dudhola, Palwal

Experiment No. 1

AIM:-Identification and testing of electronic components such as Resistor, Inductor, Capacitor, Diode and Transistor

Breadboards:

In order to temporarily construct a circuit without damaging the components used to build it, we must have some sort of a platform that will both hold the components in place and provide the needed electrical connections. In the early days of electronics, most experimenters were amateur radio operators. They constructed their radio circuits on wooden breadboards. Although more sophisticated techniques and devices have been developed to make the assembly and testing of electronic circuits easier, the concept of the breadboard still remains in assembling components on a temporary platform.

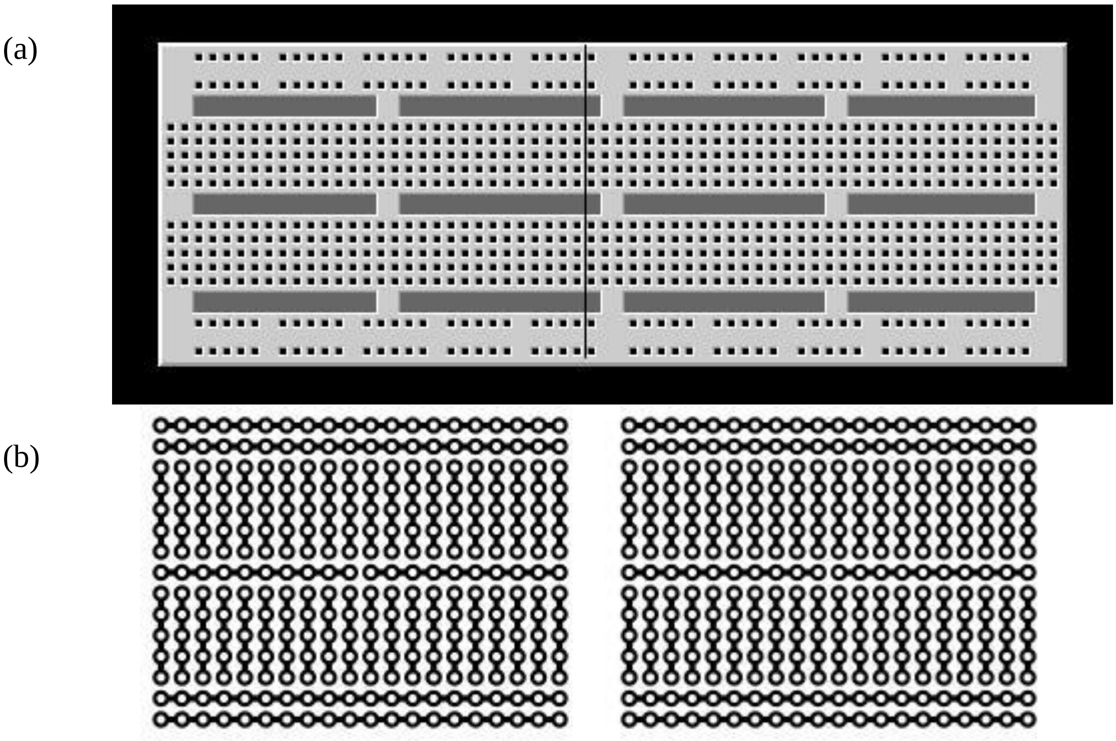


Fig. 1: (a) A typical Breadboard and (b) its connection details

A real breadboard is shown in Fig. 1(a) and the connection details on its rear side are shown in Fig. 1(b). The five holes in each individual column on either side of the central groove are electrically connected to each other, but remain insulated from all other sets of holes. In addition to the main columns of holes, however, you'll note four sets or groups of holes along the top and bottom. Each of these consists of five separate sets of five holes each, for a total of 25 holes. These groups of 25 holes are all connected together on either side of the dotted line indicated on Fig.1(a) and needs an external connection if one wishes the entire row to be connected. This makes them ideal for distributing power to multiple ICs or other circuits.

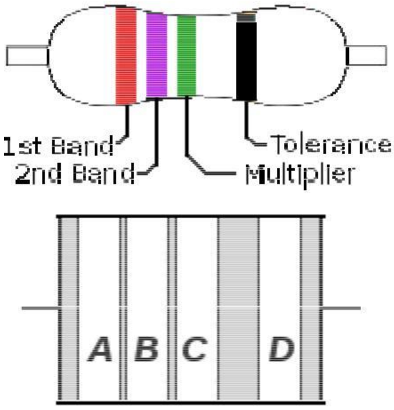
These breadboard sockets are sturdy and rugged, and can take quite a bit of handling. However, there are a few rules you need to observe, in order to extend the useful life of the electrical contacts and to avoid damage to components. These rules are:

- Always make sure power is disconnected when constructing or modifying your experimental circuit. It is possible to damage components or incur an electrical shock if you leave power connected when making changes.
- Never use larger wire as jumpers. #24 wire (used for normal telephone wiring) is an excellent choice for this application. Observe the same limitation with respect to the size of component leads.
- Whenever possible, use ¼ watt resistors in your circuits. ½ watt resistors may be used when necessary; resistors of higher power ratings should never be inserted directly into a breadboard socket.
- Never force component leads into contact holes on the breadboard socket. Doing so can damage the contact and make it useless.
- Do not insert stranded wire or soldered wire into the breadboard socket. If you must have stranded wire (as with an inductor or transformer lead), solder (or use a wire nut to connect) the stranded wire to a short length of solid hook up wire, and insert only the solid wire into the breadboard.

If you follow these basic rules, your breadboard will last indefinitely, and your experimental components will last a long time.

Resistors

Most axial resistors use a pattern of coloured stripes to indicate resistance. A 4band identification is the most commonly used colour coding scheme on all resistors. It consists of four coloured bands that are painted around the body of the resistor. Resistor values are always coded in ohms (Ω). The colour codes are given in the following table in Fig. 1



Band Color	Digit	Multiplier	Tolerance
Black	⬛ 0	1	---
Brown	🟫 1	10	±1%
Red	🟥 2	100	±2%
Orange	🟧 3	1,000	±3%
Yellow	🟨 4	10,000	±4%
Green	🟩 5	100,000	---
Blue	🟦 6	1,000,000	---
Violet	🟪 7	10,000,000	---
Gray	◼ 8	100,000,000	---
White	⬜ 9	---	---
Gold	▨ ---	0.1	±5%
Silver	▩ ---	0.01	±10%
None	---	---	±20%

Fig. 1: Colour codes of Resistors

- band **A** is first significant figure of component value
- band **B** is the second significant figure
- band **C** is the decimal multiplier
- band **D** if present, indicates tolerance of value in percent (no colour means 20%)

For example, a resistor with bands of *yellow, violet, red, and gold* will have first digit 4 (yellow in table below), second digit 7 (violet), followed by 2 (red) zeros: 4,700 ohms. Gold signifies that the tolerance is ±5%, so the real resistance could lie anywhere between 4,465 and 4,935 ohms.

Tight tolerance resistors may have three bands for significant figures rather than two, and/or an additional band indicating temperature coefficient, in units of ppm/K. For large power resistors and potentiometers, the value is usually written out implicitly as "10 kΩ", for instance.

Capacitors:

You will mostly use electrolytic and ceramic capacitors for your experiments.

Electrolytic capacitors

An **electrolytic capacitor** is a type of capacitor that uses an electrolyte, an ionic conducting liquid, as one of its plates, to achieve a larger capacitance per unit volume than other types. They are used in relatively high-current and low-Frequency electrical circuits. However, the voltage applied to these capacitors must be polarized; one specified terminal must always have positive potential with respect to the other. These are of two types, axial and radial capacitors as shown in adjacent figure. The arrowed stripe indicates the polarity, with the arrows pointing towards the negative pin.

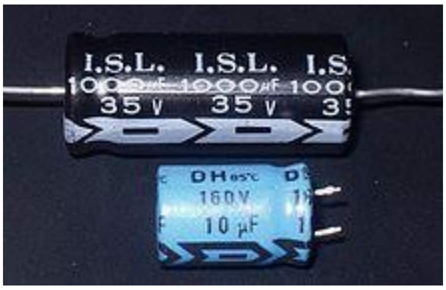


Fig. 2:Axial and Radial Electrolytic capacitors

Warning: connecting electrolytic capacitors in reverse polarity can easily damage or destroy the capacitor. Most large electrolytic capacitors have the voltage, capacitance, temperature ratings, and company name written on them without having any special colour coding schemes.

Axial electrolytic capacitors have connections on both ends. These are most frequently used in devices where there is no space for vertically mounted capacitors.

Radial electrolytic capacitors are like axial electrolytic ones, except both pins come out the same end. Usually that end (the "bottom end") is mounted flat against the PCB and the capacitor rises perpendicular to the PCB it is mounted on. This type of capacitor probably accounts for at least 70% of capacitors in consumer electronics.

Ceramic capacitors are generally non-polarized and almost as common as radial electrolytic capacitors. Generally, they use an alphanumeric marking system. The number part is the same as for resistors, except that the value represented is in pF. They may also be written out directly, for instance, 2n2 = 2.2 nF.

SMT

Fig. 3: Ceramic capacitors

Diodes:

A standard specification sheet usually has a brief description of the diode. Included in this description is the type of diode, the major area of application, and any special features. Of particular interest is the specific application for which the diode is suited. The manufacturer also provides a drawing of the diode which gives dimension, weight, and, if appropriate, any identification marks. In addition to the above data, the following information is also provided: a static operating table (giving spot values of parameters under fixed conditions), sometimes a characteristic curve (showing how parameters vary over the full operating range), and diode ratings (which are the limiting values of operating conditions outside which could cause diode damage). Manufacturers specify these various diode operating parameters and characteristics with "letter symbols" in accordance with fixed definitions. The following is a list, by letter symbol, of the major electrical characteristics for the rectifier and signal diodes.

RECTIFIER DIODES

DC BLOCKING VOLTAGE [V_R]—the maximum reverse dc voltage that will not cause breakdown.

AVERAGE FORWARD VOLTAGE DROP [$V_{F(AV)}$]—the average forward voltage drop across the rectifier given at a specified forward current and temperature.

AVERAGE RECTIFIER FORWARD CURRENT [$I_{F(AV)}$]—the average rectified forward current at a specified temperature, usually at 60 Hz with a resistive load.

AVERAGE REVERSE CURRENT [$I_{R(AV)}$]—the average reverse current at a specified temperature, usually at 60 Hz.

PEAK SURGE CURRENT [I_{SURGE}]—the peak current specified for a given number of cycles or portion of a cycle.

SIGNAL DIODES

PEAK REVERSE VOLTAGE [PRV]—the maximum reverse voltage that can be applied before reaching the breakdown point. (PRV also applies to the rectifier diode.)

REVERSE CURRENT [I_R]—the small value of direct current that flows when a semiconductor diode has reverse bias.

MAXIMUM FORWARD VOLTAGE DROP AT INDICATED FORWARD CURRENT [$V_F@I_F$]— the maximum forward voltage drop across the diode at the indicated forward current.

REVERSE RECOVERY TIME [t_{rr}]—the maximum time taken for the forward-bias diode to recover its reverse bias.

The ratings of a diode (as stated earlier) are the limiting values of operating conditions, which if exceeded could cause damage to a diode by either voltage breakdown or overheating.

The PN junction diodes are generally rated for: MAXIMUM AVERAGE FORWARD CURRENT, PEAK RECURRENT FORWARD CURRENT, MAXIMUM SURGE CURRENT, and PEAK REVERSE VOLTAGE

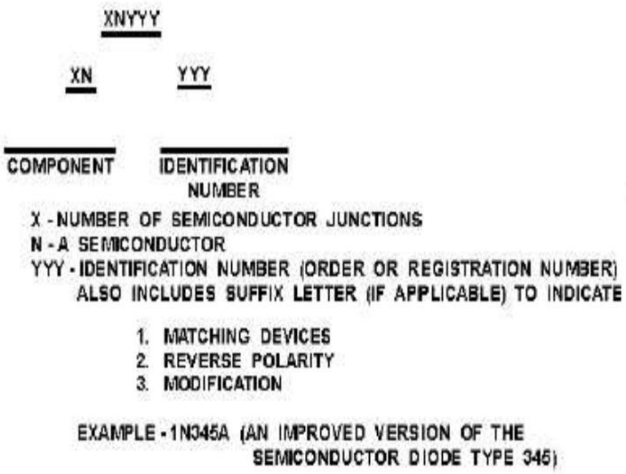
Maximum average forward current is usually given at a special temperature, usually 25º C, (77º F) and refers to the maximum amount of average current that can be permitted to flow in the forward direction. If this rating is exceeded, structure breakdown can occur.

Peak recurrent forward current is the maximum peak current that can be permitted to flow in the forward direction in the form of recurring pulses.

Maximum surge current is the maximum current permitted to flow in the forward direction in the form of nonrecurring pulses. Current should not equal this value for more than a few milliseconds.

Peak reverse voltage (PRV) is one of the most important ratings. PRV indicates the maximum reverse-bias voltage that may be applied to a diode without causing junction breakdown. All of the above ratings are subject to change with temperature variations. If, for example, the operating temperature is above that stated for the ratings, the ratings must be decreased.

There are many types of diodes varying in size from the size of a pinhead (used in sub miniature circuitry) to large 250-ampere diodes (used in high-power circuits). Because there are so many different types of diodes, some system of identification is needed to distinguish one diode from another. This is accomplished with the semiconductor identification system shown in Fig. 4. This system is not only used for diodes but transistors and many other special semiconductor devices as well. As illustrated in this figure, the system uses numbers and letters to identify different types of semiconductor devices. The first number in the system indicates the number of junctions in the semiconductor device and is a number, one less than the number of active elements. Thus 1 designates a diode; 2 designates a transistor (which may be considered as made up of two diodes); and 3 designates a tetrode (a four-element transistor). The letter "N" following the first number indicates a semiconductor. The 2- or 3-digit number following the letter "N" is a serialized identification number. If needed, this number may contain a suffix letter after the last digit. For example, the suffix letter "M" may be used to describe matching pairs of separate semiconductor devices or the letter "R" may be used to indicate reverse polarity. Other letters are used to indicate modified versions of the device which can be substituted for the basic numbered unit. For example, a semiconductor diode designated as type 1N345A signifies a two-element diode (1) of semiconductor material (N) that is an improved version (A) of type 345.



X - NUMBER OF SEMICONDUCTOR JUNCTIONS
N - A SEMICONDUCTOR
YYY - IDENTIFICATION NUMBER (ORDER OR REGISTRATION NUMBER) ALSO INCLUDES SUFFIX LETTER (IF APPLICABLE) TO INDICATE

1. MATCHING DEVICES
2. REVERSE POLARITY
3. MODIFICATION

EXAMPLE - 1N345A (AN IMPROVED VERSION OF THE SEMICONDUCTOR DIODE TYPE 345)

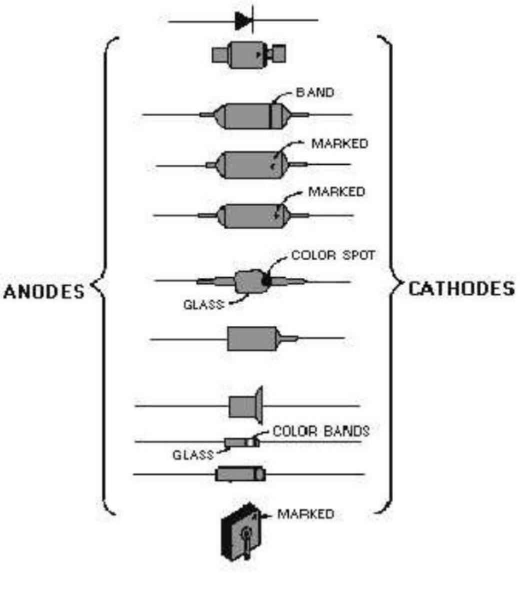


Fig. 4: Identification of Diode **Fig. 5: Identification of Cathode**

When working with different types of diodes, it is also necessary to distinguish one end of the diode from the other (anode from cathode). For this reason, manufacturers generally code the cathode end of the diode with a "k," "+," "Cath," a colour dot or band, or by an unusual shape (raised edge or taper) as shown in Fig. 5. In some cases, standard colour code bands are placed on the cathode end of the diode. This serves two purposes: (1) it identifies the cathode end of the diode, and (2) it also serves to identify the diode by number.

Transistors:

Transistors are identified by a Joint Army-Navy (JAN) designation printed directly on the case of the transistor. If in doubt about a transistor's markings, always replace a transistor with one having identical markings, or consult an equipment or transistor manual to ensure that an identical replacement or substitute is used.

Example:

2	N	130	A
NUMBER OF JUNCTIONS (TRANSISTOR)	SE MICONDUCTOR	IDENTIFICATION NUMBER	FIRST MODIFICATION

There are three main series of transistor codes used:

- **Codes beginning with B (or A), for example BC108, BC478**
  The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example C means low power audio frequency; D means high power audio frequency; F means low power high frequency. The rest of the code identifies the particular transistor. There is no obvious logic to the numbering system. Sometimes a letter is added to the end (eg. BC108C) to identify a special version of the main type, for example a higher current gain or a different case style. If a project specifies a higher gain version (BC108C) it must be used, but if the general code is given (BC108) any transistor with that code is suitable.
- **Codes beginning with TIP, for example TIP31A**
  TIP refers to the manufacturer: Texas Instruments Power transistor. The letter at the End identifies versions with different voltage ratings.
- **Codes beginning with 2N, for example 2N3053**
  The initial '2N' identifies the part as a transistor and the rest of the code identifies the particular transistor. There is no obvious logic to the numbering system.

TESTING A TRANSISTOR to determine if it is good or bad can be done with an ohmmeter or transistor tester. PRECAUTIONS should be taken when working with transistors since they are susceptible to damage by electrical overloads, heat, humidity, and radiation. TRANSISTOR LEAD IDENTIFICATION plays an important part in transistor maintenance because before a transistor can be tested or replaced, its leads must be identified. Since there is NO standard method of identifying transistor leads, check some typical lead identification schemes or a transistor manual before attempting to replace a transistor. Identification of leads for some common case styles is shown in Fig. 6.

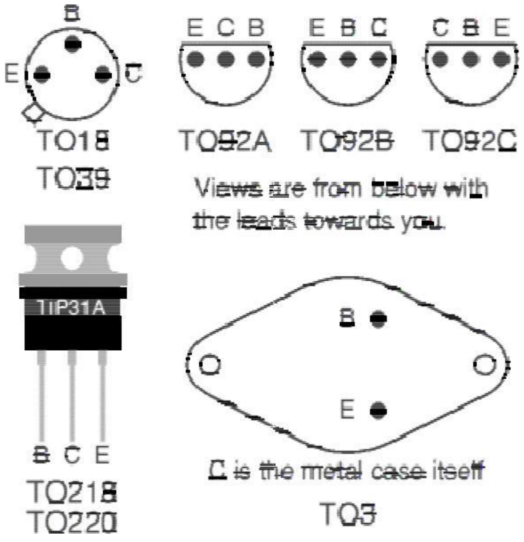


Fig. 6

Testing a transistor

Transistors are basically made up of two *Diodes* connected together back-to-back (Fig. 7). We can use this analogy to deter mine whether a transistor is of the type PNP or NPN by testing its Resistance between the three different leads, Emitter, Base and Collector.

Testing with a multimeter

Use a multimeter or a simple tester (battery, resistor and LED) to check each pair of leads for conduction. Set a digital multimeter to diode test and an analogue multimeter to a low resistance range.

Test each pair of leads both ways (six tests in total):

- The **base-emitter (BE)** junction should behave like a diode and conduct one way only.
- The **base-collector (BC)** junction should behave like a diode and conduct one way only.

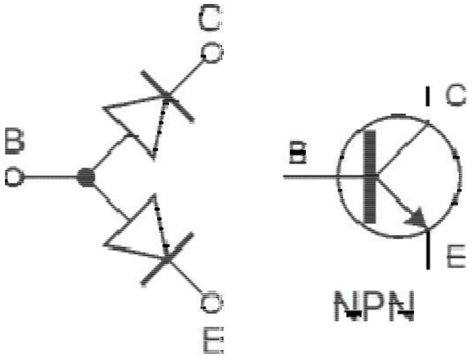


Fig. 7: Testing an NPN transistor

- The **collector-emitter (CE)** should not conduct either way.

The diagram shows how the junctions behave in an NPN transistor. The diodes are reversed in a PNP transistor but the same test procedure can be used.

Transistor Resistance Values for the PNP and NPN transistor types

Between Transistor Terminals		PNP	NPN
Collector	Emitter	RHIGH	R HIGH
Collector	Base	RLOW	R HIGH
Emitter	Collector	RHIGH	R HIGH
Emitter	Base	RLOW	R HIGH
Base	Collector	RHIGH	RLOW
Base	Emitter	RHIGH	RLOW

Experiment No. 2

AIM: Study of current, voltage and resistance measurement using of Multi-meter.

Equipment and components:

This experiment requires the use of the and Digital Multimeter (DMM), as well as a breadboard, and resistors with nominal values of 1.5 kΩ, 2.2 kΩ, 3.3 kΩ, and 4.7 kΩ.

Concepts: Current, voltage, Resistance and ohm's law.

DC (Direct Current) voltage and current do not vary with time. Voltage is an energy difference between two points. When a voltage source is included in a closed path with resistors, a circuit is completed, and current flows. Current is electron flow, or moving charge. When current flows across a resistor, which impedes current flow, voltage drop occurs across the resistor. This relationship between voltage (V), current (I), and resistance (R) is known as Ohm's Law:

$$V = IR \qquad (1)$$

Thus, if two of the above quantities are known, the third can be calculated.
In the experiment, you will use a multimeter to measure resistance, voltage, and current. The experimental results will then be compared against Ohm's Law.

Operation of Digital multimeter (DMM)

The multimeter you'll be using in this lab is the DMM, shown in Figure 2. A multimeter is a device used to take measurements of electrical quantities such as resistance, current, and voltage. DMM stands for **D**igital **M**ulti **M**eter.

To use the DMM as a voltmeter to measure voltage, insert a red wire in the jack labelled V and a black wire in the jack labelled COM. Set the meter knob to the voltage setting. Voltmeters have very high resistance that typically exceeds 1 MΩ, so when making voltage measurements, be sure the voltmeter is connected in parallel with the circuit component(s) across which voltage is measured. A common mistake is to connect the voltmeter in series with the circuit components. This error would add a 1MΩ series resistance to the circuit and drastically change the circuit parameters.

For use as an ammeter to measure current, insert a red wire in the 10 A max fused input, and black wire in the jack labelled COM. Turn the knob to measure current, and select a current range (mA or (A) dependent on the expected current measured. For this experiment the 20m range is the most appropriate. Ammeters have very low resistance that typically is less than 0.5 Ω. A common mistake is to connect the ammeter in parallel with the circuit components. This error would effectively cause a short circuit, altering the circuit parameters, and possibly damaging the ammeter. When making current measurements, make certain the ammeter is connected in series with the circuit components through which current is measured. **Never connect an ammeter directly across a power supply as it will cause a short circuit and will certainly damage the meter**.

Figure 2: Fluke Digital Multimeter shown in three different measurement configurations

Resistance Measurement:

Resistor values vary slightly from their nominal value. Since voltage and current are related to resistance, it’s a good idea to measure the actual resistance value so you know exactly what you’re working with. Manufacturers specify the percent error from which the actual value of a resistor can deviate from the nominal value. This quantity is called the tolerance. Your first task is to measure the resistance of the four resistors from the prelab and determine whether they fit within the manufacturer’s specified tolerance.

1. A gold band represents 5% tolerance, a silver band represents 10% tolerance, and no band represents 20% tolerance. Write the tolerance for each resistor in your data sheet.

2. Measure the resistance and enter the values in the data sheet. The resistor should not touch your fingers or be part of a circuit when you measure it. The resistor leads should only touch the DMM terminals.

Calculate and enter the percent error for each resistor using the following formula:

Percent Error = ((Nominal value– Measured value) / Nominal value) x 100% (2)

On the data sheet, state whether each resistor meets the manufacturer’s tolerance specifications.

3. On the data sheet, give the reason why your fingers can’t touch the resistor when measuring it.

Voltage and current measurement for single resistor circuit:

Our first circuit will be a simple series circuit in which the source voltage, V_s, the resistor voltage, V_{R1}, and their corresponding current will be measured. The current will then be checked using Ohm's Law. First assemble the circuit shown in Figure 5.

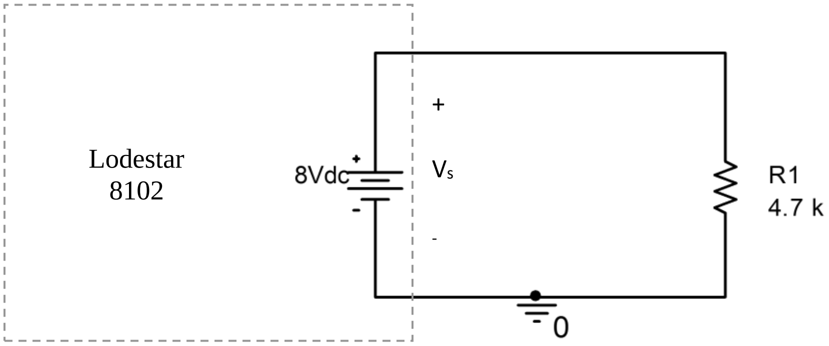
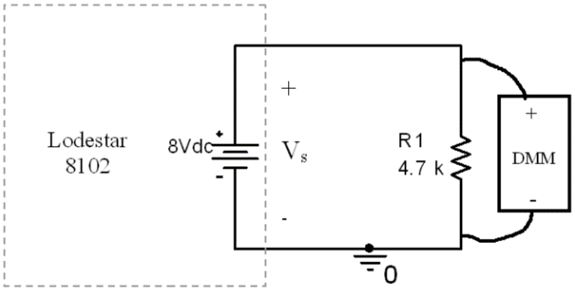


Figure 5: Series circuit for measurements

Use the DMM to make the following measurements and write the values in the data sheet.

1. For the circuit in Figure 5, use the DMM to measure V_s and write this value on the data sheet. This value is the source voltage. Since the meter on the power supply is difficult to read accurately, it is a good idea to always measure the source voltage so that you know the circuit input. If the voltage value was not exactly 8 V, use the FINE knob and the DMM to get as close to 8 V as possible.

2. Reconfigure the meter to measure voltage instead of resistance. Measure the voltage across the resistor, as shown in Figure 6. The multimeter should be in parallel with the resistor for use as a voltmeter. This is because the voltmeter has a very high input resistance, and current tends toward the path of least resistance, and ideally, we want all the current to pass through the resistor.



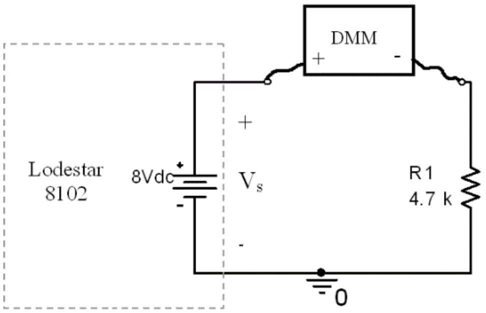


Figure 6: DMM in parallel to measure voltage **Figure 7: DMM in series to measure current**

3. Measure the current through the resistor as shown in Figure 7. Remember that the multimeter must be in series with the resistor to measure current, since ammeters (current meters) have low input resistance. We connect the DMM in series so that the current passing through the

meter and the resistor are the same. Placing the DMM in parallel would short the circuit. This could blow a fuse in the meter, and you'd wait around while someone fixes it.

4. Since the voltage source and resistor are the only circuit elements, all the voltage in the circuit is going across the one resistor. Given Ohm's Law in equation (1), use your measured values of voltage and current to calculate the resistance.

5. Measure the voltage across the resistor again, but disconnect one end of the resistor while still measuring the voltage. One end of the multimeter should be connected to the end of the resistor that's connected to the circuit, and the other end should be connected to the point on the circuit board where you disconnected the resistor. Enter the value in the data sheet. This value is known as the open-circuit voltage, V_{oc}.

6. Now do the same thing with current. Measure the current, and without changing anything else in the circuit, disconnect one side of the resistor. Write the value of the open-circuit current in the data sheet.

What you should observe from steps 5 and 6 is that current needs a closed electrical path to flow. In this sense, it can be thought of as analogous to water flowing through a pipe. Voltage, however, can exist in an open circuit, since it is an energy difference between two points. In this sense, you can think of voltage as the pressure in a water pipe that exists when the faucet is turned off.

7. Compare your measured and calculated values of I and include your observations in your answer to question 4 on your data sheet.

Resistance Measurement:

1. Colour codes, measurements, and percent error

Nominal Resistance (Ω)	Colour Code	Nominal Tolerance (%)	Measured Resistance (Ω)	Percent Error (%)	Within Manufacturer's Spec (y/n)
1500					
2200					
3300					
4700					

Voltage and current measurement for single resistor circuit:

2. Voltage and current values

V_S (V)	V_{R1} (V)	I_{R1} (mA)	V/I (Ω)	V_{OC} (V)	I_{OC} (mA)

Experiment No. 3

AIM: Study of Power and Energy measurement using Wattmeter and Energy meter.

MEASUREMENT IN A THREE PHASE AC CIRCUITS BY TWO -WATTMETERS

APPARATUS REQUIRED

Serial No.	Equipment	Specification	Quantity	Remark
1	Dynamometer type Watt meters	500V, 10A	2	
2	MI ammeters	0 –10A	1	
3	MI voltmeter	0-500V	1	
3	3-Phase Balanced load	440V, 50Hz	1	
4	TPIC switch		1	
5	Connecting Wires			

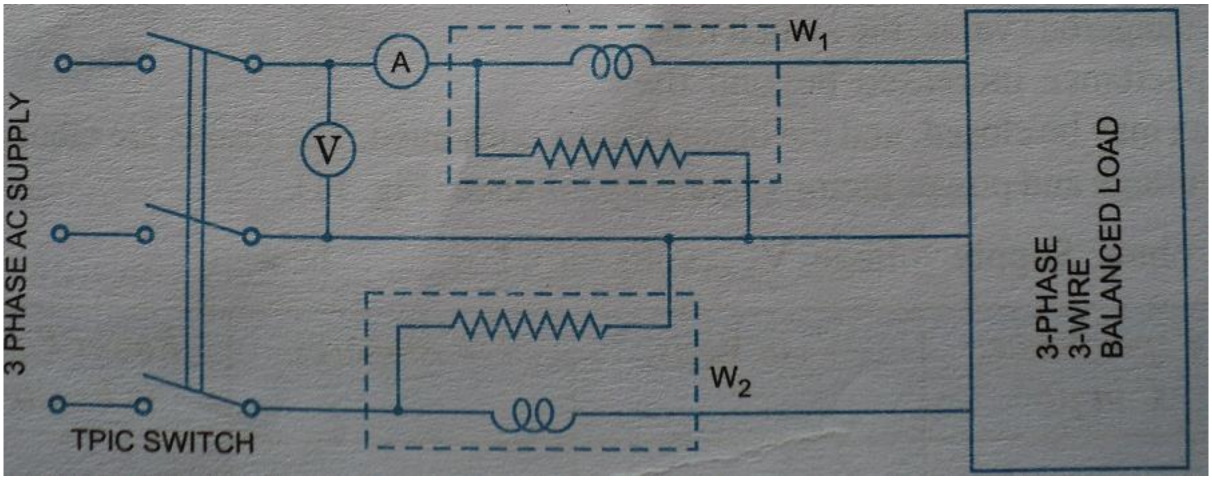
3.BRIEF THEORY: The connection diagram is shown in figure below. The sum of two wattmeter readings gives the total power of the circuit irrespective of the fact that the circuit is balanced or unbalanced and star-connected or delta-connected.

The total power is given as the sum of two wattmeter readings W_1 and W_2.

Total power of the load $P = W_1 + W_2$.

Power factor of the load, $\cos \phi = \cos \left(\tan^{-1} \sqrt{3}\, \frac{W_1 - W_2}{W_1 + W_2}\right)$

4.CIRCUIT DIAGRAM:



PROCEDURE: -

(i) Connect the circuit as per circuit diagram.
(ii) Vary the load.
(iii) Note down all the readings carefully in the observation table.
(iv) If one wattmeter reads negative or gives reverse readings, the readings of the wattmeter are taken by reversing the current coil terminal.

OBSERVATION TABLE:

S.No.	Voltage V_L (in volts)	Current IL (in amps.)	Power P_1 (watts)	Power P_2 (watts)	Total Power (P)	Power factor cosΦ

CALCULATIONS:

$$\text{Total power (P)} = P_1 + P_2$$

P = ……. watts

$$\text{Power factor} = \cos\phi = \cos\left(\tan^{-1}\sqrt{3}\,\frac{W_1 - W_2}{W_1 + W_2}\right)$$

RESULT AND DISCUSSION: The sum of two wattmeter readings gives the total power of the circuit no matter whether the circuit is balanced or unbalanced and star-connected or delta-connected. Power consumed and power factor at various loads is shown in the observation table.

MEASURE ENERGY BY A SINGLE-PHASE ENERGY METER

APPARATUS REQUIRED:

Serial No.	Equipment	Specification	Quantity	Remark
1	Energy Meter	5 A,240 V	1	
2	MI voltmeter	0-300V	1	
3	MI ammeter	0-5 A	1	
4	Dynamometer Type wattmeter	5 A,240 V	1	
5	Auto-transformer or Variac	0- 300 V	1	
6	Lamp load			
7	Spot watch			
8	DPIC switch		1	
9	Connecting leads			

BRIEF THEORY:

Energy meter is an integrating instrument which is used to record the energy consumed by the load during a given time period. 1- Phase Induction type energy meter, as shown in figure 1, is the most common form of AC KWH meters used every day in domestic and industrial installations. These meters measure electrical energy in Kilo-watt hours. The principle of this meter is practically the same as that of the induction wattmeter.

There are four parts of the energy meter:

(i) **Driving System:**

The driving system of the energy meter consists of two silicon steel laminated electromagnet M1 & M2.M1 is called as a series magnet and M2 is called as a shunt magnet. M1 is called current coil connected in series with the circuit. M2 is called as a voltage coil and is connected across the supply.

Short-circuited copper shading bands are provided on the lower part of the central limb of the shunt magnet. These loops are called power factor compensators. by adjusting the position of these poles, the shunt magnet flux can be made to lag behind the voltage by 90 degree, the function of upper band is to provide fractional compensation.

(ii) **Moving System:**

This system consists of a thin aluminium disc mounted on a spindle. The disc is placed in the air gap between the series & shunt magnets so that it cuts the fluxes of both the magnets. A deflecting torque is produced by the flux of earth magnet with eddy current induced in the disc by the flux of another magnet.

Braking System:

It consists of a permanent magnet known as brake magnet. it is placed near the edger of the aluminium disc. When the disc rotates in the field of the brake magnet, eddy currents react with the flux and exert a braking or retarding torque and this is proportional to the speed of the disc. The amount of this torque can be adjusted by adjusting the position of the brake magnet. In some brake magnets are placed diagonally.

(iv) Registering System:

The disc spindle is connected through a set of gears to a counting mechanism and records a number, which is proportional to the number of revolutions of the disc and indicates the energy consumed directly in KWh.

The data mentioned on the name plate of the energy meter are as follows:

No of phases: single

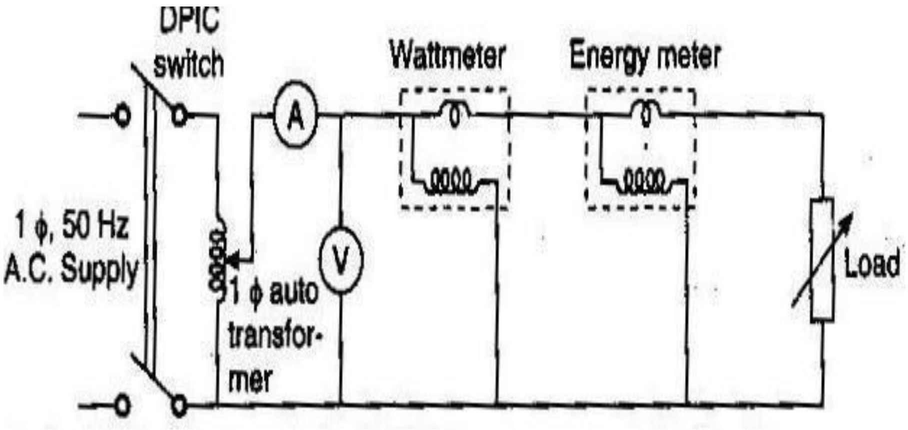
Volts: 230/240/250 V

Frequency: 50 Hz

Current rating: 5/10/25 A

Energy meter constant: ……revolution/kWh

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit according to circuit diagram.
2. Apply the rated voltage by auto transformer at no load.
3. The current coil of energy meter is connected in series with load, while the pressure coils across the supply.
4. Connect the variable resistor or lamp load between phase and neutral. Note the readings of all meters.
5. Note down the time for particular revolution of disc of energy meter.

Experiment No. 4

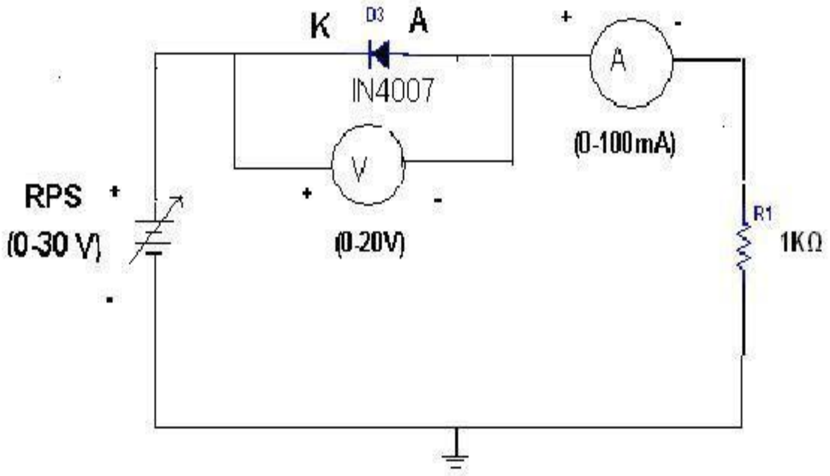
AIM: To plot the characteristics curve of PN junction diode in Forward & Reverse bias.

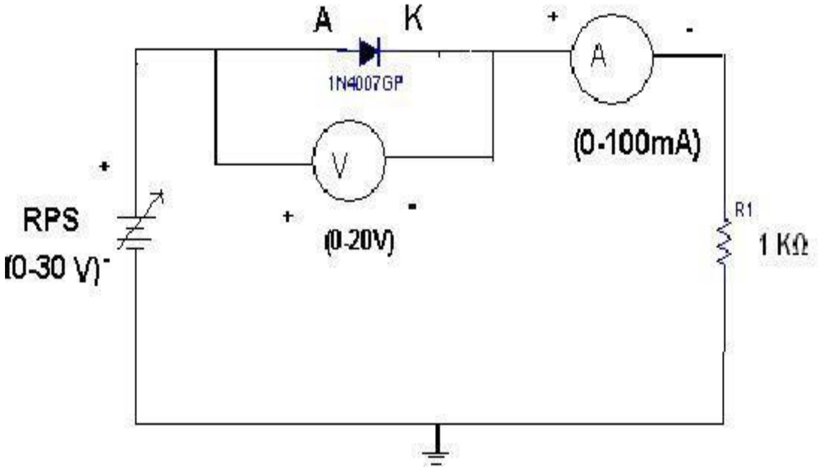
Apparatus Required:

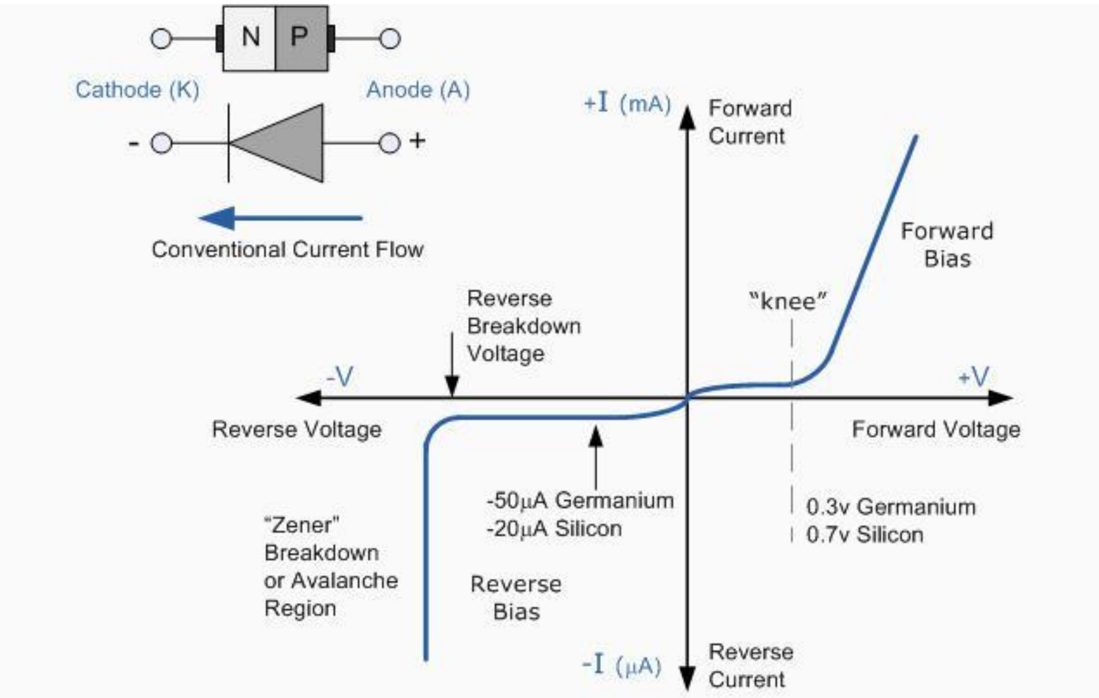
S.No.	Apparatus	Specification	Required No.
1.	Bread Board	6*2 inch	01
2.	Voltmeter	0-10 volt D.C.	01
3.	Ammeter	0-100 mA.	01
4.	DC power supply	0-10 Volt	01
5.	Connection Wire	single wire	08-10

CIRCUIT DIAGRAM: -

REVERSE BIAS & FORWARD BIAS:







The Basic Diode Symbol and Static V-I Characteristics.

Theory: -

This is a two terminal device consisting of a P-N junction formed either in Ge or Si crystal. A P-N junction is illustrated in fig. shows P-type and N-type semiconductor pieces before they are joined.

P-type material has a high concentration of holes and N-type material has a high concentration of free electrons and hence there is a tendency of holes to diffuse over to N side and electrons to P-side. The process is known as diffusion.

Volt-Ampere Characteristics Of P-N Junction: - Fig. shows the circuit arrangement for drawing the volt-ampere characteristics of a P-N junction diode. When no external voltage is applied the circuit current is zero. The characteristics are studied under the following two heads:

(i) Forward bias (ii) Reverse bias

(i)Forward bias: - For the forward bias of a P-N junction, P-type is connected to the positive terminal while the N-type is connected to the negative terminal of a battery. The potential at P-N junction can be varied with the help of potential divider. At some forward voltage (0.3 V for Ge and 0.7V for Si) the potential barrier is altogether eliminated and current starts flowing. This voltage is known as threshold voltage (Vth) or cut in voltage or knee voltage. It is practically same as barrier voltage V_B. For $V<V_{th}$, the current flow is negligible. As the forward applied voltage increases beyond threshold voltage, the forward current rises exponentially.

(ii)Reverse bias: - For the reverse bias of p-n junction, P-type is connected to the negative terminal while N-type is connected to the positive terminal of a battery.

Under normal reverse voltage, a very little reverse current flows through a P-N junction. But when the reverse voltage is increased, a point is reached when the junction break down with sudden rise in reverse current. The critical value of the voltage is known as break down (VBR). The break down voltage is defined as the reverse voltage at which P-N junction breakdown with sudden rise in reverse current.

Observation Table

Forward Bias-

S.No.	Forward voltage V_f (volt)	Forward Current I_f(mA)

Reverse Bias-

S.No	Forward voltage V_f (volt)	**Forward Current I_f(µA)**

Result:

The V-I characteristics of junction diode in forward and reverse bias condition has been be plotted on the graph

Experiment No.5

AIM: - **To plot the characteristics of a Zener Diode**.

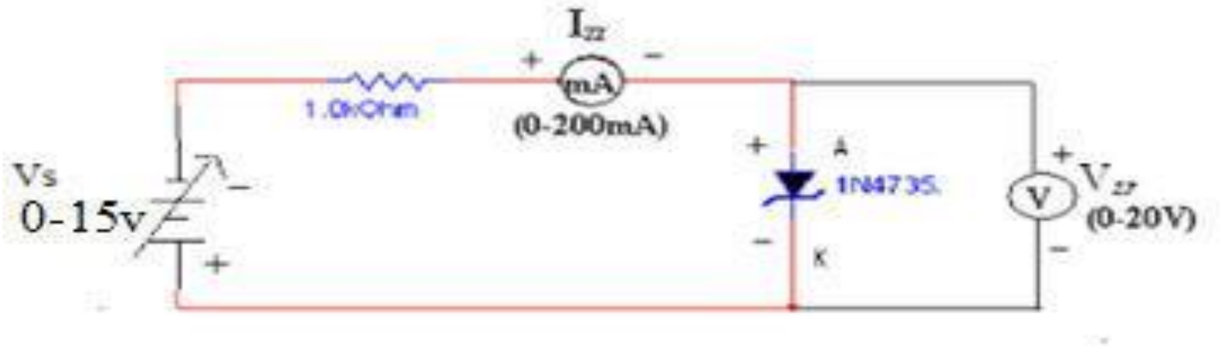
Apparatus Required: -Training kit, Connecting Wires, Multimeter.

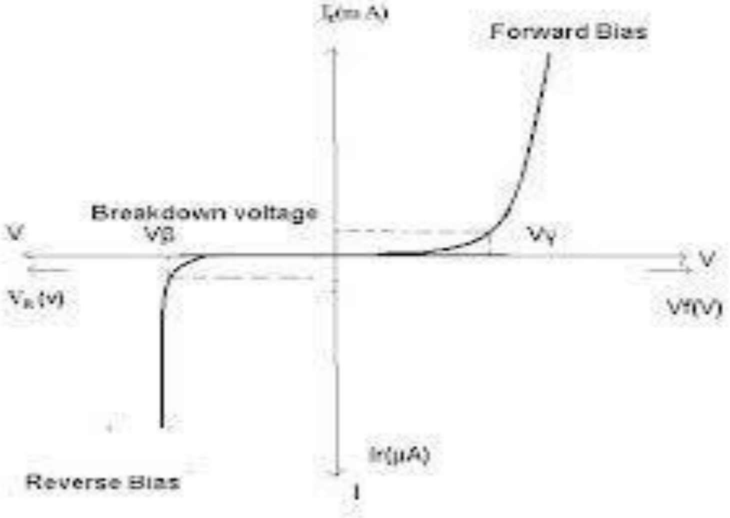
Theory: -

Special diodes are constructed which can operate at voltage that equal or exceed their breakdown voltage rating. These special diode are commonly referred to as zener diode. The overall forward and reverse characteristics of the zener diode are similar to those of an ordinary junction diode. The primary difference is simple that the zener diode is specifically designed to operate with a reverse bias voltage that is high enough to

Cause the device to breakdown and conduct a high reverse current. Then the reverse current through the diode increases at an extremely rapid rate as the reverse voltage increases beyond the breakdown point.

The V-I curve therefore shows that beyond the breakdown point, a very large change in reverse current is accompanied by only a very small change in reverse voltage. This action occurs because the resistance of the diode drops considerably as its reverse voltage is increased beyond the breakpoint. Once the breakdown point is exceeded the diode is said to be operating in its zener breakdown region or simply its zener region.





VOLTAGE REGULATION WITH ZENER DIODE:-

Although the zener diode may be used to perform a number of important functions it is perhaps most widely used in applications where it is continually reverse biased so that it operates constantly within its zener breakdown region. Under these conditions, the zener diode so effectively used to provide voltage stabilization or regulation.

Procedure: -

1. Construct the circuit as shown in fig. using take 1K ohm potentiometer on your
1. Experimenter, a 470 ohm resistor and the zener diode. Figure shows one-way you can write the circuit.
2. Power supply voltage (approx.15 V.D.C.) will be applied to the 1K ohm potentiometer (designated as R1) to control the voltage applied to the zener diode (D1) and its series 470 ohm resistor (R2). Observe the polarity of the voltage applied to D1. Is D1 forward or reverse biased?
3. Turn the 1K potentiometer R fully counter clockwise, and then turn on your experimenter.
4. Connect voltmeter across D1 as indicated in fig. then turn R1 slowly clockwise and observe the increase in voltage across D1 as indicated on your meter. Continue turning R1 until the voltage across D1 stops increasing at a rapid rate and effectively remains constant. At this point stop turning D1 and as accurately as you can measure the voltage acrossD1. Record this voltage in the DIODE VOLTAGE column (upper space).
5. Next use voltmeter to measure the voltage across R2. Then use the voltage across R2 and the resistance of R2 (470 ohms) to calculate the current flowing in the circuit according to ohms law (I=E/R). Your calculated value of current represent the amount of

current that is now flowing through resister R2 and diode D1. Record this current in the diode current column (upper space).

6. Measure the input voltage Vin between potentiometer terminal 1 and 2 indicated in fig. Record your value in the INPUT VOLTAGE column (upper space) of the table. Now you will make several voltage measurements, which must be performed quickly to avoid overheating the diode. First measure the voltage across D1 as you turn potentiometer D1 fully clockwise. Note the voltage across D1 with R1 fully clockwise and record this voltage in the DIODE VILTAGE column (lower space).Next measure the input voltage and record this value in fig. Then measure the voltage across R2. The voltage across R2 is now equal to ------- volts. Now turn off your experiment.
7. Use the voltage across R2 (recorded above) and the resistance of R2 to calculate the current flowing through R2 according to ohms law. This calculated value of current represents the current that flows through R2 and D1. Record this current in the DIODE CURRENT column (lower space).
8. Reverse the diode leads and turn R1 fully counter clockwise. Then turn on the experimenter. Connect your voltmeter between terminal 1 and 2 of potentiometer R1 and adjust the input voltage Vine to 5 volts.
9. Measure the voltage across the diode with your voltmeter. The diode voltage now equal to ---------- volts. Is the diode forward or reverse biased?
10. You will now use your experimental circuit to supply a regulated output voltage of 5.1 volts to various resistive loads. When a load resistor is connected across the sneer diode, the circuit effectively becomes a simple voltage regulator circuit. This circuit is capable of operating with input voltage between 9 and 12 volts and output load currents between 0 and 30 mill amperes. You will now test this circuit by setting the input voltage to its lower limit of 9 volts and observing the regulated output voltage for various load currents. Reverse the diode leads to return the circuit to its original condition.
11. Insure that the +ve voltage control is turned fully clockwise. Then turn on your experimenter. Next connect your voltmeter between the arm of the potentiometer and the anode D1 (across R2 and D1) and adjust the 1K ohms potentiometer R1 until the meter indicates that the voltage applied to R1 and D1 is equal to 9 volts.
12. With no load resistor connected across diode D1 (no load current) use your voltmeter to measure the voltage across D1. Record the indicated voltage in the OUTPUT VOLTAGE column of the table.
13. Now connect a 1K ohm resistor across diode D1. This resistor will serve as a load and will draw a load current of approximately 5 mill amperes at the rated output voltage of 5.1 volts. Measure the output voltage across D1 at this time and record the indicated voltage in the appropriate space in the OUTPUT VOLTAGE column.
14. Now repeat step 14 using load resistor with values of 470,220 and 47 ohm. These resistors will draw load currents of approximately 11, 23 and 108 mill amperes respectively. Assuming the output voltage remains at 5.1 volts. After you connect each load resistor across D1 and measure the voltage across D1, record the indicated voltage.

Then turn off your experimenter and explain any unusual variations in output voltage noted.

Observation Table:-

INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT

Results: -

The V-I characteristics of zener diode has been studied and graph is plotted.

Precautions:-

1. Patch cords should be properly connected.
2. Power supply should be on after completed the connections.

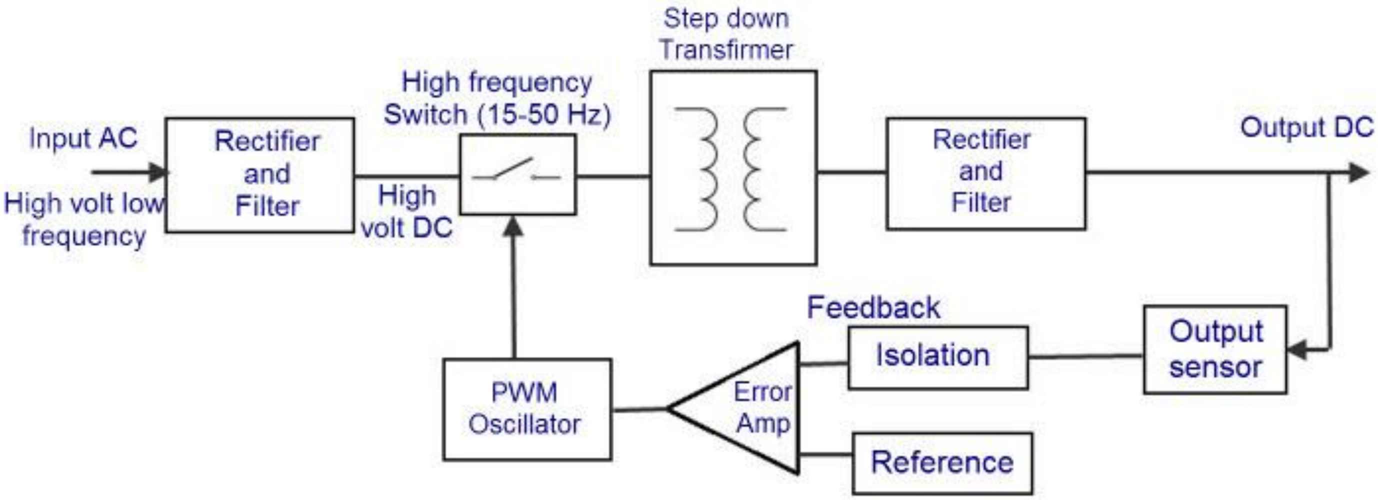
EXPERIMENT NO.-6

AIM:- To Study Circuit of a SMPS.

Apparatus Required:-

1. FILTER.
2. RECTIFIER
3. REGULATOR
4. CHOPPER(DC TO DC CONVERTER)

CIRCUIT DIAGRAM:-



THEORY:-

SMPS stands for switch mode PSU. In such a supply, power handling electronic components are continuously switching "on" and "off" with high frequency in order to provide the transfer of electric energy via energy storage components (inductors and capacitors). By varying duty cycle, frequency or a relative phase of these transitions an average value of output voltage or current is controlled. The operating frequency range of a commercial SMPS units varies typically from 50 kHz to several MHz. Below is a circuit diagram of a typical off-line SMPS.

WORKING OPERATION:-

AC power provided via the input connector, first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s).

Note that except for ATX computer power supplies and CompactPCI systems, output connectors and pinouts in general are not standardized and are left up to the manufacturers.

F1 and F2 shown on the left of the circuit diagram are fuses. Their main purpose is to protect the line from overloading and overheating, prevent tripping of an external circuit breaker, and prevent a fire that may be triggered by components that failed into a short circuit.The low-pass EMI filter is designed to reduce high frequency currents getting into the AC line to an acceptable level. This is necessary to prevent interference on the other devices connected to the same electrical wiring.

The filter is followed by the rectifier- a circuit that converts bipolar AC waveforms to unipolar pulsating ones. It has four diodes in a bridge arrangement to provide the same polarity of the output voltage for both polarities of the input.

The rectified input voltage is fed into the next stage, whose prime purpose is to increase power factor (PF). There are various **regulations** that limit the input current harmonic content. The DC-DC converter runs off the PFC output, generates a set of DC busses required for the load, and normally also provides input-to-output isolation. Finally, the housekeeping supply provides bias for all control circuitry. It may also provide a separate stand-by voltage (SBV) which remains active when the PS unit is shut down for any reason. In today's computer power supply a 5VDC SBV is a standard feature.

Experiment No. 7

AIM:-To draw the wave shape of electrical signals at input and output of Half Wave Rectifier

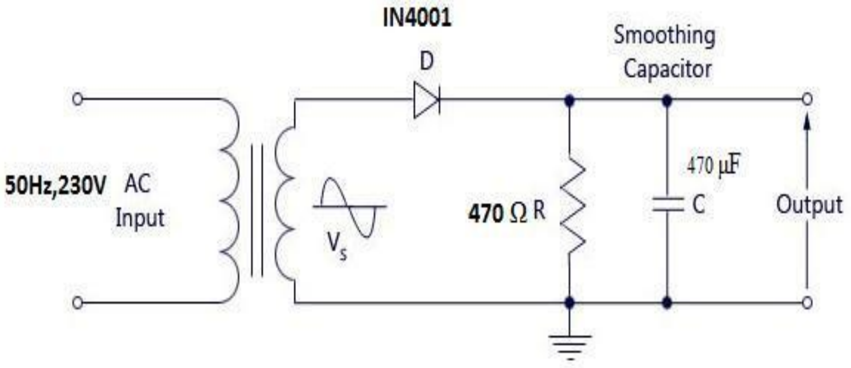
Apparatus Required:-

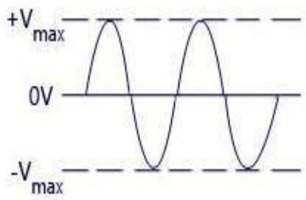
- Transformer
- Diodes
- Capacitors
- Resistors
- CRO (Cathode Ray Oscilloscope)
- Connecting Wire

Theory:- A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non-zero average component is called a rectifier. A practical half wave rectifier with a resistive load is shown in the circuit diagram. In positive half cycle, Diode D is forward biased and conducts. Thus the output voltage is same as the input voltage. In the negative half cycle, Diode D is reverse biased, and therefore output voltage is zero. A smoothing filter is induced between the rectifier and load in order to attenuate the ripple component. The filter is simply a capacitor connected from the rectifier output to ground. The capacitor quickly charges at the beginning of a cycle and slowly discharges through R_L after the positive peak of the input voltage. The variation in the capacitor voltage due to charging and discharging is called ripple voltage. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

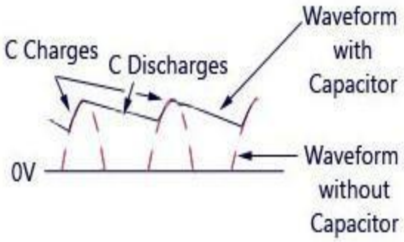
Ripple factor is a measure of effectiveness of a rectifier circuit and defined as a ratio of RMS value of ac component to the dc component in the rectifier output.

Circuit Diagram of Half Wave Rectifier





AC Input Waveform



Resultant Output Waveform

Characteristics of Half Wave Rectifier:

1. The output current in the load contains, in addition to dc component, ac components of basic frequency equal to that of the input voltage frequency. Ripple factor is high and an elaborate filtering is, therefore, required to give steady dc output.
2. The power output and, therefore, rectification efficiency is quite low. This is due to the fact that power is delivered only during one half cycle of the input alternating voltage.
3. Transformer utilization factor is low.
4. DC saturation of transformer core resulting in magnetizing current and hysteresis losses and generation of harmonics.

Procedure:-

1. Connections are given as per the circuit diagram without capacitor.
2. Apply AC main voltage to the primary of the transformer. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.
3. Now connect the capacitor in parallel with load resistor and note down the amplitude and time period of the waveform.

4. Measure the amplitude and time period of the transformer secondary (input waveform) by connecting CRO.
5. Plot the input, output without filter and with filter waveform on a graph sheet.

Result: The Rectified output Voltage of Half Wave Rectifier Circuit is observed

Experiment No.8

AIM:- To draw the wave shape of electrical signals at input and output of Full Wave Rectifier

Apparatus Required:-

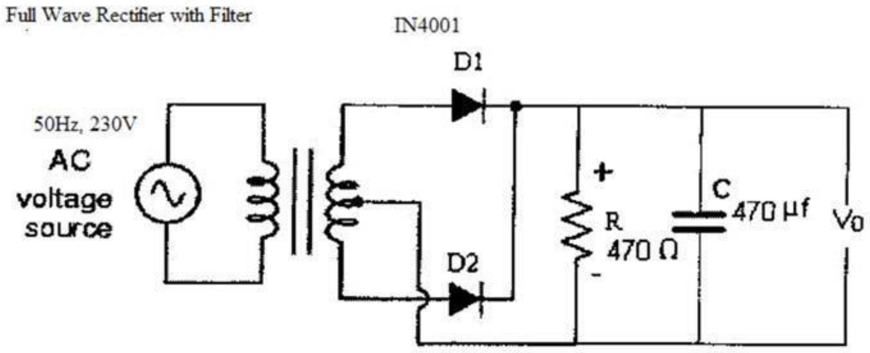
- Transformer
- Diodes
- Capacitors
- Resistors
- CRO (Cathode Ray Oscilloscope)
- Connecting Wire

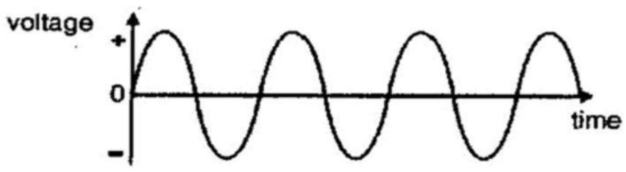
Theory:- A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non-zero average component is called a rectifier.

A practical half wave rectifier with a resistive load is shown in the circuit diagram. It consists of two half wave rectifiers connected to a common load. One rectifies during positive half cycle of the input and the other rectifying the negative half cycle. The transformer supplies the two diodes (D1 and D2) with sinusoidal input voltages that are equal in magnitude but opposite in phase. During input positive half cycle, diode D1 is ON and diode D2 is OFF. During negative half cycle D1 is OFF and diode D2 is ON. Peak Inverse Voltage (PIV) is the maximum voltage that has to be withstand by a diode when it is reverse biased. Peak inverse voltage for Full Wave Rectifier is $2V_m$ because the entire secondary voltage appears across the non-conducting diode.

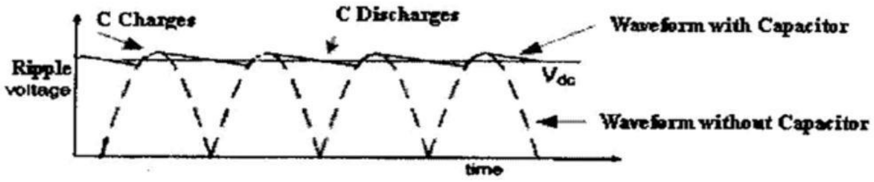
The output of the Full Wave Rectifier contains both ac and dc components. A majority of the applications, which cannot tolerate a high value ripple, necessitates further processing of the rectified output. The undesirable ac components i.e. the ripple, can be minimized using filters.

Circuit Diagram of Full Wave Rectifier:





Input Waveform



Resultant Output Waveform

Characteristics of Full Wave Rectifier:

1. The peak voltage in the full-wave rectifier is only half the peak voltage in the half-wave rectifier. This is because the secondary of the power transformer in the full-wave rectifier is centre tapped; therefore, only half the source voltage goes to each diode.
2. A larger transformer for a given power output is required with two separate but identical secondary windings making this type of full wave rectifying circuit costly compared to the “Full Wave Bridge Rectifier” circuit equivalent

Procedure:

1. Connections are given as per the circuit diagram without capacitor.
2. Apply AC main voltage to the primary of the transformer. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.
3. Now connect the capacitor in parallel with load resistor and note down the amplitude and time period of the waveform.
4. Measure the amplitude and time period of the transformer secondary (input waveform) by connecting CRO.
5. Plot the input, output without filter and with filter waveform on a graph sheet.

Result:

The Rectified output Voltage of Full Wave Rectifier Circuit is observed.