EXPERIMENT No.1

OBJECTIVE: Identification of various electronics, electrical components and study of measuring instruments and sources used in electronic circuits.

(i) CRO (ii) Function Generator (iii) Multi-meter (iv) DC Supply

APPARATUS & MATERIAL REQUIRED:- Cathode-ray Oscilloscope, Function Generator, BNC to BNC co-axial cable, CRO Probes, multi-meter and dc power supply .

THEORY:

1. Cathode-Ray Oscilloscope: The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability, and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode-ray tube shown schematically in Fig. 1.

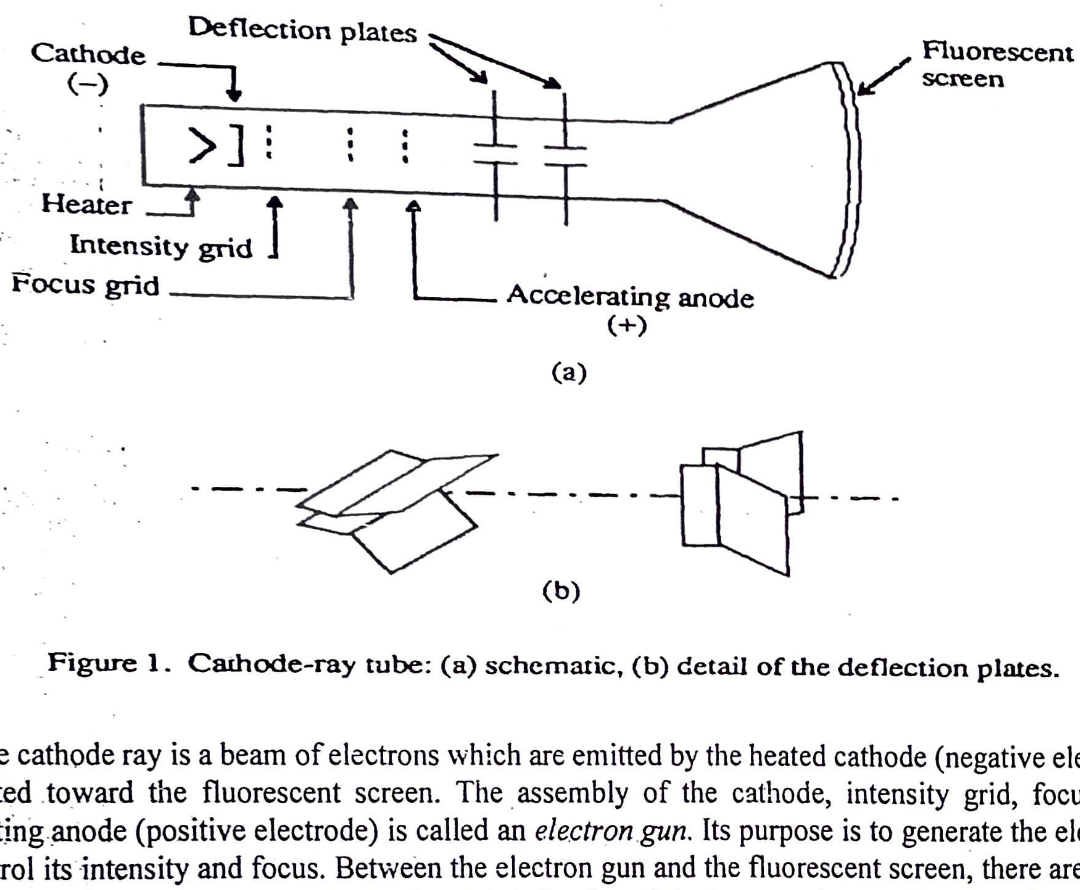


Figure 1. Cathode-ray tube: (a) schematic, (b) detail of the deflection plates.

The cathode ray is a beam of electrons which are emitted by the heated cathode (negative electrode) and accelerated toward the fluorescent screen. The assembly of the cathode, intensity grid, focus grid, and accelerating anode (positive electrode) is called an *electron gun*. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen, there are two pair of metal plates - one oriented to provide horizontal deflection of the beam and one pair oriented to give vertical deflection to the beam. These plates are thus referred to as the *horizontal* and *vertical deflection plates*. The combination of these two deflections allows the beam to reach any portion of the fluorescent screen. Wherever the electron beam hits the screen, the *phosphor* is excited and light is emitted from that point. This conversion of electron energy into light allows us to write with points or lines of light on an otherwise darkened screen.

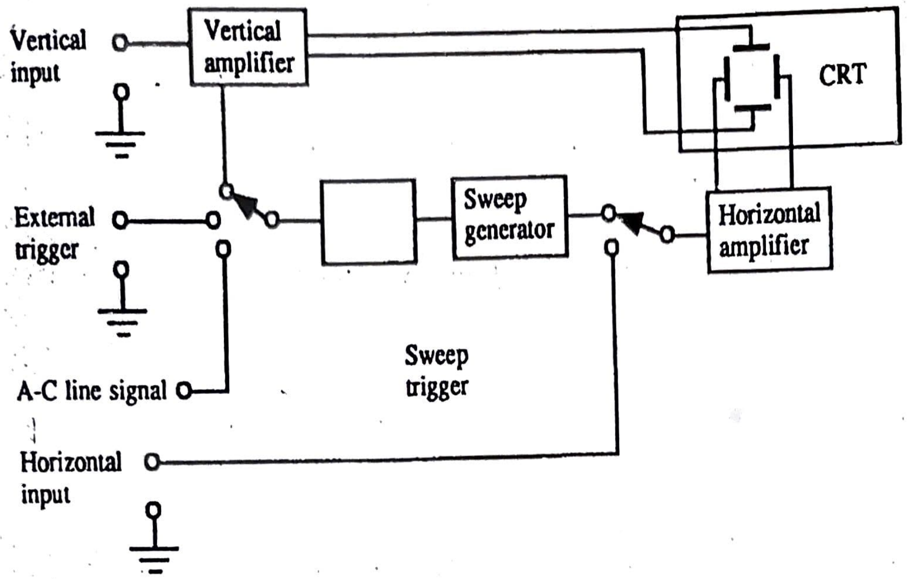


Figure 3. Block diagram of a typical oscilloscope.

CRO Controls:

The controls available on most oscilloscopes provide a wide range of operating conditions and thus make the instrument especially versatile.

1. On–off switch.
2. INTENSITY. This is the intensity control connected to the grid G to control the beam intensity and hence the brightness of the screen spot.
3. AMPL/DIV. is a control of the Y (i.e. vertical) amplitude of the signal on the screen. (There is one of these for each channel).
4. AC/DC switch. This should be left in the DC position unless you cannot get a signal on-screen otherwise. (There is one of these for each channel).
5. ALT/CHOP/ADD switch. This is used to display both input channels separately or to combine them into one.
6. +/- Switch. This is used to invert the B channel on the display.
7. X POSITION: This is used to adjust the horizontal position of the signals on the screen.
8. LEVEL: This is used to determine the trigger level; i.e. the point of the waveform at which the ramp voltage will begin in time-base mode.
9. X5- Switch when pressed inward gives 5 times magnitude of signal.
10. Time/Div:This selector controls the frequency at which the beam sweeps horizontally across the screen in time-base mode, as well as whether the oscilloscope is in time-base mode or XY mode. This switch has the following positions:
11. (a) X VIA A In this position, an external signal connected to input A is used in place of the internally generated ramp. (This is also known as XY mode.)

(b) .5, 1, 2, 5, etc. Here the internally generated ramp voltage will repeat such that each large (cm) horizontal division corresponds to .5, 1, 2, 5, etc. ms. or μs depending on the multiplier and magnitude settings.

12. CH-I/CH-II, TRIG-I/ TRIG-II: When out, select and trigger CH-I and when pressed, select and trigger CH-II

CATHODE-RAY TUBE:

Power ON/OFF: Push button switch for supplying power to instrument.

Focus: Focus the spot or trace on the screen. It control sharpness of trace.

Intensity: Regulates the brightness of the spot or trace.

VERTICAL AMPLIFIER SECTION

Position: Controls vertical positioning of oscilloscope display.

Sensitivity: Selects the sensitivity of the vertical amplifier in calibrated steps.

Variable Sensitivity: Provides a continuous range of sensitivities between the calibrated steps. Normally the sensitivity is calibrated only when the variable knob is in the fully clockwise position.

AC-DC-GND: Selects desired coupling (ac or dc) for incoming signal applied to vertical amplifier, or grounds the amplifier input. Selecting dc couples the input directly to the amplifier; selecting ac send the signal through a capacitor before going to the amplifier thus blocking any constant component.

HORIZONTAL-SWEEP SECTION

Sweep time/cm: Selects desired sweep rate from calibrated steps or admits external signal to horizontal amplifier.

Sweep time/cm Variable: Provides continuously variable sweep rates. Calibrated position is fully clockwise.

Position: Controls horizontal position of trace on screen.

Horizontal Variable: Controls the attenuation (reduction) of signal applied to horizontal amplifier through Ext. Horiz. Connector.

TRIGGER

The trigger selects the timing of the beginning of the horizontal sweep.

Slope: Selects whether triggering occurs on an increasing (+) or decreasing (-) portion of trigger signal.

Coupling: Selects whether triggering occurs at a specific dc or ac level.

Source: Selects the source of the triggering signal.

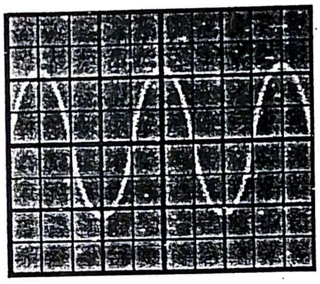
INT - (internal) - from signal on vertical amplifier
EXT -(external) -from an external signal inserted at the EXT.TRIG. I/P
LINE - 60 cycle trigger

Level: Selects the voltage point on the triggering signal at which sweep is triggered. It also allows automatic (auto) triggering of allows sweep to run free (free run).

1. Voltage Measurement-

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.



Y AMPLIFIER: 2V/cm
TIMEBASE: 5ms/cm

Example measurements:

peak-peak voltage = 8.4V
amplitude voltage = 4.2V

time period = 20ms
frequency = 50Hz

Voltage = distance in cm × volts/cm
Example: peak-peak voltage = 4.2cm × 2V/cm = 8.4V
amplitude (peak voltage) = ½ × peak-peak voltage = 4.2V

2. Time period/ Frequency Measurement-

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 cycles per second, *frequency = 1/time period*

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

Time = distance in cm × time/cm
Example: time period = 4.0cm × 5ms/cm = 20ms
and frequency $= {}^{1}/_{time\ period} = {}^{1}/_{20ms} = 50Hz$

OBSERVATION TABLE:

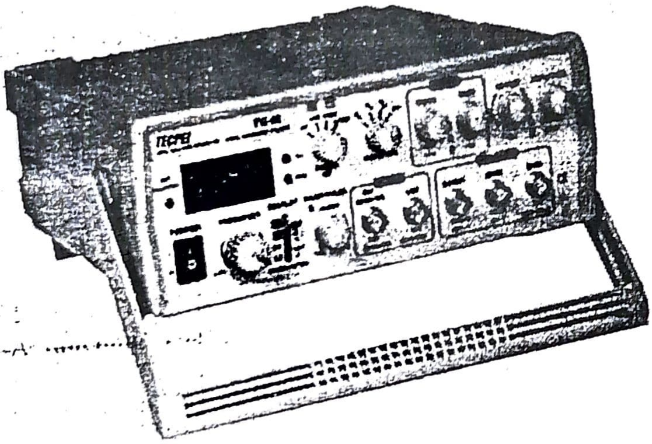
S.No.	*Input Frequency*	*Input Amplitude*	*Calculated Frequency*	*% error*
1				
2				

RESULT – Operating Principle and application of CRO have been studied.

2. FUNCTION GENERATOR

A **function generator** is a piece of electronic test equipment or software used to generate electrical waveforms. These waveforms can be either repetitive, or single-shot in which case some kind of triggering source is required (internal or external).

Another type of function generator is a sub-system that provides an output proportional to some mathematical function of its input; for example, the output may be proportional to the square root of the input.



Analog function generators usually generate a triangle waveform as the basis for all of its other outputs. The triangle 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.

Most function generators also contain a non-linear diode shaping circuit that can convert the triangle wave into a reasonably accurate sine wave. It does so by rounding off the hard 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 and uses a BNC connector, usually requiring a 50 or 75 ohm termination. Specialized RF generators are capable of gigahertz frequencies and typically use N-type output connectors.
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.

CONTROLS AND INDICATORS:

1. **POWER SWITCH**- Push the switch "ON" will light the LED to indicate power "ON".

2. **FREQUENCY CONTROL KNOB** – Used to adjust the required frequency for selected range with the multiplication factor of 0.04 to 4.0.
3. **SYNC OUTPUT** – The TTL level square signal Output synchronous with frequency of Main Output.
4. **SWEEP OUTPUT**- Sweep signal is available regardless of position of SWEEP ON switch provided with Sweep Rate Knob.
5. **MAIN OUTPUT** – Function Output signal provides normal mode or sweep mode output depending on mode selected. The maximum Output impedance is 50Ω.
6. **AMPLITUDE KNOB**- The amplitude of signal can be adjusted from 0.1Vp-p to 20Vp-p at No Load. Pull the Knob to attenuate the signal 10 times.
7. **DC OFFSET**- This Knob can apply a DC Offset to Main Signal. Turn the Knob clockwise for Positive Offset and anti-clockwise for Negative Offset.
8. **SWEEP RATE** –This Knob is used to adjust the sweep rate from 5 seconds to 25 milliseconds. Also if this Knob is pulled, then Sweep mode operation will be ON.
9. **SWEEP WIDTH** –This Knob is used to adjust the Sweep Width. When the knob is in "Push" condition, a Linear Sweep Output will be available and When Knob is in "Pull" condition, then LOG Sweep Output will be available.
10. **FUNCTION SELECTOR SWITCH** – A rotary Switch for waveform selection.
11. **FREQUENCY RANGE SELECTOR SWITCH** – A rotary Switch to select the range from 10Hz to 1MHz in 6 steps.
12. **COUPLING SWITCH** – It is three way switch to select Internal / External High Frequency / External Low Frequency mode.
13. **CMOS ADJUST KNOB** – For adjusting the CMOS level of SYNC Output while in CMOS mode. Pull the Knob for CMOS ON.
14. **EXTERNAL INPUT BNC** – Connector for counting external signal frequency.
15. **VCF INPUT BNC** – For connecting external DC or AC signal from 0 to 10V to achieve voltage controlled frequency output.

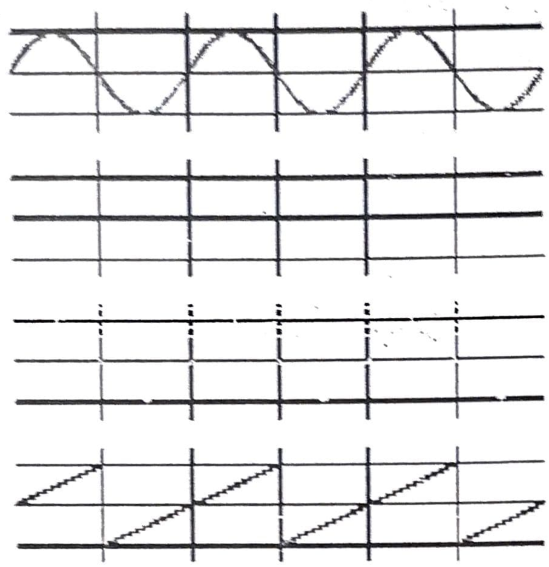
FUNCTION GENERATOR OUTPUT:

1. Select the type of waveform required by rotary switch of FUNCTION.
2. Select the Range of frequency by rotary switch of RANGE.
3. Connect Main Output signal to Channel 1 of oscilloscope and Sync Output signal to Channel 2 of oscilloscope. Set the trigger source of oscilloscope at Channel 2.
4. Set the frequency of the signal by adjustment knob. The display shows the frequency reading of signal.
5. Adjust the amplitude of the signal Amplitude knob. Pull the knob if the signal is to be attenuated 10 times.
6. Set the DC Offset of signal by OFFSET knob to required level (-10V to +10V).
7. Check the impedance of the load before connecting (50W max.).

PRECAUTIONS:

1. Before switching ON the device be familiar with its control knobs.
2. Operate control knobs smoothly.

3. Ensure position of calibrated/variable control knob at calibrated position.



SINUSOIDAL WAVE

RECTANGULAR WAVEFORM

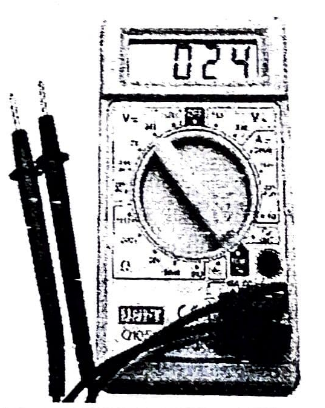
TRIANGULAR

RAMP WAVEFORM

OUTPUT WAVEFORMS ON CRO

Multimeter

A **multimeter** or a **multitester**, also known as a **VOM** (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter may include features such as the ability to measure voltage, current and resistance. Multimeters may use analog or digital circuits—**analog multimeters** (AMM) and **digital multimeters** (often abbreviated **DMM** or **DVOM.)** Analog instruments are usually based on a micro ammeter whose pointer moves over a scale calibrated for all the different measurements that can be made; digital instruments usually display digits, but may display a bar of a length proportional to the quantity being measured. A multimeter can be a hand-held device useful for basic fault finding and field service work or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.



Power Supply

A **power supply** is a device that supplies electric power to one or more electric loads. The term is most commonly applied to devices that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source

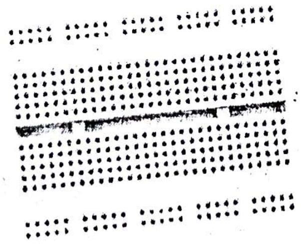
Active Elements & Passive Elements → Resistor colour coding

"The elements within a circuit will either control the flow of electric energy or respond to it. Those elements which control the flow of electric energy are known as active elements and those which dissipate or store the electric energy are passive elements."

"The three linear passive elements are the Resistor, the Capacitor and the Inductor. Examples of non-linear passive devices would be diodes, switches and spark gaps. Examples of active devices are Transistors, Triacs, Varistors, Vacuum Tubes, relays, solenoids and piezo electric devices."

Bread Board

A breadboard (protoboard) is a construction base for prototyping of electronics. The term is commonly used to refer to solderless breadboard (plugboard). Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design.



RESULTS AND DISCUSSION:

Study of lab equipments- CRO, Multimeter, Function Generator, Power supply- Active, and Passive Components & Bread Board has been studied successfully.

POST EXPERIMENT QUESTIONS:

1. What is the basic function of CRO and how it performs?
2. What is the basic function of Function Generator and how it performs?
3. What do you mean by active element and passive element ?
4. What is the purpose of the grid and X&Y-plates?
5. For a certain ac input signal, if the Volt/Div knob is set to a lower value, what effect does this have on the size of the signal on the screen?
6. What is the physical meaning of the root-mean-square value of an ac signal?

EXPERIMENT NO.2

OBJECTIVE: To study the PN junction diode characteristics under Forward & Reverse bias conditions.

APPARATUS & MATERIAL REQUIRED:

S.No.	Component	Specifications	Quantity
1	R.P.S	0-30 V	1
2	Ammeter	0-100 µA	1
3	Voltmeter	(0-1)V	1
4	Diode	IN4001	1
5	Resistor	1KΩ	1
6	Wires		As Required

THEORY:

A PN junction diode is a two terminal junction device. It conducts only in one direction (only on forward biasing).

Forward bias:

On forward biasing, initially no current flows due to barrier potential. As the applied potential exceeds the barrier potential the charge carriers gain sufficient energy to cross the potential barrier and hence enter the other region. The holes, which are majority carriers in the P-region, become minority carriers on entering the N-regions, and electrons, which are the majority carriers in the N-region, become minority carriers on entering the P-region. This injection of Minority carriers results in the current flow, opposite to the direction of electron movement.

Reverse bias:

On reverse biasing, the majority charge carriers are attracted towards the terminals due to the applied potential resulting in the widening of the depletion region. Since the charge carriers are pushed towards the terminals no current flows in the device due to majority charge carriers. There will be some current in the device due to the thermally generated minority carriers. The generation of such carriers is independent of the applied potential and hence the current is constant for all increasing reverse potential. This current is referred to as Reverse Saturation Current (I_O) and it increases with temperature. When the applied reverse voltage is increased beyond the certain limit, it results in breakdown. During breakdown, the diode current increases tremendously.

PROCEDURE:

Forward bias:

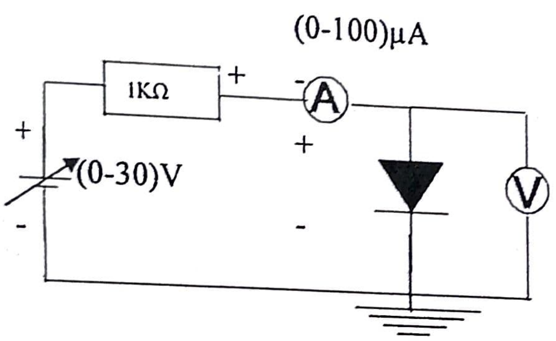
1. Connect the circuit as per the diagram.
2. Vary the applied voltage V in steps of 0.1V.
3. Note down the corresponding Ammeter readings I_f.
4. Plot a graph between V_f & I_f

Reverse bias:

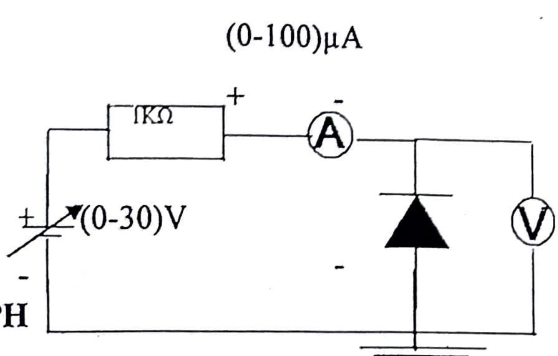
1. Connect the circuit as per the diagram.
2. Vary the applied voltage V_r in steps of 0.5V.
3. Note down the corresponding Ammeter readings I_r.
4. Plot a graph between V_r & I_r

CIRCUIT DIAGRAM:

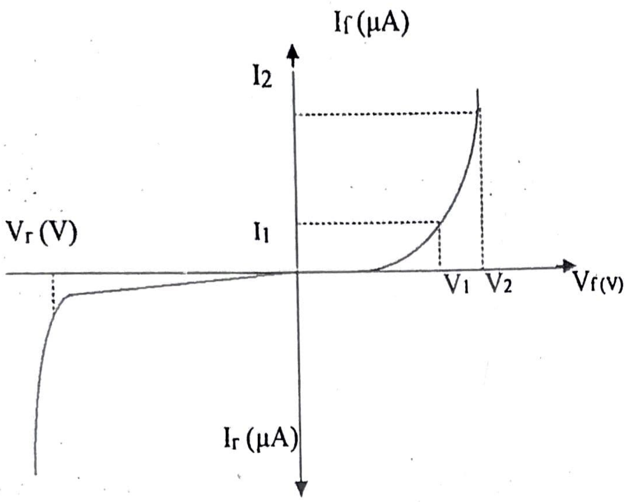
FORWARD BIAS:



REVERSE BIAS:



MODEL GRAPH



Observation table:

Forward bias:

S.No.	V_f	I_f

reverse bias:

S.No.	V_r	I_r

RESULT:

Forward and Reverse bias characteristics of the PN junction diode was Studied.

PRECAUTIONS:

1) Make the connections as per the circuit diagram carefully.
2) Observe the waveform carefully on the CRO.
3) The connections should be tight.

POST- EXPERIMENT QUESTIONS:

1. Name different types of diode capacitances.
2. Define peak inverse voltage.
3. What is the importance of barrier potential in diode?
4. Discuss the formation of depletion region.
5. Give the relationship between leakage current and temperature.

EXPERIMENT NO.3

OBJECTIVE: To study the working of Half Wave and Full wave (Bridge Type) Rectifier.

APPARATUS REQUIRED: Cathode Ray Oscilloscope (CRO), Bread board, Transformer, diodes, resistors, connecting wires.

THEORY:

Diode rectifier circuits

The basic half-wave rectifier circuit is shown in Figure 1. The input signal V_{in} to the rectifier is assumed to be a purely AC signal with a time-average value of zero. Since current passes through an ideal diode only when the input signal is positive, the output signal V_{out} across the load resistor will be as shown below.

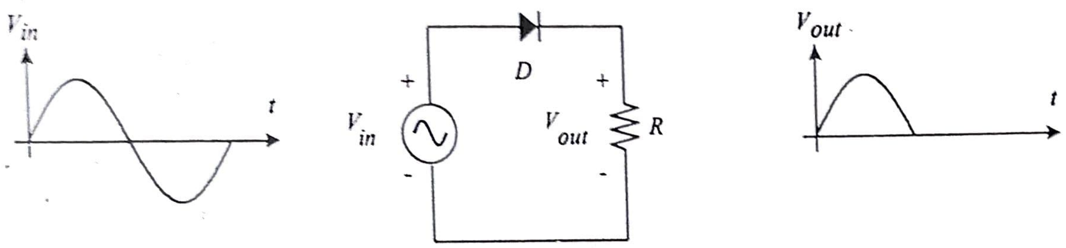


Figure 1: Half-wave rectifier circuit and respective waveforms

A half-wave rectifier can be connected to the transformer secondary as shown in Figure 2to generate the typical half-wave output signal as discussed before. The half-wave rectifier circuit produces an output signal whose fundamental frequency is the same as the input AC signal.

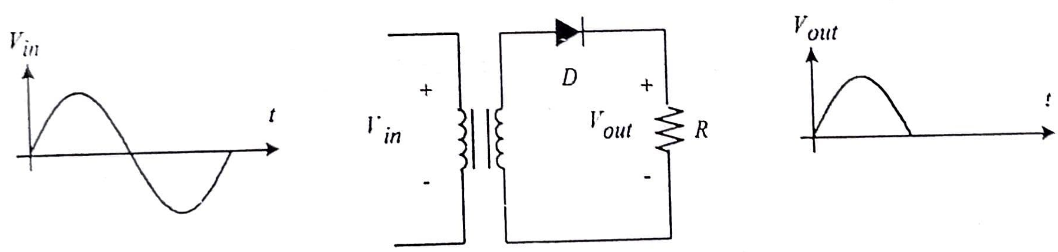


Figure 2: Half-wave rectifier circuit using a transformer

When input AC signal is applied across the bridge rectifier, during the positive half cycle diodes D_1 and D_3 are forward biased and allows electric current while the diodes D_2 and D_4 are reverse biased and blocks electric current. On the other hand, during the negative half cycle diodes D_2 and D_4 are forward biased and allows electric current while diodes D_1 and D_3 are reverse biased and blocks electric current.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative. This causes the diodes D_1 and D_3 forward biased and at the same time, it causes the diodes D_2 and D_4 reverse biased.

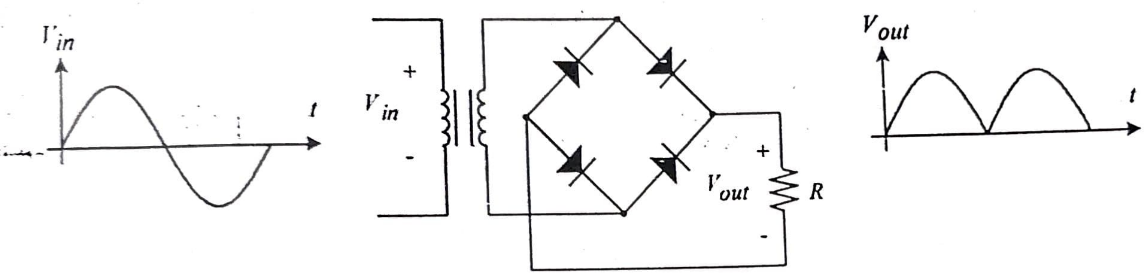


Figure 3: Full-wave rectifier using the bridge circuit

PROCEDURE:

1. Connect the circuit as shown in the circuit diagram.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input.
3. Using a CRO, measure the maximum voltage V_m of the AC input voltage (at the anode) of the rectifier and AC voltage (at the cathode) at the output of the rectifier.
4. Using a DC voltmeter, measure the DC voltage at the load resistance.
5. Observe the Waveforms at the secondary windings of transformer and across load resistance for a load of 1KΩ.
6. Calculate the ripple factor (γ), percentage of regulation and efficiency (η) with the below given formulae.

RESULT:

The application of diode as Rectifier circuits have been studied and input-output waveforms have been observed on the CRO.

PRECAUTIONS:

1. Make the connections as per the circuit diagram carefully.
2. Observe the waveform carefully on the CRO.
3. The connections should be tight.

POST EXPERIMENT QUESTIONS:

1. **What is a Rectifier?**
2. **What is a Ripple Factor (γ) and Efficiency (η)?**
3. **What is PIV and TUF?**
4. **What are the applications of rectifier?**

EXPERIMENT NO.4

OBJECTIVE: To study the application of diode as (i) Clipper circuit and (ii) Clamper Circuit.

APPARATUS & MATERIAL REQUIRED:

S.No.	Component	Specifications	Quantity
1	CRO	25MHz	1
2	Function Generator	3MHz	1
3	Bread Board		1
4	DC Supply	0-5V	1
5	Diode	1N4007	1
6	Digital Multimeter		1
7	Resistors	4.7KΩ , 100KΩ	Each 1
8	Capacitors	1μF,10V	1
9	Connecting wires & CRO Probes		As Required

THEORY:

A clipper is a circuit with which the waveform is shaped by removing or clipping a portion of the applied input signal waveform without distorting the remaining part. Clippers fall into the general category of wave-shaping circuits. The function of a clipper is to limit the amplitude of a signal to some particular maximum positive or negative value. Clipper can remove signal voltages above or below a specified level.

Clipper Circuits: Clippers are networks which clip away part of the applied signal.

Clippers are used to:

- Create a specific type of signal.
- Limit the voltage that can be applied to a network.

Clipper circuit consists of:

- AC-source.
- Diode.
- DC-Source (to shift the operating point to the required value).

Clamper Circuits:

Clamping circuits shifts or change a signal to different d.c. level. Clamping circuit introduces a d.c. level to an a.c signal. Clampers are networks that clamp the input signal to a different dc level, but the peak-to-peak swing of the applied signal will remain the same. Clamper circuit consists of clipper components plus capacitor.

CIRCUIT- DIAGRAMS:

Clipper Circuits:-

This circuit limits an input voltage to certain minimum and maximum values. In the circuit in Figure-1, as long as *VI* is less than VB1, then the diode will be reverse biased (an open circuit). In this case, the output voltage will track the input voltage. If *VI* exceeds VB1 then the diode turns on and then Vo will be VB1 thus this circuit limits the output voltage to less than VB1. By rearranging the components, variations on this circuit can be achieved.

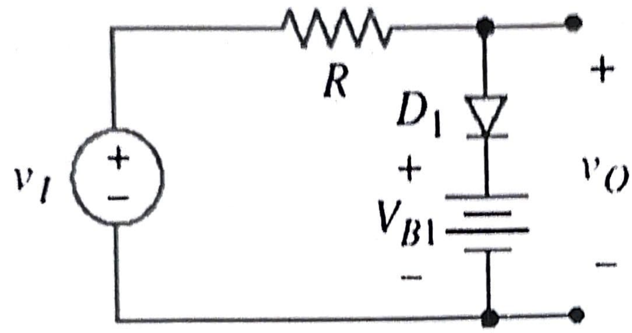


Figure 1: Schematic of a clipper circuit.

Clamper Circuits:-

This circuit works by allowing the capacitor to charge up and act like a battery. This is the voltage across the capacitor depends on the input waveform, the output maximum(or the minimum depending on the orientation of the diode) will be clamped to a fixed reference point .

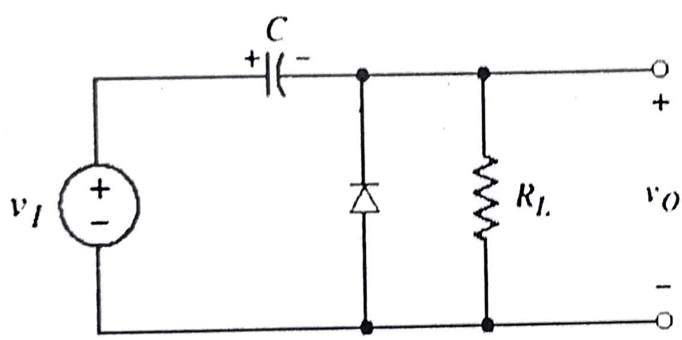


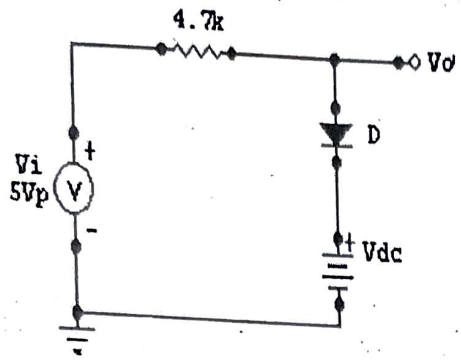
Figure 2: Schematic of a clamper circuit.

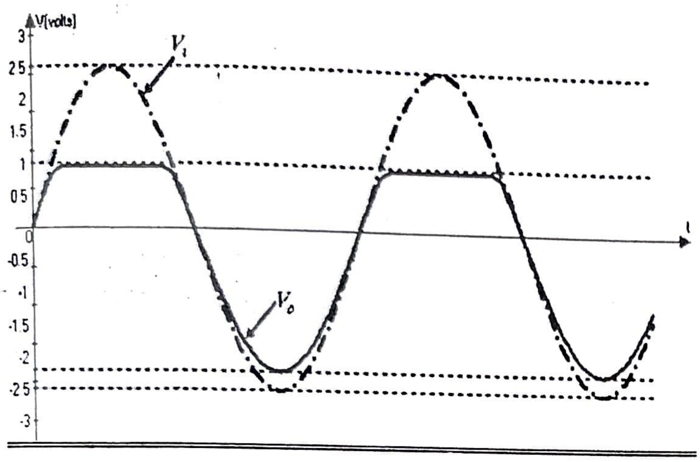
PROCEDURE:

DIODE CLIPPER CIRCUITS:

1. Connect the circuit in Figure a. Use R = 100 KΩ and a 1N4007 diode. For the input signal v_I, use $5V_{p\text{-}p}$, 1KHz sine wave and use variable power supply to provide the battery voltage. Set V_B=1 V. Measure and sketch the input and output waveforms.

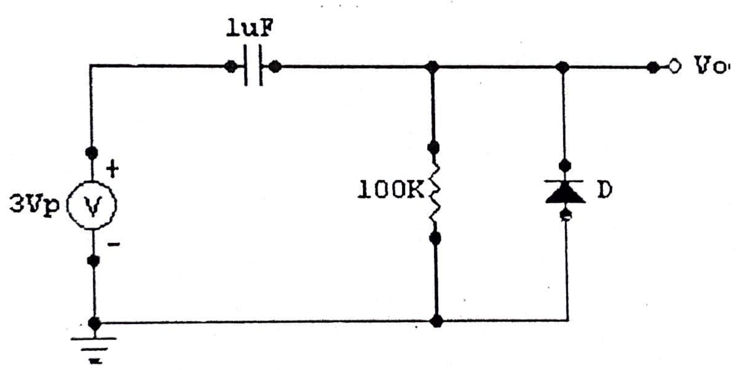
2. Repeat the procedure for the remaining circuits. For Fig-d, set V_{B1}=0.5 V, V_{B2}=1 V. Again verify Variable Supply Source output voltages using Voltmeter. Re-adjust if necessary. Observe the input and output waveforms on the CRO.



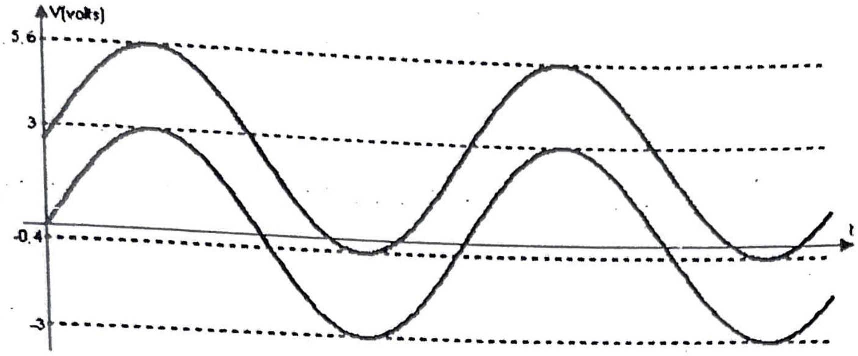


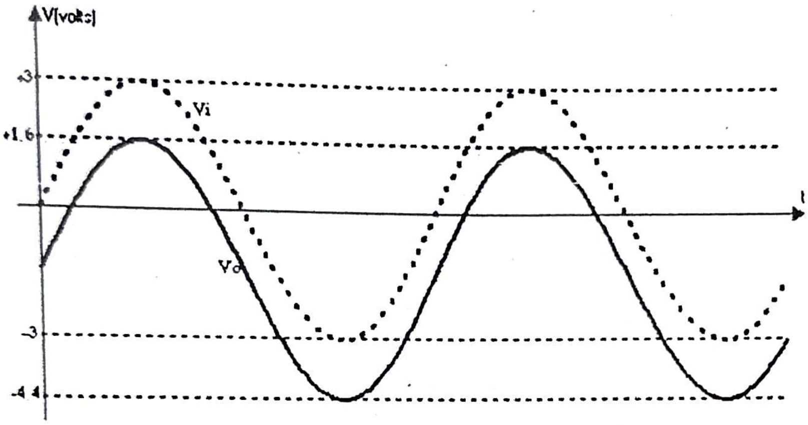
DIODE CLAMPER CIRCUITS:

Connect the circuit as shown below in Fig.



The input and output waveforms are:





RESULT:

The application of diode as Clipper and Clamper circuits have been studied and input-output waveforms have been observed on the CRO.

PRECAUTIONS:

4. Make the connections as per the circuit diagram carefully.
5. Observe the waveform carefully on the CRO.
6. The connections should be tight.

POST- EXPERIMENT QUESTIONS:

1. Name different types of clipper circuits.
2. What is the difference between series clipper and shunt clipper?
3. What are the types of clamper circuits?
4. Discuss the output waveforms from the clipper circuits. How do these waveforms differ from those expected if ideal diodes were used? Why?
5. What is the difference between clipping circuit and clamping circuit?

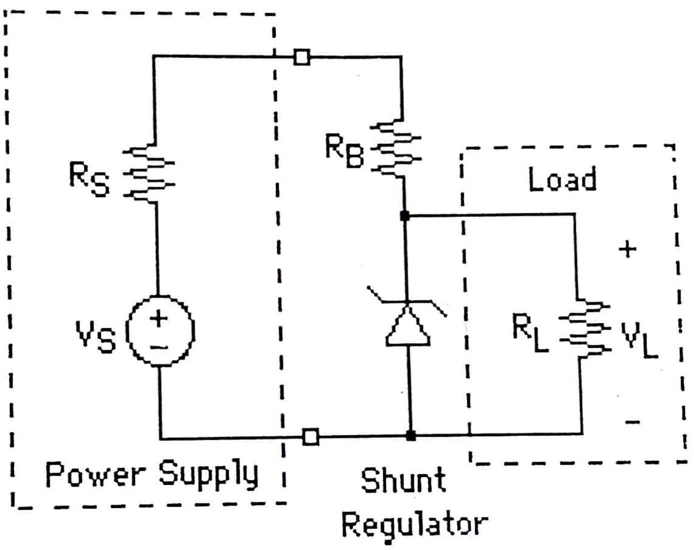
EXPERIMENT NO.5

OBJECTIVE: To study the application of Zener diode as a voltage regulator.

APPARATUS & MATERIAL REQUIRED:

S.No.	Component	Specifications	Quantity
1.	Zener diode	ZD-9V	01
2.	Bread board		01
3.	Variable DC supply	0-30V	01
4.	Multi-meter	200mV-1000V	01
5.	Resistors	1KΩ,10KΩ	Each 1
6.	Variable load (potentiometer)	10KΩ	01

CIRCUIT DIAGRAM: -



THEORY:

VOLTAGE REGULATION:-

Voltage Regulator: A voltage regulator circuit is required to maintain a constant dc output voltage across the load terminals in spite of the variation:

- Variation in input mains voltage
- Change in the load current
- Change in the temperature

The voltage regulator circuit can be designed using Zener diode. For that purpose, Zener diode is operated always in reverse biased condition. Here, Zener is operated in break-down region and is used to regulate the voltage across a load when there are variations in the supply voltage or load current.

The figure shows the Zener voltage regulator, it consists of a current limiting resistor R_S connected in series with the input voltage V_s and Zener diode is connected in parallel with the load R_L in reverse biased condition. The output voltage is always selected with a breakdown voltage V_Z of the diode.

The input source current, $I_S = I_Z + I_L$............. (1)
The drop across the series resistance, $R_s = V_{in} - V_z$........ (2)
And current flowing through it, $I_S = (V_{in} - V_Z) / R_S$ .... (3)
From equation (1) and (2), we get, $(V_{in} - V_z)/R_s = I_z + I_L$ .... (4)

Regulation with a varying input voltage (line regulation): It is defined as the change in regulated voltage with respect to variation in line voltage. It is denoted by 'LR'.

In this, input voltage varies but load resistance remains constant hence, the load current remains constant. As the input voltage increases, form equation (3) Is also varies accordingly. Therefore, Zener current I_z will increase. The extra voltage is dropped across the R_s. Since, increased I_z will still have a constant V_z and V_z is equal to V_{out}. The output voltage will remain constant. If there is decrease in V_{in}, I_z decreases as load current remains constant and voltage drop across R_s is reduced. But even though I_z may change, V_z remains constant hence, output voltage remains constant.

PROCEDURE:

i) Connect the circuit as per the figure.
ii) Disconnect load and take reading of voltage at no load.
iii) Now connect load and vary the input voltage and take reading of the $V_{out} = V_z$ i.e. voltage across load. Also measure the current.
iv) Calculate voltage regulation form the observation table. Now apply constant output voltage at input terminal and vary the load, measure the voltage across load.

$$\% \text{ Regulation} = \frac{V_{no\text{-}load} - V_{full\text{-}load}}{V_{full\text{-}load}}$$

OBSERVATION TABLE:

1. Fix the load at 10 KΩ

S.No	V_{in} (input voltage)	R_L	Vout=Vz

2. Fix the input at V_z

Sr. No.	V_{in}(input voltage)	R_L	Vout=Vz

RESULT:

The regulation of zener diode as a voltage regulator under the load of 10 KΩ is equal to...................

PRECAUTIONS:

1. Check the circuit connection before giving supply.
2. Do not retain more reverse voltage for longer time.

POST EXPERIMENT QUESTIONS:-

1. Define the phenomenon of 'Zener breakdown'.
2. Why Zener is suitable for voltage regulation?
3. What is voltage regulator? What is the need of it?
4. What is need of voltage regulation?
5. What are zener and avalanche break down?
6. What is effect of temperature on zener and avalanche break down?