Government Girls' Polytechnic, Bilaspur

Name of the Lab: **Electronics Lab**

Practical: **Electronics Devices & Circuit Lab**

Class :**3^{rd} Semester (ET&T) , 3^{rd} Semester (IT)**
FOR ET&T
Teachers Assessment:10 End Semester Examination: 50
FOR IT
Teachers Assessment:30 End Semester Examination: 70

EXPERIMENT No- 1

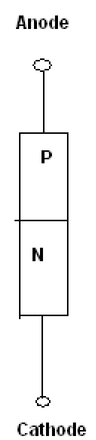
OBJECTIVE: - Plot the V-I characteristics of: (i) Silicon Diode (ii) Germanium Diode.

EQUIPMENT REQUIRED: - Power Supply (0-30V), Voltmeter (0-30V), Ammeter (μA & mA range), resistors, p-n junction diode.

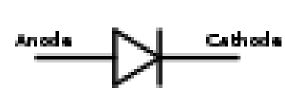
THEORY: - Diode is an electronics component having two terminals, cathode &anode, having non-linear characteristic .The semiconductor diode is formed by forming a junction between! P-type & other N-type of semiconductor

A P-N junction is known as Semiconductor diode or Crystal diode. It is the combination of P-type & N-type Semiconductor. Which offer 's nearly zero resistance to current on forward biasing & nearly infinite Resistance to the flow of current when in reverse biased. Diode is a semiconductor device that, only allow current flow in one direction.

The construction and symbol shown in Figure, in the symbol, bar denotes cathode or N material while the arrow is the anode or the P-material. Current flows from P to N or anode to cathode.



Construction



Symbol

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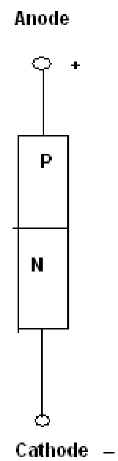
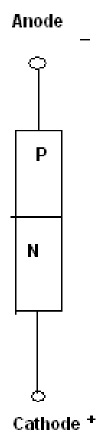
Forward biasing: When P-type semiconductor is connected to the +ve terminal and N-type to –ve terminal of voltage source. Nearly zero resistance is offered to the flow of current. Diode is conducted in forward biasing.



Reverse biasing: When P-type semiconductor is connected to the –ve terminal and N-type to +ve Terminal. High resistance is offered to the flow of current so nearly zero current flow in this condition.



Diodes are widely used in applications such as mixers, detectors, protection circuits. In this experiment you will investigate few applications of diodes such as AND gate, half wave rectifiers and Zener limiter.

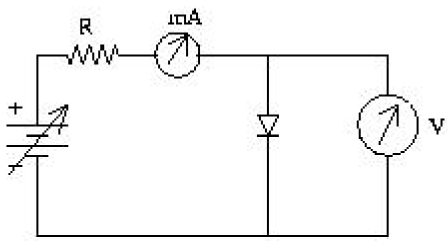
Current–voltage characteristics: **-** The operation of diodes (as with other semiconductor devices) is often described by a special graph called a "characteristic curve". These graphs show the relationship between the currents and voltages associated with the different terminals of the device. An understanding of these graphs helps in understanding how the device operates.

The shape of the curve is determined by the transport of charge carriers through the so-called depletion layer or depletion region that exists at the p-n junction between differing semiconductors.

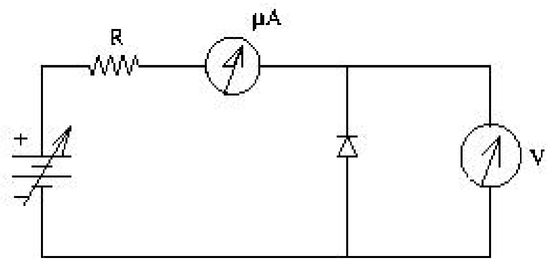
If an external voltage is placed across the diode with the same polarity as the built-in potential, the depletion zone continues to act as an insulator, preventing any significant electric current flow this is the reverse bias phenomenon. However, if the polarity of the external voltage opposes the built-in potential, recombination can once again proceed, resulting in substantial electric current through the p-n junction .For silicon diodes, the built-in potential is approximately **0.7 V(for silicon) and 0.3 V (for Germanium).** Thus, if an external current is passed through the diode, about 0.7 V will be developed across the diode such that the P-doped region is positive with respect to the N-doped region and the diode is said to be “turned on” as it has a forward bias.

A diode’s 'I–V characteristic' can be approximated by four regions of operation. At very large reverse bias, beyond the peak inverse voltage or PIV, a process called reverse breakdown occurs which causes a large increase in current that usually damages the device permanently. The third region is forward bias, where only a small forward current is conducted .As the potential difference is increased above an arbitrarily defined “cut-in voltage” or “on-voltage” or “diode forward voltage drop (V_d)”, the diode current becomes appreciable. In a normal silicon diode at rated currents, the arbitrary “cut-in” voltage is defined as 0.6 to 0.7 volts.

CIRCUIT DIAGRAM:-



Forward Biased diode



Reverse Biased diode

PROCEDURE: - 1) Wire up the circuit shown in figure

2) Record the voltage across the diode (V) and current (I) through it as a function of input voltage for both silicon and germanium diode.
3) Repeat the experiment of the reverse biased diode for both silicon and germanium diode.
4) Plot the relevant graphs for both silicon and germanium diode.

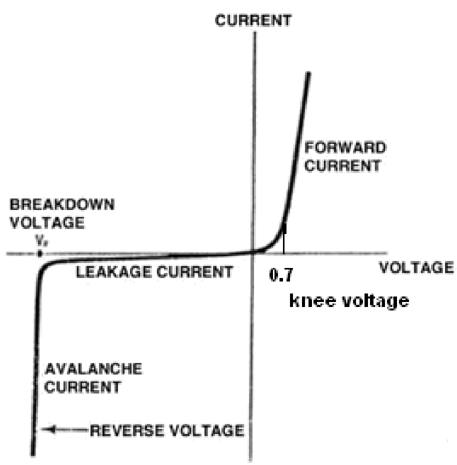
OBSERVATION TABLE:- a) For silicon diode

Procedure	When diode is forward biased		When diode is reverse biased	
	Current (mA)	Voltage (V)	Current (μA)	Voltage (V)
1				
2				
3				

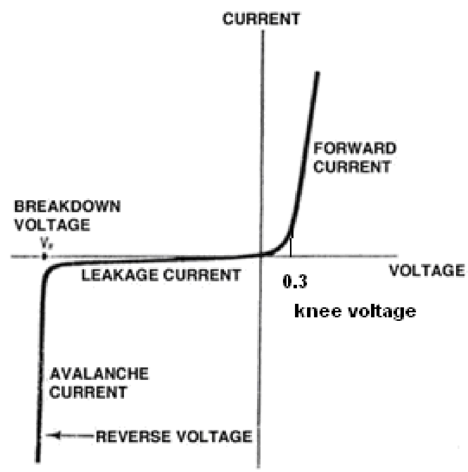
b) For germanium diode

Procedure	When diode is forward biased		When diode is reverse biased	
	Current (mA)	Voltage (V)	Current (µA)	Voltage (V)
1				
2				
3				

RESULT:- A diode's 'V – I' characteristic' can be approximated by four regions of operation. Silicon diode has knee voltage is 0.7 and germanium diode has knee voltage is 0.3.



V-I Characteristics of silicon diode



V-I Characteristics of germanium diode

PRECAUTIONS: - 1) All the connection should be tight.

2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6) Before the circuit connection it should be check out working condition of all the Component.

EXPERIMENT No- 2

OBJECTIVE: - Verify the action of diode as a: (i) Positive Clipper (ii) Negative Clipper.

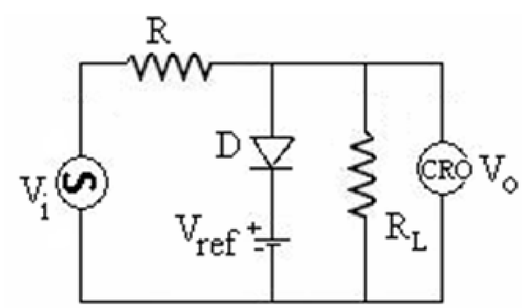
EQUIPMENT REQUIRED: - Diode, Resistors, potentiometer, DC regulated power supply, Signal generator and CRO.

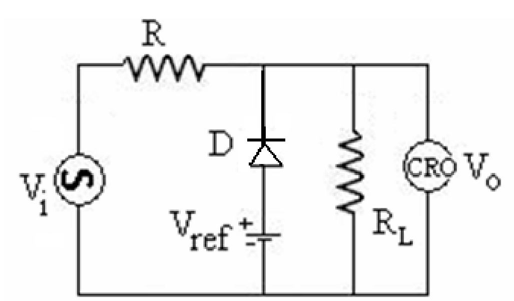
THEORY:- Diode clippers are wave-shaping circuits in that they are used to prevent signal voltages from going above or below certain levels without distorting the remaining part of the applied waveform.. The clipping level may be either equal to the diode's barrier potential or made variable with a dc source voltage. Because of this limiting capability, the clipper is also called a limiter. Thus a clipper circuit can remove certain portions of an arbitrary waveform near the positive or negative peaks. Clipping may be achieved either at one level or two levels. Usually under the section of clipping, there is a change brought about in the wave shape of the signal.

Positive Clipper:-The clipper which removes the positive half cycles of the input voltage is called the positive clipper. While input side is positive, the diode D is forward biased and conducts heavily (that is, diode acts as a closed switch). So the voltage drop across the diode or across the load resistance R_L is zero. Thus output voltage during the positive half cycles is zero that is; positive half cycle is clipped off. During the negative half cycles of the input signal voltage, the diode D is reverse biased and behaves as an open switch. Consequently the entire input voltage appears across the diode or across the load resistance R_L if R is much smaller than R_L, so the negative half cycle appears across the output.

Negative Clipper:-The clipper which removes the negative half cycles of the input voltage is called the negative clipper. While input side is negative, the diode D is forward biased and conducts heavily (that is, diode acts as a closed switch). So the voltage drop across the diode or across the load resistance R_L is zero. Thus output voltage during the negative half cycles is zero that is; negative half cycle is clipped off. During the positive half cycles of the input signal voltage, the diode D is reverse biased and behaves as an open switch. Consequently the entire input voltage appears across the diode or across the load resistance R_L if R is much smaller than R_L, so the positive half cycle appears across the output.

CIRCUIT DIAGRAM: -





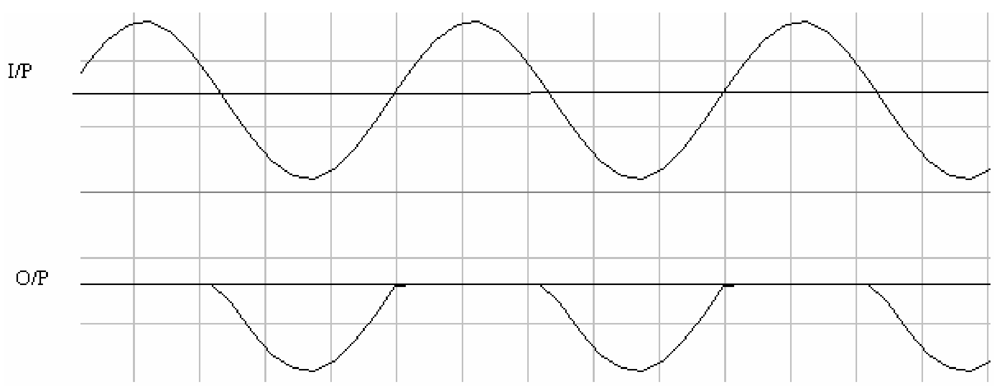
Circuit diagram for positive clipper

Circuit diagram for negative clipper

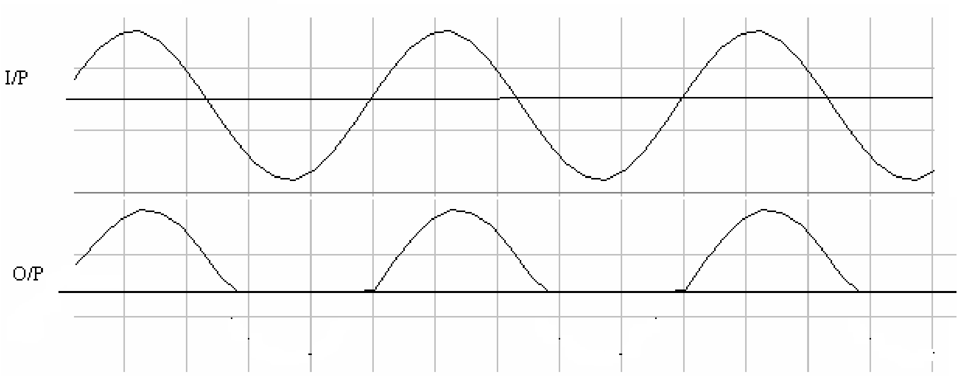
PROCEDURE:- 1. Before making the connections check all components using multimeter.

2. Make the connections as shown in circuit diagram.
3. Using a signal generator (Vi) apply a sine wave of 1KHz frequency and peak-to peak amplitude of 10V to the circuit. (Square wave can also be applied.)
4. Keep the CRO in dual mode, connect the input (Vi) signal to channel 1 and output waveform (Vo) to channel 2.
5. Observe the clipped output waveform. Also record the amplitude and time data from the waveforms.
6. Now keep the CRO in X-Y mode and observe the transfer characteristic waveform.
7. Vary Vref and observe the variation in clipping level. For this use variable DC power supply for Vref.
8. Change the direction of diode and repeat the procedure 1 to 7 and Vref to realize a negative clipper.

OBSERVATION: - Observe the waveforms on the CRO for both the positive and negative clipper.



Waveform for positive clipper



Waveform for negative clipper

RESULT: - Output voltage V_0 =__________ during positive half cycle
=__________ during negative half cycle

PRECAUTIONS: - 1) All electrical apparatus that connects to the AC power line must have a protective ground through a three-wire power cable.
2) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
3) Always switch the circuit power off before changing components or connections. It is tempting to become lazy and change connections in low-power circuits with the supply on, but this is asking for trouble in the form of unintentional short circuits and blown components.
4) Always ask for directions or help if you are unsure of the correct measurement procedure or circuit connection.

EXPERIMENT No- 3

OBJECTIVE: - Verify the action of diode as a: (i) Positive Clamper (ii) Negative Clamper.

EQUIPMENT REQUIRED: - Diode, Resistors, Capacitor, DC regulated power Supply, Signal generator and CRO.

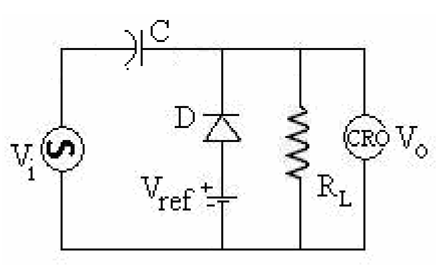
THEORY:- A clamper is an electronic circuit that prevents a signal from exceeding a certain defined magnitude by shifting its DC value. The clamper does not restrict the peak-to-peak excursion of the signal, but moves it up or down by a fixed value. A diode clamp relies on a diode, which conducts electric current in only one direction; resistors and capacitors in the circuit are used to maintain an altered dc level at the clamper output. A clamping circuit (also known as a clamper) will bind the upper or lower extreme of a waveform to a fixed DC voltage level. These circuits are also known as DC voltage restorers.The clamper is also referred to as an ac signal level shifter. The clamping network is one that will "clamp" a signal to a different DC level. The network must have a capacitor, a diode and a resistive element, but it can also employ an independent DC supply (Vref) to introduce an additional shift. The magnitude of R and C must be chosen such that time constant τ = RLC is large enough to ensure the voltage across capacitor does not discharge significantly during the interval of the diode is non-conducting.

TYPES

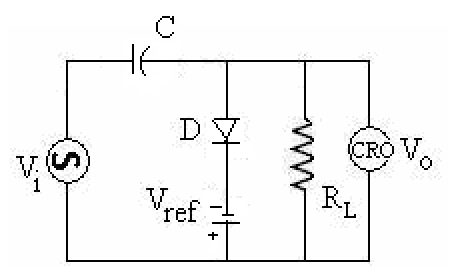
Positive clamper: When the circuit pushes the signal on the positive side or upward, the negative peak of the signal coincides with the zero level and the circuit is called the positive clamper. In the negative cycle of the input AC signal, the diode is forward biased and conducts, charging the capacitor to the peak positive value of V_{IN}. During the positive cycle, the diode is reverse biased and thus does not conduct. The output voltage is therefore equal to the voltage stored in the capacitor plus the input voltage again, so $V_{OUT} = 2V_{IN}$

Negative clamper: When the signal is pushed on the negative side or downward, the positive peak of the input signal coincides with the zero level and the circuit is called the negative clamper.A negative clamp is the opposite of the equivalent positive clamp. In the positive cycle of the input AC signal, the diode is forward biased and conducts, charging the capacitor to the peak value of V_{IN}. During the negative cycle, the diode is reverse biased and thus does not conduct. The output voltage is therefore equal to the voltage stored in the capacitor plus the input voltage again, so $V_{OUT} = -2V_{IN}$

CIRCUIT DIAGRAM:-



Circuit diagram for positive clamper



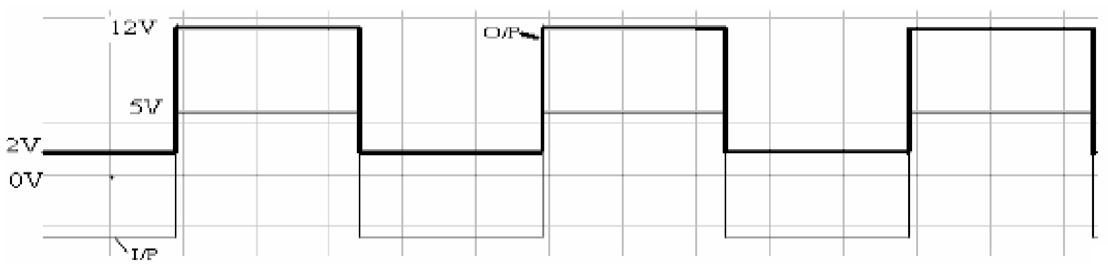
Circuit diagram for negative clamper

PROCEDURE:-1. Before making the connections check all components using multimeter.
2. Make the connections as shown in circuit diagram.
3. Using a signal generator apply a square wave input (Vi) of peak-to-peak amplitude of 10V (and

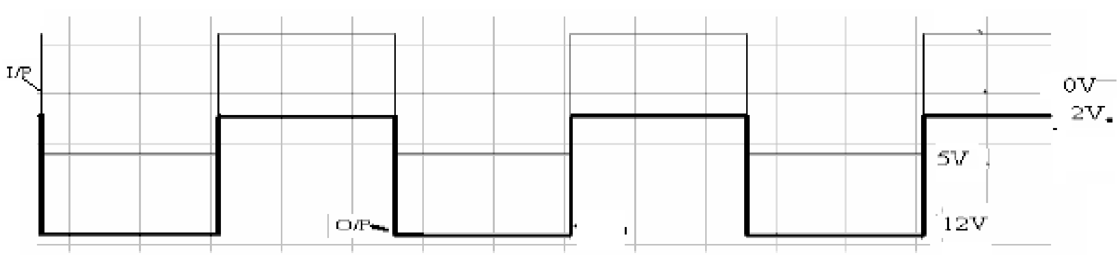
frequency greater than 50Hz) to the circuit. (Sine wave can also be applied)

4. Observe the clamped output waveform on CRO
5. CRO in DUAL mode and DC mode. Also the grounds of both the channels can be made to have
the same level so that the shift in DC level of the output can be observed.
6. For negative clampers reverse the directions of both diode and reference voltage and repeat the
procedure 2,3,4 and 5.

OBSERVATION: - Observe the waveforms on the CRO for both the positive and negative clamper.



Input and output waveform for positive clamper circuit with reference voltage = 2V



Input and output waveform for negative clamper circuit with reference voltage = 2V

RESULT: - Output voltage V_0 =__________ during positive half cycle
=__________ during negative half cycle

PRECAUTIONS: - 1) All electrical apparatus that connects to the AC power line must have a protective ground through a three-wire power cable.
2) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
3) Always switch the circuit power off before changing components or connections. It is tempting to become lazy and change connections in low-power circuits with the supply on, but this is asking for trouble in the form of unintentional short circuits and blown components.
4) Always ask for directions or help if you are unsure of the correct measurement procedure or circuit connection.

EXPERIMENT No- 4

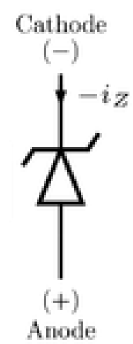
OBJECTIVE: - Verify the V-I characteristics of a zener diode.

EQUIPMENT REQUIRED: - Experimental kit, wire.

THEORY:- A Zener diode is a type of diode that permits current not only in the forward direction like a normal diode, but also in the reverse direction if the voltage is larger than the voltage known as "Zener knee voltage" or "Zener voltage". The device was named after Clarence Zener, who discovered this electrical property. Zener diodes differ from ordinary diodes in that it special reverses bias characteristics .After a particular reverse voltage the diodes breakdown. In this region the voltage remain constant through the current veries.This characteristics of zener diodes helps in many circuits as regulators power supplies etc

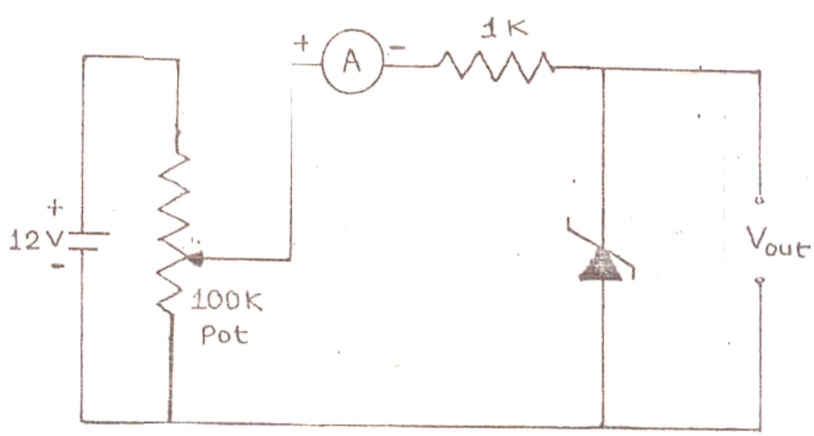
A conventional solid-state diode will not allow significant current if it is reverse-biased below its reverse breakdown voltage. When the reverse bias breakdown voltage is exceeded, a conventional diode is subject to high current due to avalanche breakdown. Unless this current is limited by circuitry, the diode will be permanently damaged. In case of large forward bias (current in the direction of the arrow), the diode exhibits a voltage drop due to its junction built-in voltage and internal resistance. The amount of the voltage drop depends on the semiconductor material and the doping concentrations.

The Zener diode's operation depends on the heavy doping of its p-n junction allowing electrons to tunnel from the valence band of the p-type material to the conduction band of the n-type material.



Symbol

CIRCUIT DIAGRAM: -



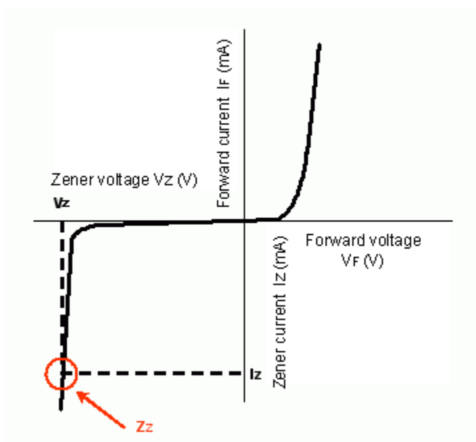
PROCEDURE: - 1) Make connections as in fig.

2) Very the input by setting of potentiometer & measure the voltage across zener diode Vz.
3) Measure the current Iz for each setting of potentiometer form the ammeter.
4) Plot the graph between Vz & Iz.

OBSERVATION TABLE:-

Procedure	When zener diode is forward biased		When zener diode is reverse biased			
	Current (+ I_F)	Voltage (+V_F)	Current (- I_R)	Voltage (-V_R)	Current (- I_Z)	Voltage (-V_Z)
1						
2						
3						
4						

RESULT: - V- I characteristics of zener diode are determined.



Voltage and current characteristics

By the graph analysis we found that after Vz, current Iz, across the zener diode is constant.

PRECAUTIONS: - 1) All the connection should be tight.

2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5) Before the circuit connection it should be check out working condition of all the Component.
6) Circuit should be handling carefully.

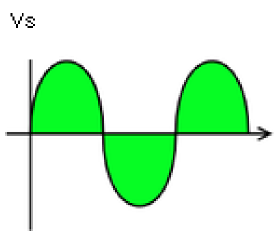
EXPERIMENT No- 5

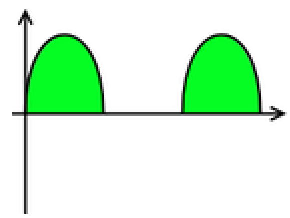
OBJECTIVE: - Set up the circuit and verify the waveforms of: (i) H.W. rectifier (ii) F.W. (Centre tapped) rectifier (iii) Bridge rectifier.

EQUIPMENT REQUIRED: - Power supply, rectifier kit. CRO, Connecting Leads.

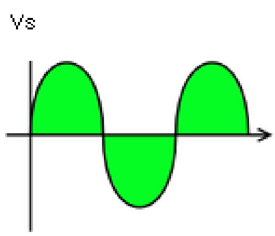
THEORY: - Rectifiers convert alternating currents (AC) into direct current (DC).Alternating currents reverse direction each cycle while direct current moves in only one Direction. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components.

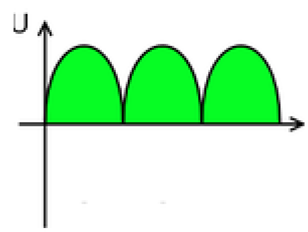
In half-wave rectifier, only one diode is used. During +ve half Cycle the diode is forward biased &, it conducts current through the load resistor R .During –ve half cycle diode is reverse biased Hence, no current flow through the circuit. Only +ve half cycle appears across the load, whereas, the –ve half Cycle is suppressed.





In full-wave rectification, When A.C supplied at the input, both the half cycles current flows through the load in the same direction.

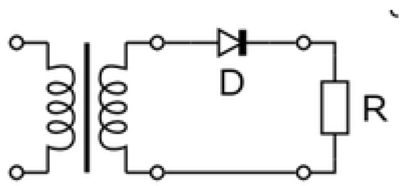




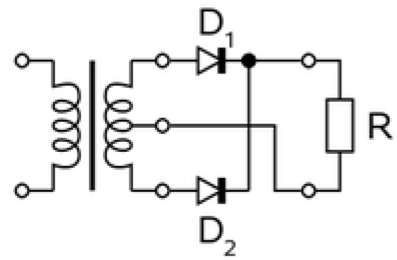
Centre-tap full-wave Rectifier: In this rectifier, two diodes & a center-tap transformer is used. +ve half cycle the diode D1 is forward biased & D2 is reverse biased .Output will be obtained across load resistor R. During –ve half cycle diode D1 is reversed biased &D2 is forward biased. Output will be obtained across load resistor R again & the direction of output is same i.e., DC output is obtained

Bridge Rectifier: The ckt. Contains four diodes connected to form a bridge. In this an ordinary Transformer is used. During +ve half cycle of secondary voltage, diodes D1 & D3 are forward biased & diodes D2& D4 are reverse biased & vice versa.

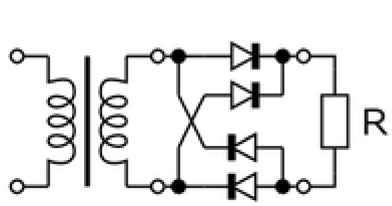
CIRCUIT DIAGRAM:-



Circuit diagram for half wave rectifier



Circuit diagram for center tap full Wave rectifier



Circuit diagram for bridge full Wave rectifier

PROCEDURE: - 1) The activity board has one transformer and three rectifier circuits. One oscillator on the board provides the AC voltage and is connected to the transformer input. The output leads of the transformer are connected to the rectifier circuit under study as indicated in the following steps.

2) Half wave rectifier: - Connect the fixed frequency oscillator and one oscilloscope channel to the input of the transformer. Connect one lead of the transformer output to the input of the half wave rectifier diode. Connect the output lead of the transformer to a ground post. Connect the other oscilloscope channel to the output side of the half wave rectifier diode.

3) Using the voltmeter to measure DC voltages, measure the voltage produced by the oscillator (should be zero volts, AC voltages average to zero volts) and then the voltage produced by the rectifier (approximately +.5 volts).

4) Full wave rectifier. Connect the fixed frequency oscillator and one oscilloscope channel to the input of the transformer. Connect one lead of the transformer output to one of the full wave rectifier diodes; connect the second output lead of the transformer to the other full wave rectifier diode. Connect the center tap of the transformer output to a ground post. Connect the other oscilloscope channel to the output side of the full wave rectifier diodes.

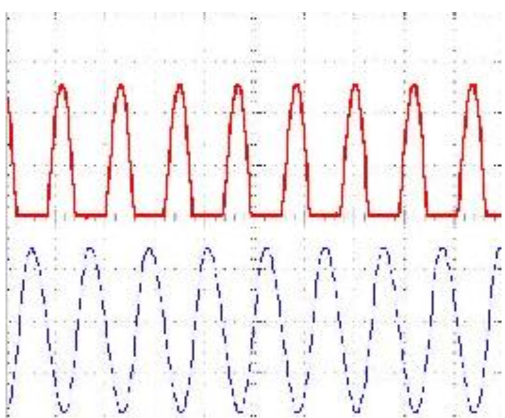
5)Full wave bridge rectifier. Connect the fixed frequency oscillator and one oscilloscope channel to the input of the transformer. Connect one lead of the transformer output to one input of the bridge; connect the second output lead of the transformer to the other input of the bridge. Connect the other oscilloscope channel to the output side of the full wave bridge rectifier diodes. The oscilloscope display should be look.

OBSERVATION TABLE:-

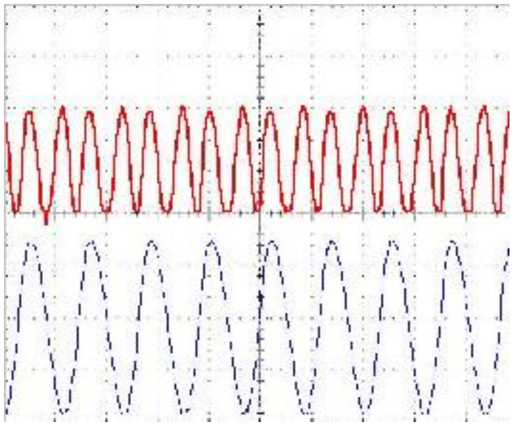
Procedure	Supply voltage (Vs)	Output voltage(Vo)		
		Half wave	Full wave	
			Centre tap	Bridge

RESULT: - The various wave forms are observed in CRO.

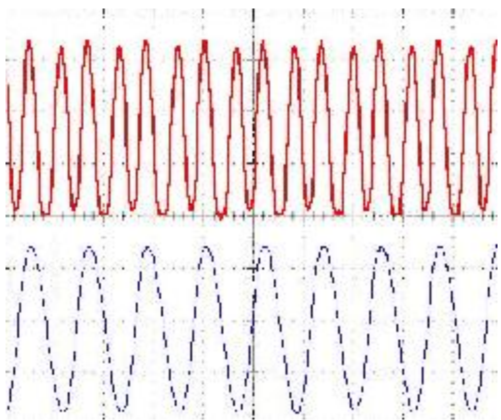
For Half wave rectifier:-



For Center tap Full wave rectifier:-



For Bridge Full wave rectifier:-



PRECAUTIONS: - - 1) All the connection should be tight.

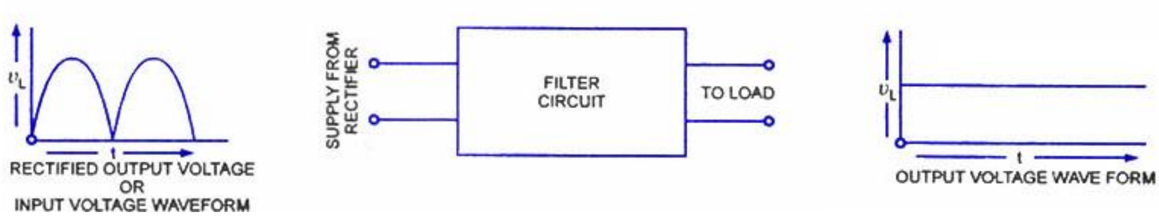
2) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
3) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
4) Before the circuit connection it should be check out working condition of all the Component.
5) Circuit should be handling carefully.

EXPERIMENT No- 6

OBJECTIVE:- Observe the output waveform of a rectifier circuit with: (i) Capacitive filter (ii) Inductive filter.

EQUIPMENT REQUIRED: -Step down transformer with centre tap, C.R.O., diodes, capacitor resistors, inductor, regulator chips.

THEORY: - The output from any of the rectifier circuit is not purely dc but also has some ac components called ripples, along it. The ripples are maximum in the single phase half-wave rectifier and being reduced in the full-wave rectifier and being reduced further with the increase in the number of phases. Such supply is not useful for driving sophisticated electronic devices/circuits. Of course, for a circuit such as battery charger the pulsating nature of supply available from a rectifier is no great detriment as long as the dc level provided results in charging of battery. But for supply circuits to radio or tape-recorder the pulsating dc results in 50 – (or 100) Hz signal appearing in the output, thereby making the operation of the overall circuit poor. For such applications, as well as for many more, the output dc developed will have to be much steady or smoother than that of the pulsating dc obtained directly from half-wave or full-wave rectifier circuits. Hence, it becomes essential to reduce the ripples from the pulsating dc supply available from rectifier circuits to the minimum. This is achieved by using a filter or smoothing circuit which removes (or filters out) the ac components and allows only the dc component to reach the load. Obviously, a filter circuit should be placed between, the rectifier and the load.



Block diagram for filter circuit

"A filter circuit is a device that converts pulsating output of a rectifier into a steady dc level."

A filter is generally a combination of inductors L and Capacitors C. The filtering action of L and C depends upon the facts that an inductor allows only dc and a capacitor allows ac only to pass. So a suitable L and C network can effectively filter out (or remove) the ac components from the rectified output.
Commonly used types of filter circuits are:

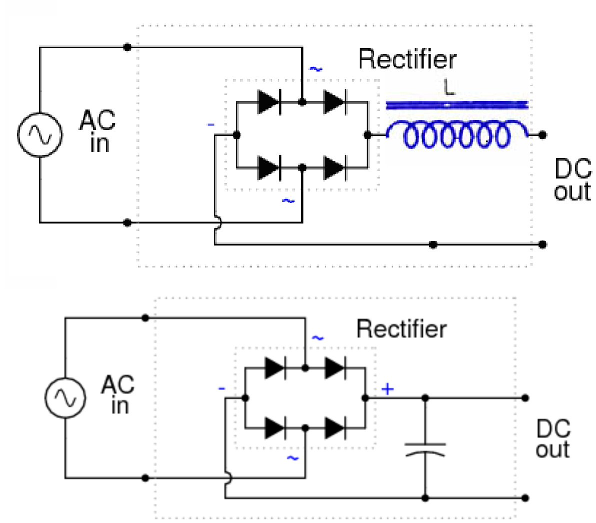
(a) Series Inductor filter
(b) Shunt Capacitor Filter
(c) Choke Input Filter
(d) Capacitor input or pie filter
(e) R-C filter

Series Inductor filter :- In this arrangement a high value inductor or choke L is connected in series with the rectifier element and the load. The filtering action of an inductor filter depends upon its property of opposing any change in the current flowing through it. When the output current of the rectifier increases above a certain value, energy is stored in it in the form of magnetic field and this energy is given up when the output current falls below the average value. Thus by placing a choke coil in series with the rectifier output and load, any sudden change in current that might have occurred in the circuit without an inductor is smoothed out by the presence of the inductor L
The function of the inductor filter may be viewed in terms of impedances. The choke offers high impedance to the ac components but offers almost zero resistance to the desired dc components. Thus ripples are removed to a large extent.

Shunt Capacitor Filter:- If we place a capacitor at the output of the full-wave rectifier, the capacitor will charge to the peak voltage each half-cycle, and then will discharge more slowly through the load while the

rectified voltage drops back to zero before beginning the next half-cycle. Thus, the capacitor helps to fill in the gaps between the peaks.
The function of the capacitor filter may be viewed in terms of impedances. The large value capacitor C offers a low impedance shunt path to the ac components or ripples but offers high impedance to the dc component. Thus ripples get bypassed through capacitor C and only dc component flows through the load.

CIRCUIT DIAGRAM:-

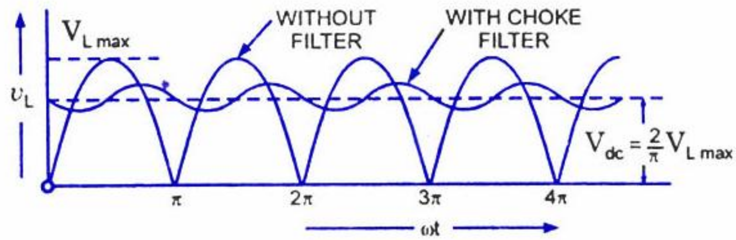


Circuit diagram for rectifier with (1) series inductor filter (2) shunt capacitor filter

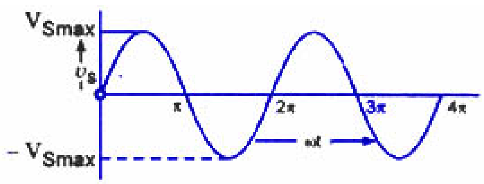
PROCEDURE:-

1. Connect the circuit as shown Fig. (1) for an full wave rectifier. You may assemble the circuit by using the function generator (set for 50 Hz) also instead of transformer. Check the waveform across the secondary of the transformer (or the function generator) by displaying on one of the channel of oscilloscope. After setting the oscilloscope to observe the above wave forms, connect the other channel of the oscilloscope to the output resistor of the circuit. Trace the output and input (secondary of the transformer) waveforms Measure peak to peak voltages and dc voltage if any.
2. Connect the second filter circuits of fig (2)
3. Display the input and out put voltages both on the scope. Measure the dc voltages and peak to peak ripple voltages. Also measure the time elapsed between two consecutive cycles of diode conduction. Compare the results with the theoretical estimates.

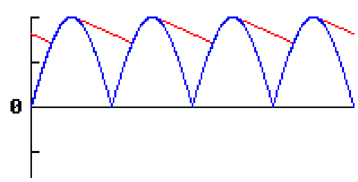
OBSERVATION: - Observe the waveforms on the CRO for both the inductive and capacitive filter.



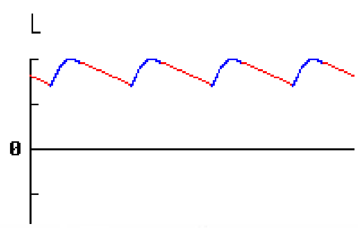
Output Voltage Waveforms
Full-Wave Rectifier With Series Inductor Filter



Input Voltage Waveform To Rectifier



Rectified and Filtered Output Voltage Waveforms



Load Current Waveform

RESULT: - The rectifier output is the pulsating dc voltage it is make pure dc by the filter circuit. So the output of the filter circuit is observed by this experiment in CRO.

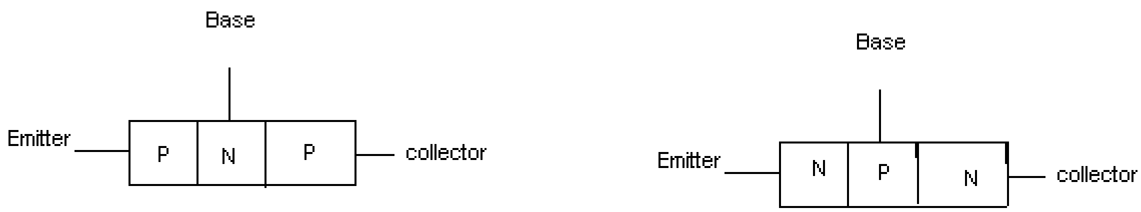
PRECAUTIONS: - 1) All electrical apparatus that connects to the AC power line must have a protective ground through a three-wire power cable.
2) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
3) Always switch the circuit power off before changing components or connections. It is tempting to become lazy and change connections in low-power circuits with the supply on, but this is asking for trouble in the form of unintentional short circuits and blown components.
4) Always ask for directions or help if you are unsure of the correct measurement procedure or circuit connection.

EXPERIMENT No- 7

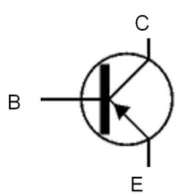
OBJECTIVE: - Obtain the input & output transistor characteristics for CB configuration.

EQUIPMENT REQUIRED: - Experimental kit, wire

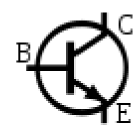
THEORY: - A transistor is a three terminal current sensing device. It can be looked upon as two pn junction placed back to back. The three terminals are named as emitter base & collector. The transistor may be NPN or PNP type. The sandwiched materials produce two pn junctions. BJTs are current amplifiers. These two junctions form two diodes-the emitter-base diode and base-collector diode. A small base current is amplfied to a larger current in the collector-emitter circuit form two diodes-the emitter-base diode and base-collector diode.



Construction of PNP and NPN Transistor



Symbol of PNP



Symbol of NPN

A transistor may be connected in three configurations namely:

a) Common Emitter (CE)
b) Common Base (CB)
c) Common collector (CC)

Each configuration, as you will see later, has particular characteristics that make it suitable for specific applications. An easy way to identify a specific transistor configuration is to follow three simple steps:

- Identify the element (emitter, base, or collector) to which the input signal is applied.
- Identify the element (emitter, base, or collector) from which the output signal is taken.
- The remaining element is the common element, and gives the configuration its name.

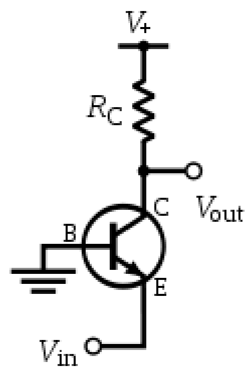
The common-base configuration (CB), is mainly used for impedance matching, since it has a low input resistance (30 ohms-160 ohms) and a high output resistance (250 kilohms-550 kilohms). However, two factors limit its usefulness in some circuit applications: (1) its low input resistance and (2) its current gain of less than 1. Since the CB configuration will give voltage amplification, there are some additional applications, which require both a low-input resistance and voltage amplification, that could use a circuit configuration of this type; for example, some microphone amplifiers.

In the common-base configuration, the input signal is applied to the emitter, the output is taken from the collector, and the base is the element common to both input and output. Since the input is applied to the emitter, it causes the emitter-base junction to react in the same manner as it did in the common-emitter circuit.

The current gain in the common-base circuit is calculated in a method similar to that of the common emitter except that the input current is I_E not I_B and the term ALPHA (a) is used in place of beta for gain. Alpha is the relationship of collector current (output current) to emitter current (input current). Alpha is calculated using the formula:

This is a current gain of less than 1.

$$\alpha = \frac{\Delta I_C}{\Delta I_E}$$

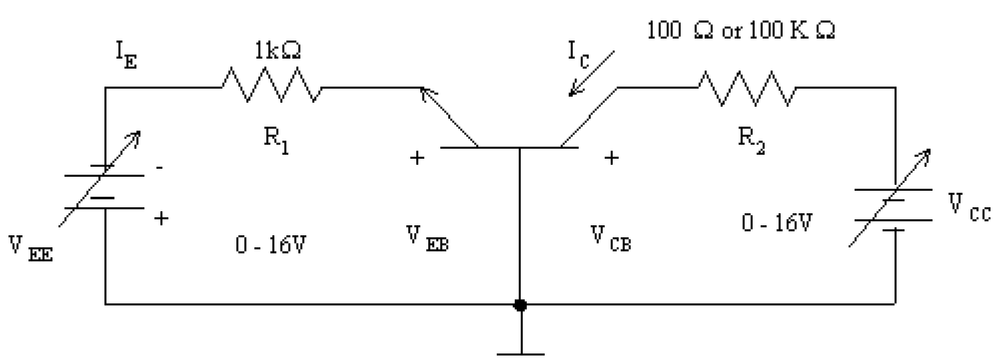


Basic NPN common-base circuit

Input Characteristics, a graph of the base current I_E versus V_{BE} with constant V_{CB} , which is the voltage between the base and the collector, looks like that of an ordinary diode. I_E increases rapidly with small increase in $V_{BE.}$ The I_E is almost independent of $V_{CB.}$

Output characteristics are found by considering the collector loop. A graph of the collector current I_C versus the collector-base voltage V_{CB} with constant I_E. The I_C varies with V_{CB} only at very low voltages (< 1 v). Beyond this value I_C became constant and dependent upon only I_E . A very large change in produces only a tiny change in the I_C

CIRCUIT DIAGRAM:-



Circuit diagram for common-base configuration

PROCEDURE:-1) Construct the common-base circuit of Figure, with R_1 = 1 kilohm, R_2 = 100 kilohms, and independent power supplies for V_{EE} and V_{CC}. Be sure to measure R_1 and R_2 as accurately as possible because they will be used to determine current.
2) Open-circuit the input. Increase V_{CC} to 16 V and take sufficient data to plot a smooth curve of I_C vs. V_{CB} for all regions. Return V_{CC} to zero. The value of I_C may be too small to accurately measure.
3) Set R_2 to 100 ohms, reconnect the input circuit, and adjust V_{EE} so that I_E = 1 mA. Set $V_{CB} = 5V$, and record V_{EB}. Increase V_{CC} until I_C reaches 1 mA or until V_{CC} = 16 V. Then take data for a plot of I_C vs V_{CB}. Be sure to keep I_E constant during the data run.
4) Repeat Part 3 for I_E = 2, 3, 4, and 5 mA. Tabulate your results.

OBSERVATION TABLE:-

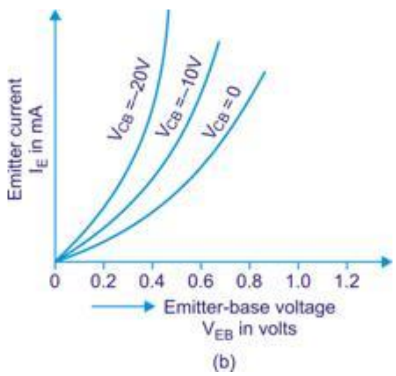
For Input characteristics

Procedure	For V_{CB} =0 V		For V_{CB} =10V		For V_{CB} =20V	
	V_{BE} (v)	I_E (mA)	V_{BE}(v)	I_E(mA)	V_{BE}(v)	I_E(mA)
1						
2						
3						

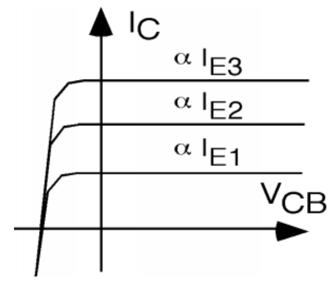
For Output characteristics

Procedure	For I_E = 10 mA		For I_E =20mA		For I_E =30mA	
	V_{CB}(v)	I_C (mA)	V_{CB}(v)	I_C(mA)	V_{CB}(v)	I_C(mA)
1						
2						
3						

RESULT: - The input and output characteristics of Common Base configuration are determined



Input characteristics of CB



Output characteristics of CB

PRECAUTIONS: - 1) All the connection should be tight.

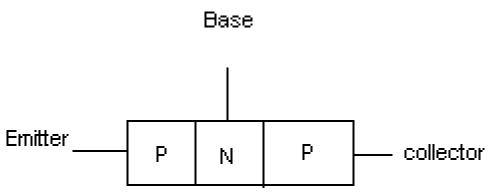
2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5) Before the circuit connection it should be check out working condition of all the Component.

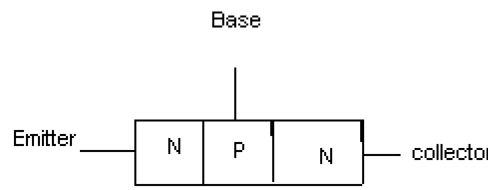
EXPERIMENT No- 8

OBJECTIVE: - Obtain the input & output transistor characteristics for CE configuration.

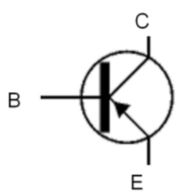
EQUIPMENT REQUIRED: - Experimental kit, wire

THEORY: - A transistor is a three terminal current sensing device. It can be looked upon as two pn junction placed back to back. The three terminals are named as emitter base & collector. The transistor may be NPN or PNP type. The sandwiched materials produce two pn junctions. BJTs are current amplifiers. These two junctions form two diodes-the emitter-base diode and base-collector diode. A small base current is amplfied to a larger current in the collector-emitter circuit form two diodes-the emitter-base diode and base-collector diode.

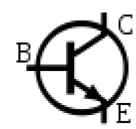




Construction of PNP and NPN Transistor



Symbol of PNP



Symbol of NPN

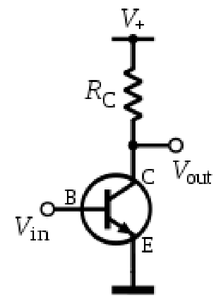
In common emitter or CE circuit, the base terminal of the transistor serves as the input, the collector is the output, and the emitter is common to both, hence its name. It is used for amplification. A small signal introduced into the base produces a larger signal at the output.

The term common is used to denote the element that is common to both input and output circuits. Because the common element is often grounded, these configurations are frequently referred to as grounded emitter, grounded base, and grounded collector. A transistor may be connected in three configurations namely:

a) Common Emitter (CE)
b) Common Base (CB)
c) Common collector (CC)

CE configuration has following characteristics:

A) High voltage gain
b) High current gain
c) Medium input impendence.
d) Output impendence equal too the load resistance



Basic NPN common-emitter circuit

The transistor gain, or β, is the ratio of the collector current I_C to the base current I_B , The gain tells how much the input signal is amplified. It is a constant that depends on the transistor type.

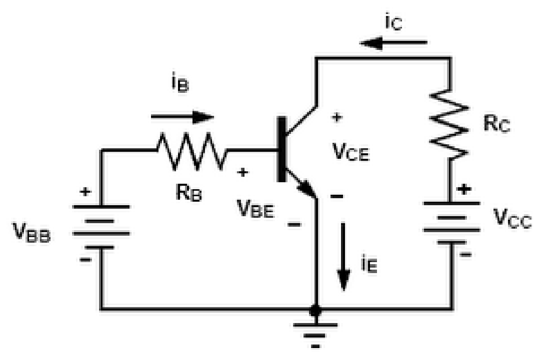
$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

Input Characteristics, a graph of the base current I_B versus V_{BE} with constant $V_{CE,}$ which is the voltage between the base and the emitter, looks like that of an ordinary diode. The current is zero until V_{BE} reaches 0.7 volts, where it then increases very suddenly.

Output characteristics are found by considering the collector loop. A graph of the collector current I_C versus the collector-emitter voltage V_{CE} with constant I_B. As V_{CE} increases, I_C will remain zero and then suddenly shoot up when the voltage reaches a certain value, much the same way as I_B. Unlike I_B, I_C will remain constant as V_{CE} increases

	Definition	**Expression**
Current gain	$A_i \triangleq \frac{i_{out}}{i_{in}}$	β
Voltage gain	$A_v \triangleq \frac{v_{out}}{v_{in}}$	$-\frac{\beta R_C}{r_\pi + (\beta+1)R_E}$
Input impedance	$r_{in} \triangleq \frac{v_{in}}{i_{in}}$	$r_\pi + (\beta + 1)R_E$
Output impedance	$r_{out} \triangleq \frac{v_{out}}{i_{out}}$	R_C

CIRCUIT DIAGRAM:-



Circuit diagram for CE Configuration

PROCEDURE:-.

1) Make connections as in fig.
2) Set P2 to get a value of V_{CE}
3) With the same V_{CE} measure V_{BE} for different I_B.
4) Repeat step (3) for different V_{CE} Plot a graph between V_{BE} & I_B to get input characteristics.
6) Now fix I_B to a value &measure I_C for different V_{CE}
7) Change I_B & repeat step (6)
8) Plot a graph between V_{CE} & I_C for different I_B to get output characteristics.

OBSERVATION TABLE:-

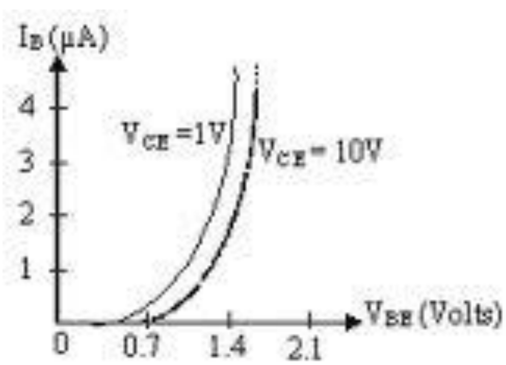
For Input characteristics

Procedure	For V_{CE} =1V		For V_{CE} =5V		For V_{CE} =10V	
	V_{BE} (v)	I_B (μA)	V_{BE}(v)	I_B(μA)	V_{BE}(v)	I_B(μA)
1						
2						
3						

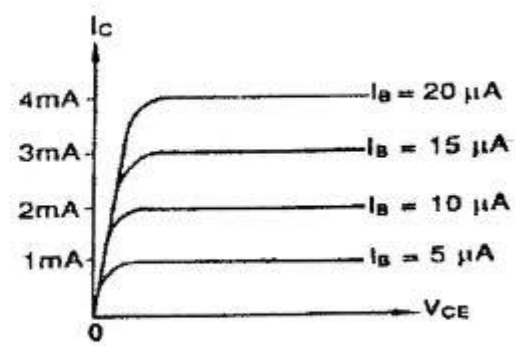
For Output characteristics

Procedure	For I_B =5 μA		For I_B =10 μA		For I_B =15 μA	
	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)
1						
2						
3						

RESULT: - The input and output characteristics of Common Emitter configuration are determined.



Input characteristics of CE



Output characteristics of CE

PRECAUTIONS: - 1) All the connection should be tight.

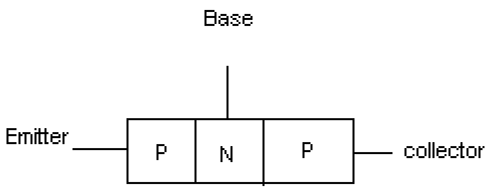
2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5) Before the circuit connection it should be check out working condition of all the Component.

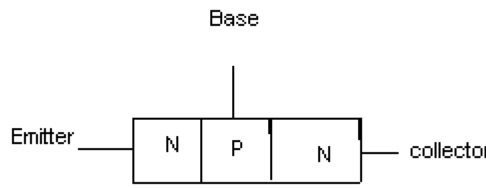
EXPERIMENT No- 9

OBJECTIVE: - Obtain the input & output transistor characteristics for CC configuration.

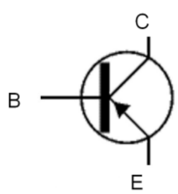
EQUIPMENT REQUIRED: - Experimental kit, wire

THEORY: - A transistor is a three terminal current sensing device. It can be looked upon as two pn junction placed back to back. The three terminals are named as emitter base & collector. The transistor may be NPN or PNP type. The sandwiched materials produce two pn junctions. BJTs are current amplifiers. These two junctions form two diodes-the emitter-base diode and base-collector diode. A small base current is amplfied to a larger current in the collector-emitter circuit form two diodes-the emitter-base diode and base-collector diode.

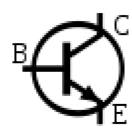




Construction of PNP and NPN Transistor



Symbol of PNP



Symbol of NPN

A transistor may be connected in three configurations namely:

a) Common Emitter (CE)
b) Common Base (CB)
c) Common collector (CC)

The common-collector configuration (CC) is used mostly for impedance matching. It is also used as a current driver, because of its substantial current gain. In the common-collector circuit, the input signal is applied to the base, the output is taken from the emitter, and the collector is the element common to both input and output. The input resistance for the common collector ranges from 2 kilohms to 500 kilohms, and the output resistance varies from 50 ohms to 1500 ohms. The current gain is higher than that in the common emitter, but it has a lower power gain than either the common base or common emitter. Like the common base, the output signal from the common collector is in phase with the input signal. The common collector is also referred to as an emitter-follower because the output developed on the emitter follows the input signal applied to the base.

Transistor action in the common collector is similar to the operation explained for the common base, except that the current gain is not based on the emitter-to-collector current ratio, alpha (a). Instead, it is based on the emitter-to-base current ratio called GAMMA (g), because the output is taken off the emitter. Since a small change in base current controls a large change in emitter current, it is still possible to obtain high current gain in the common collector. However, since the emitter current gain is offset by the low output resistance, the voltage gain is always less than 1 (unity), exactly as in the electron-tube cathode follower

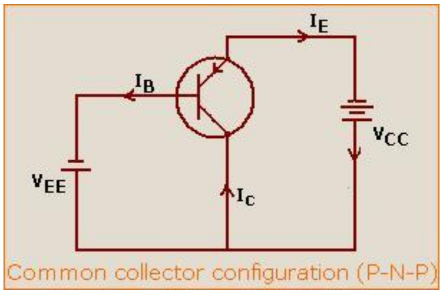
The common-collector current gain, gamma (g), is defined as

$$\gamma = \frac{\Delta I_E}{\Delta I_B}$$

Input Characteristics, a graph of the base current I_B versus V_{CB} with constant $V_{CE,}$ which is the voltage between the base and the emitter, looks like that of an ordinary diode. The current is zero until V_{CB} reaches 0.7 volts, where it then increases very suddenly.

Output characteristics are found by considering the collector loop. A graph of the emitter current I_E versus the collector-emitter voltage V_{CE} with constant I_B. As V_{CE} increases, I_E will remain zero and then suddenly shoot up when the voltage reaches a certain value, much the same way as I_B. Unlike I_B, I_E will remain constant as V_{CE} increases

CIRCUIT DIAGRAM:-



PROCEDURE:-. 1) Make connections as in fig.

2) Set P2 to get a value of V_{CE}
3) With the same V_{CE} measure V_{CB} for different I_B.
4) Repeat step (3) for different V_{CE} Plot a graph between V_{CB} & I_B to get input characteristics.
6) Now fix I_B to a value &measure I_E for different V_{CE}
7) Change I_B & repeat step (6)
8) Plot a graph between V_{CE} & I_E for different I_B to get output characteristics.

OBSERVATION TABLE:-

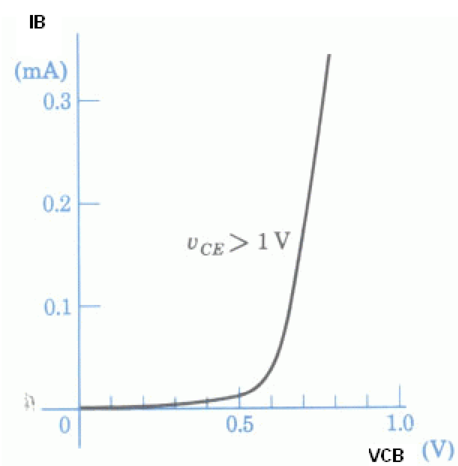
For Input characteristics

Procedure	For V_{CE} =1V		For V_{CE} =2V		For V_{CE} =3V	
	V_{CB}(V)	I_B (μA)	V_{CB}(V)	I_B (μA)	V_{CB}(V)	I_B(μA)
1						
2						
3						

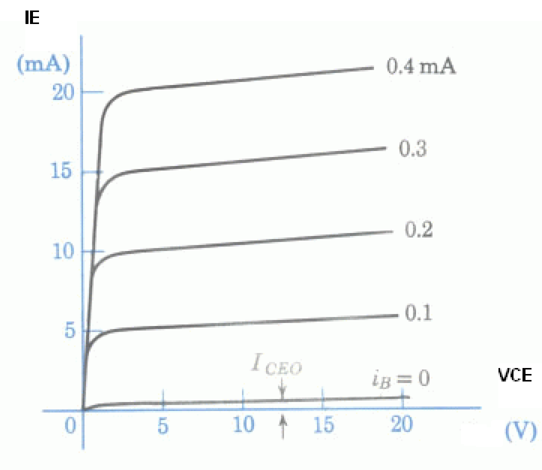
For Output characteristics

Procedure	For I_B =0 μA		For I_B =10 μA		For I_B =20 μA	
	V_{CE}(V)	I_E (mA)	V_{CE}(V)	I_E(mA)	V_{CE}(V)	I_E(mA)
1						
2						
3						

RESULT: - The input and output characteristics of Common Collector configuration are determined.



Input characteristics of CC



Output characteristics of CC

PRECAUTIONS: - 1) All the connection should be tight.

2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5) Before the circuit connection it should be check out working condition of all the Component.

EXPERIMENT No- 10

OBJECTIVE: - Verify the operation of BJT & FET as a switch.

EQUIPMENT REQUIRED: - Transistor, FET, resistor, lamp.

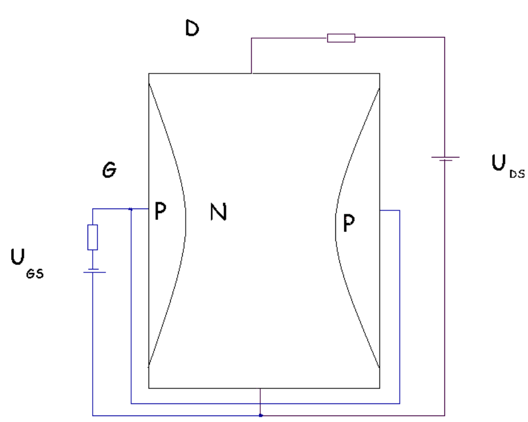
THEORY:- A switch is a device that is used to 'open' or 'close' a circuit. Opening a circuit means creating a break in the circuit, preventing current flow and thus, turning it 'off'. Closing a circuit, on the other, means completing the circuit path, thereby allowing current to flow around it and thus, turning it 'on'.

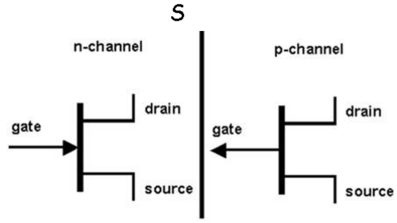
The bipolar transistor, whether NPN or PNP, may be used as a switch. Recall that the bipolar transistor has three regions of operation: the cut-off region, the linear or active region, and the saturation region. When used as a switch, the bipolar transistor is operated in the cut-off region (the region wherein the transistor is not conducting, and therefore makes the circuit 'open') and saturation region (the region wherein the transistor is in full conduction, thereby closing the circuit).

The bipolar transistor is a good switch because of its large transconductance Gm, with Gm = Ic/Vbe where Ic is the collector-to-emitter (output) current and Vbe is the base-emitter (input) voltage. Its high Gm allows large collector-to-emitter currents to be easily achieved if sufficient excitation is applied at the base.

The field-effect transistor (FET) relies on an electric field to control the shape and hence the conductivity of a channel of one type of charge carrier in a semiconductor material. FETs are sometimes called unipolar transistors to contrast their single-carrier-type operation with the dual-carrier-type operation of bipolar (junction) transistors (BJT). The concept of the FET predates the BJT, though it was not physically implemented until after BJTs due to the limitations of semiconductor materials and the relative ease of manufacturing BJTs compared to FETs at the time.

The FET controls the flow of electrons (or electron holes) from the source to drain by affecting the size and shape of a "conductive channel" created and influenced by voltage (or lack of voltage) applied across the gate and source terminals.



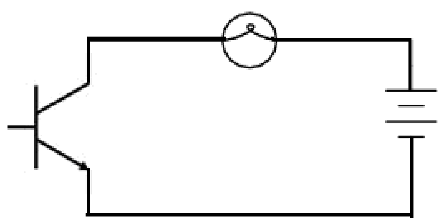


FET

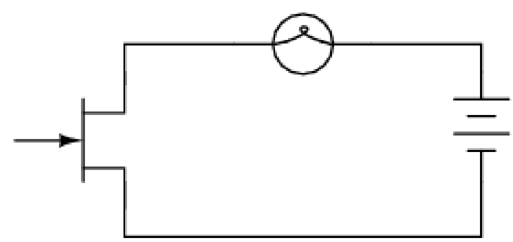
Field-Effect Transistor

Like its bipolar, the field-effect transistor may be used as an on/off switch controlling electrical power to a load. Remembering that the controlled current in a JFET flows between source and drain, we substitute the source and drain connections of a JFET for the two ends of the switch Unlike the bipolar junction transistor where the emitter is clearly distinguished from the collector by the arrowhead, a JFET's source and drain lines both run perpendicular into the bar representing the semiconductor channel. This is no accident, as the source and drain lines of a JFET are often interchangeable in practice! In other words, JFETs are usually able to handle channel current in either direction, from source to drain or from drain to source. Like the bipolar transistor, it matters little where or what the controlling voltage comes from. We could use a solar cell, thermocouple, or any other sort of voltage-generating device to supply the voltage controlling the JFET's conduction. All that is required of a voltage source for JFET switch operation is sufficient voltage to achieve pinch-off of the JFET channel. This level is usually in the realm of a few volts DC, and is termed the pinch-off or cutoff voltage. The exact pinch-off voltage for any given JFET is a function of its unique design, and is not a universal figure like 0.7 volts is for a silicon BJT's base-emitter junction voltage

CIRCUIT DIAGRAM:-



Circuit diagram for BJT as a switch



Circuit diagram for FET as a switch

PROCEDURE:-. 1) Make connections as in fig (1)
2) Applying no voltage at the base of the transistor will put it in the cut-off region, preventing current from flowing through it and through the load. Hence lamp is off.
3) Applying enough voltage at the base of the transistor will cause it to saturate and become fully conductive. Hence lamp is on.
4) Make connections as in fig (2)
5) Applying no voltage between gate and source, with zero applied voltage the JFET's channel will be "open," allowing full current to the lamp. Hence lamp is on.
6) Applying voltage between gate and source, a reverse-biased PN junction, it firmly opposes the flow of any electrons through it. As a voltage-controlled device, the JFET requires negligible input current. Hence lamp is off.

OBSERVATION:- By the above experiment we can seen the operation of BJT and FET as a switch by observe the on and off the lamp.

RESULT: - One limitation of this simple design is that the switch-off time of the transistor is slower than its switch-on time if the load is a resistor. This is because of the stray capacitance across the collector of the transistor and ground, which needs to charge through the load resistor during switch-off. On the other hand, this stray capacitance is easily discharged to ground by the large collector current flow when the transistor is switched on. JFETs are normally-on (normally-saturated) devices. The application of a reverse-biasing voltage between gate and source causes the depletion region of that junction to expand, thereby "pinching off" the channel between source and drain through which the controlled current travels.

PRECAUTIONS: - 1) All electrical apparatus that connects to the AC power line must have a protective ground through a three-wire power cable.

2) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.

3) Always switch the circuit power off before changing components or connections. It is tempting to become lazy and change connections in low-power circuits with the supply on, but this is asking for trouble in the form of unintentional short circuits and blown components.

4) Always ask for directions or help if you are unsure of the correct measurement procedure or circuit connection.

EXPERIMENT No- 11

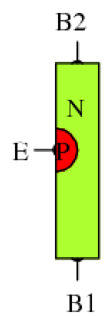
OBJECTIVE: - Verify the V-I characteristics of a UJT.

EQUIPMENT REQUIRED:- Experimental kit, Ammeter (0-30mA), Voltmeter (0-10V).

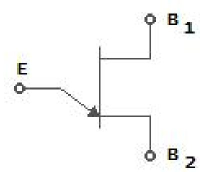
THEORY:- An Uni-Junction transistor (UJT) is a semiconductor device having only one p-n junction and three terminals. These three terminals are named as Base1, Base2, and Emitter.

UJT characteristics

The graph of emitter to base1 voltage versus emitter current is called UJT characteristics. The characteristics can be divided in three regions, cut-off region, negative resistance region and saturation region. The most important region is negative resistance region. Negative resistance region is the part of the characteristics where as current increases voltage decreases



Construction

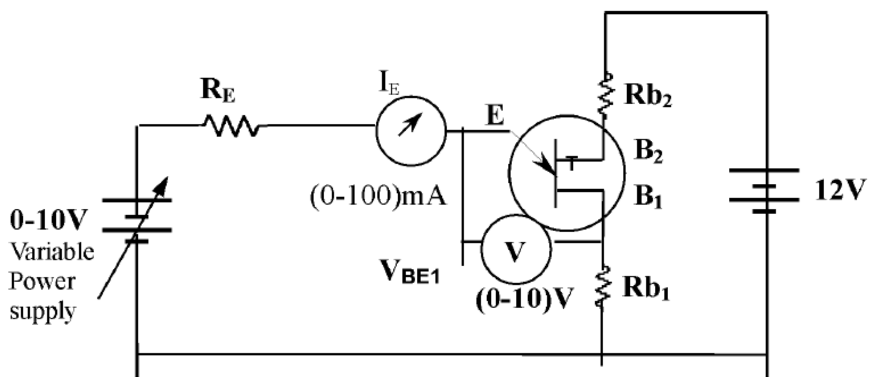


Symbol

The UJT is biased with a positive voltage between the two bases. This causes a potential drop along the length of the device. When the emitter voltage is driven approximately one diode voltage above the voltage at the point where the P diffusion (emitter) is, current will begin to flow from the emitter into the base region. Because the base region is very lightly doped, the additional current (actually charges in the base region) causes conductivity modulation which reduces the resistance of the portion of the base between the emitter junction and the B2 terminal. This reduction in resistance means that the emitter junction is more forward biased, and so even more current is injected. Overall, the effect is a negative resistance at the emitter terminal. This is what makes the UJT useful, especially in simple oscillator circuits.

In addition to its use as the active device in relaxation oscillators, one of the most important applications of UJTs or PUTs is to trigger thyristors (SCR, TRIAC, etc.). In fact, a DC voltage can be used to control a UJT or PUT circuit such that the "on-period" increases with an increase in the DC control voltage. This application is important for large AC current control.

CIRCUIT DIAGRAM:-



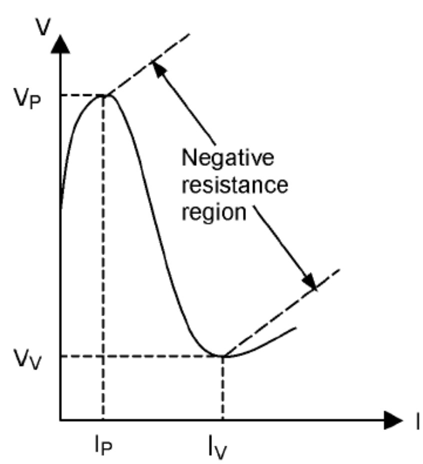
PROCEDURE:- 1) Make connections as per circuit diagram.

2) Switch on the circuit.
3) Observe peak voltage.
4) Increase the supply voltage step by step so that current increases.
5) Note down respective voltages.
6) Note down valley point voltage.
7) Take two or three readings in saturation region.
8) Take two or three readings in the negative resistance region.

OBSERVATION TABLE:-

Sr. No.	V_{BE1}	I_E	Remark
1.			
2.			
3.			
4.			
5.			

RESULT: - V-I characteristics of UJT are determined.



PRECAUTIONS: - 1) All the connection should be tight.

2) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.

3) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).

4) Before the circuit connection it should be check out working condition of all the Component.

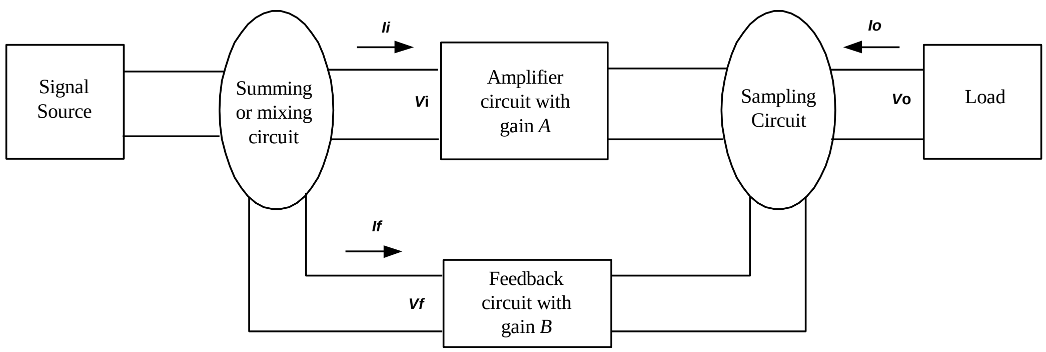
5) Circuit should be handling carefully

EXPERIMENT No- 12

OBJECTIVE: - Observe the characteristics of a: (i) Current series feedback amplifier
(ii) Voltage series feedback amplifier.

EQUIPMENT REQUIRED:- Power supply, transistor, signal generator, CRO, resistors, capacitors.

THEORY:- Feedback can be classified into two categories, a negative feedback and a positive feedback. The first category is the most widely used in all stable systems. Other systems that operate under unstable operating condition mainly use positive feedback. For example, Oscillator uses a positive feedback under certain conditions. The feedback process starts at the output terminals of the circuit or the system to be controlled. A small portion of the output (current or voltage) is taken, then inverted (changing its sign) and added to the input signal. Figure 1 shows the general block diagram of the negative feedback system.

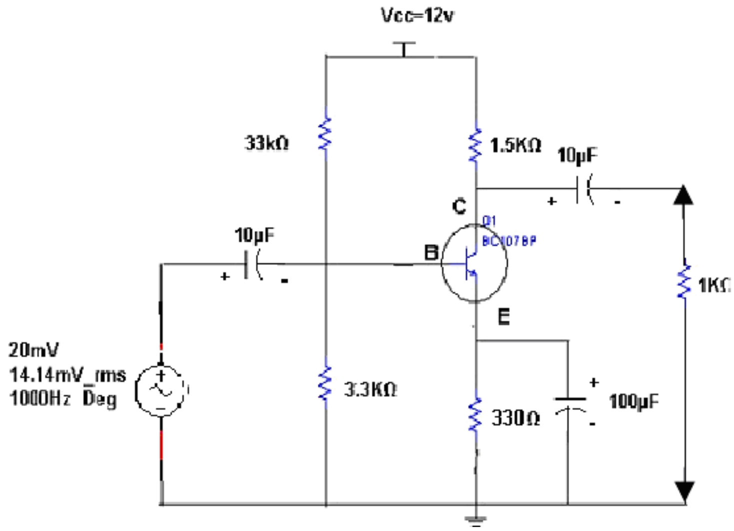


Applying the concept of the general feedback to the amplifier circuit, the sample of the output signal will be current or voltage with phase shift of 180 degree compared to the input signal. The negative feedback is found to improve the amplifier stability, improve the circuit's noise immunity, and extend the bandwidth of the amplifier and control the input and output resistance of the amplifier by selecting the appropriate feedback topology.

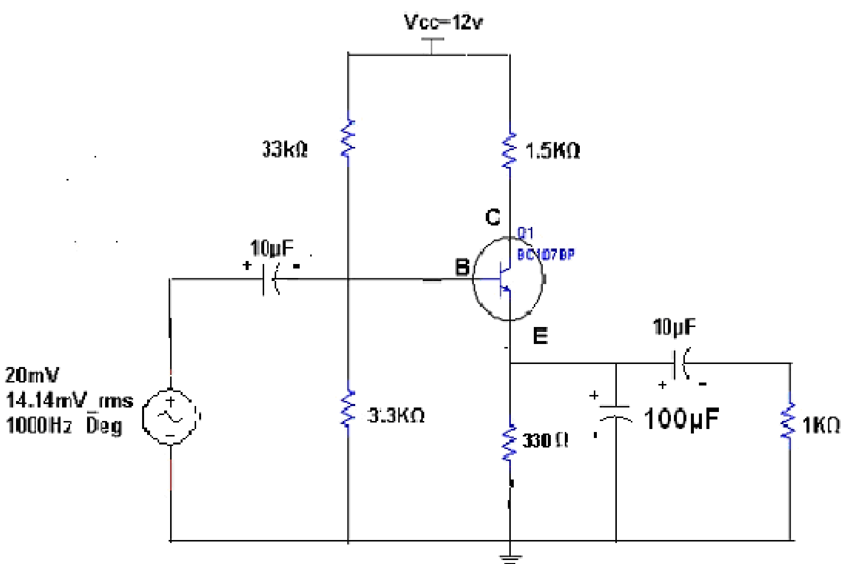
In **current – series feedback**, the input impedance and the output impedance are increased. Noise and distortions are reduced considerably.

In **voltage – series feedback**, the input impedance of the amplifier is decreased and the output impedance is increased. Noise and distortions are reduced considerably.

CIRCUIT DIAGRAM:-



(a)Circuit diagram for current- series feedback amplifier



(b)Circuit diagram for voltage-series feedback amplifier

PROCEDURE:- 1) Connection is made as per circuit diagram (a).

2) Keep the input voltage constant at 20 mV peak-peak and 1 kHz frequency. For different values of load resistance, note down the output voltage and calculate the gain by the expression

$$A_V = 20 \log (V_0/V_i) \text{ dB.}$$

3) Remove the emitter by pass capacitor and repeat step 2 and observe the effect of feedback on the gain of the amplifier.

4) For plotting the frequency the input voltage is kept constant at 20 mV peak-peaks and the frequency is varied from 100 Hz to 1 MHz.

5) Note down the value of output voltage for each frequency. All the readings are tabulated and the voltage gain in dB is calculated by, $A_V = 20 \log (V_0/V_i)$.

6) A graph is drawn by taking frequency on X-axis and gain on Y-axis.

7) Connection is made as per circuit diagram (b).

8) Keep the input voltage constant at 20 mV peak-peak and 1 kHz frequency. For different values of load resistance, note down the output voltage and calculate the gain by the expression

$$A_V = 20 \log (V_0/V_i) \text{ dB.}$$

9) Add the emitter by pass capacitor and repeat step 2 and observe the effect of feedback on the gain of the amplifier.

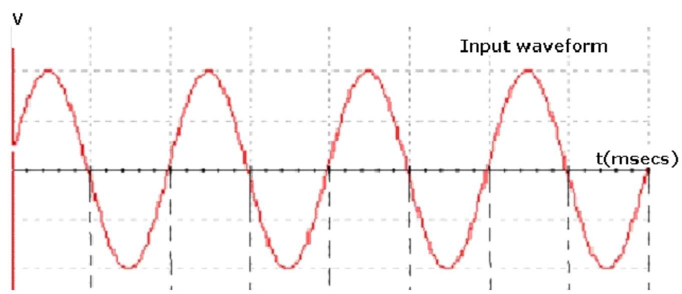
10) Repeat the procedure 4, 5 and 6.

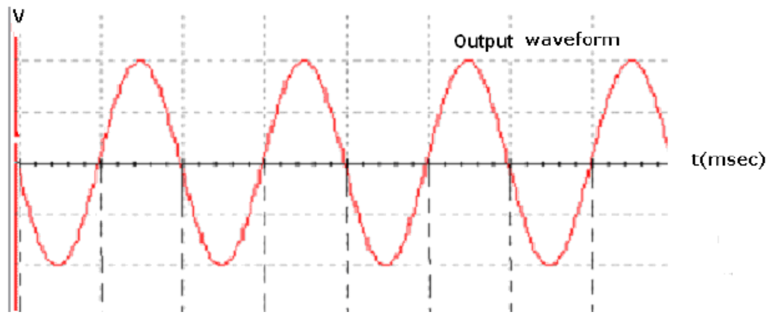
OBSERVATION TABLE:- **Voltage Gain =--------------**

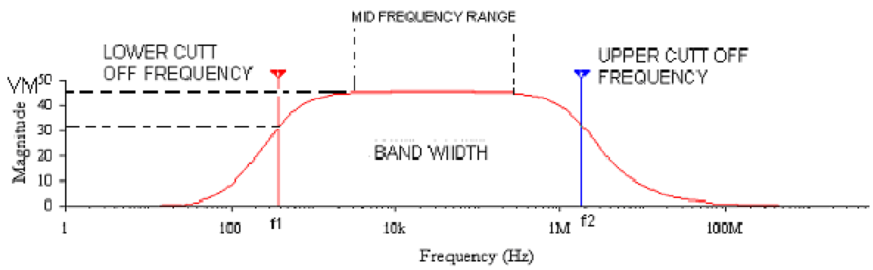
S.No.	O/P voltage (Vo) with feedback		O/P voltage (Vo) without feedback		Gain (dB) with feedback		Gain (dB) without feedback	
	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback
1								
2								
3								
4								

S.No.	Frequency (Hz)		O/P voltage (Vo)		Gain A= Vo / Vi		Gain in dB 20 log (Vo/Vi)	
	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback	Current-series feedback	Voltage – series feedback
1								
2								
3								
4								

RESULT:- The various wave forms are observed in CRO.







The effect of negative feedback (current-series and voltage-series) on the amplifier is observed. The voltage gain and frequency response of the amplifier are obtained. Also gain bandwidth product of thr amplifier is calculated.

PRECAUTIONS: - 1) While taking the observation for the frequency response, the input voltage must be maintain constant.
2) The frequency should be slowly increased in steps.
3) The three terminals of the transistor should be carefully identify.
4) All the connections should be correct.

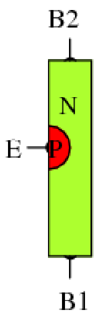
EXPERIMENT No- 13

OBJECTIVE: - Verify the action of UJT as a relaxation oscillator

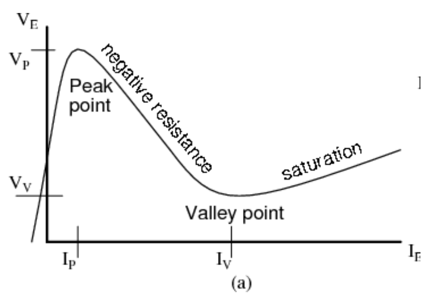
EQUIPMENT REQUIRED: - UJT, resistance box, decade condenser box, variable d.c. power supply, C.R.O. and connecting terminals.

THEORY:- The UJT has negative resistance characteristic, because of this character the UJT provides trigger pulse. Any one of the three terminals can be taken for triggering pulse. The UJT can be used as relaxation oscillator i.e. it produces non-sinusoidal waves.

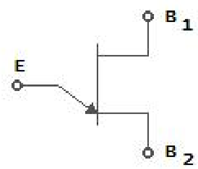
First the capacitor 'C' starts charging through the resistor R when VBB is switched on. During the charging of the capacitor, the voltage across it increases exponentially until it reaches to the peak point voltage VP. Up to now, the UJT is in off state, i.e. no conducting state at which RB1 value is high. When the voltage across the capacitor reaches to peak point voltage (VP) then, UJT comes into conducting state as the junction is forward biased and RB1 falls to low value (50_). Then the capacitor 'C' quickly discharges through UJT that means the discharging time is very less as the capacitor discharges through the low resistance UJT. When the voltage across the capacitor decreases to valley point voltage (VV) then the UJT shifts to off state and once again the capacitor gets charged through the resistor R and this process is repeated. This generates saw-tooth wave form



Construction



Characteristics



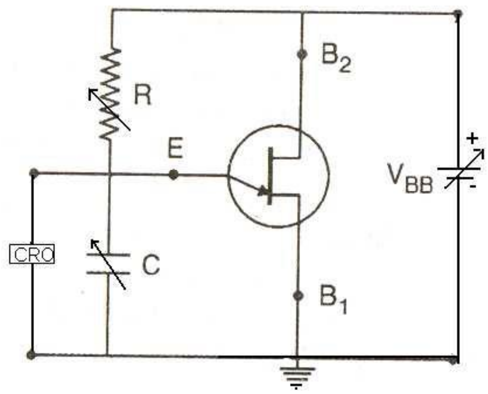
Symbol

Formula: - Frequency of oscillator

$$f = \frac{1}{2.303\,RC\,\log_{10}\left(\frac{1}{1-\eta}\right)}\,Hz$$

Where R = Resistance of the resistor (Ω)
C = Capacity of the condenser (F)
η = Intrinsic stand off ratio = 0.6

CIRCUIT DIAGRAM:-



PROCEDURE: - 1) Connect the circuit as shown in Fig and apply a fixed voltage VBB (5V to 10V) between the two bases B1 and B2.

2) As the Y – plates of CRO is connected across the condenser a saw tooth wave form is observed on its screen when the power is switch on.

3) Adjust of voltage sensitivity band switch of Y-plates and time base band switch X-plates such that at least one or two waves displayed in the screen.

4) Now note the horizontal length(l) between two successive peaks, in the table. When this horizontal length (l) is multiplied by the time base(t) i.e. sec/div , we get the time-period(T).

5) The reciprocal of the time-period(1/T) gives the frequency(f). This is the experimental value.

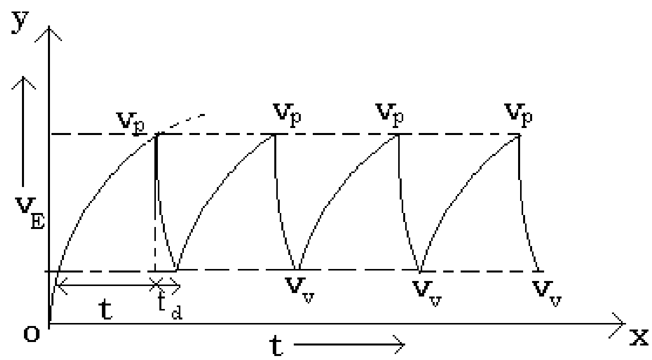
6) Note the values of resistance R and capacitance C of those connected in the circuit and take the intrinsic stand off ratio η as 0.6, substitute these values in the above formula and find the frequency. This is the theoretical value. Compare the theoretical and experimental frequencies. Repeat the experiment by changing the values of R or C or both.

OBSERVATION TABLE:-

$\eta = 0.6$

S. No.	R Ω	C F	Measurement of time period			Frequency	
			Horizontal length(l) div.	Time base (t) sec/div	T = lxt Sec.	Experimental f= 1/T	Theoretical $f = \frac{1}{2.303 RC \log_{10}(\frac{1}{1-\eta})} Hz$

RESULT: - Saw-tooth wave form across the capacitor which can be viewed on the CRO Screen.



PRECAUTIONS: - 1) The continuity of the connecting terminals should be checked before going to connect the circuit.

2) Identify the two bases and emitter of UJT and connect properly.
3) The power supply should be ‘on’ only when the observations are taken.
4) Measure the horizontal length of the wave with out any error.

EXPERIMENT No- 14

OBJECTIVE: - Setup an RC phase shift oscillator and analyses its operation.

EQUIPMENT REQUIRED: - Transistor, resistors, capacitors, potentiometer, CRO, power supply.

THEORY:- An electronic oscillator is an electronic circuit that produces a repetitive electronic signal, often a sine wave or a square wave. They are widely used in innumerable electronic devices. Common examples of signals generated by oscillators include signals broadcast by radio and television transmitters, clock signals that regulate computers and quartz clocks, and the sounds produced by electronic beepers and video games.

A phase-shift oscillator is a simple electronic oscillator. It contains an inverting amplifier, and a feedback filter which 'shifts' the phase of the amplifier output by 180 degrees at the oscillation frequency.

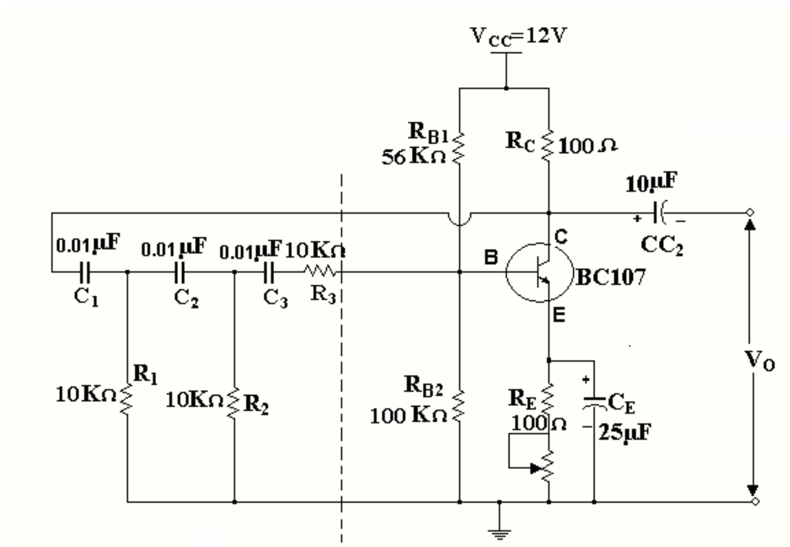
The filter produces a phase shift that increases with frequency. It must have a maximum phase shift of considerably greater than 180° at high frequencies, so that the phase shift at the desired oscillation frequency is 180°.The most common way of achieving this kind of filter is using three identical cascaded resistor-capacitor filters, which together produce a phase shift of zero at low frequencies, and 270 degrees at high frequencies. At the oscillation frequency each filter produces a phase shift of 60 degrees and the whole filter circuit produces a phase shift of 180 degrees.

In the RC phase shift oscillator, the combination RC provides self-bias for the amplifier. The phase of the signal at the input gets reverse biased when it is amplified by the amplifier. The output of amplifier goes to a feedback network consists of three identical RC sections. Each RC section provides a phase shift of 60 Thus a total of 180 phase shift is provided by the feedback network. The output of this circuit is in the same phase as the input to the amplifier The frequency of oscillations is given by

$$f_{\text{oscillation}} = \frac{1}{2\pi RC\sqrt{6}}$$

if R1 = R2 = R3 = R, and C1 = C2 = C3 = C

CIRCUIT DIAGRAM:-

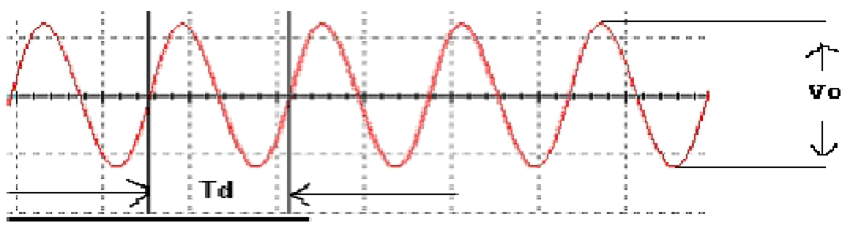


PROCEDURE: - 1) Connect the circuit as shown in Fig
2) Switch on the power supply
3) Connect the CRO at the output of the circuit
4) Adjust the RE to get undistorted waveform
5) Measure the Amplitude and Frequency
6) Compare the theoretical and practical values
7) Plot the graph amplitude versus frequency

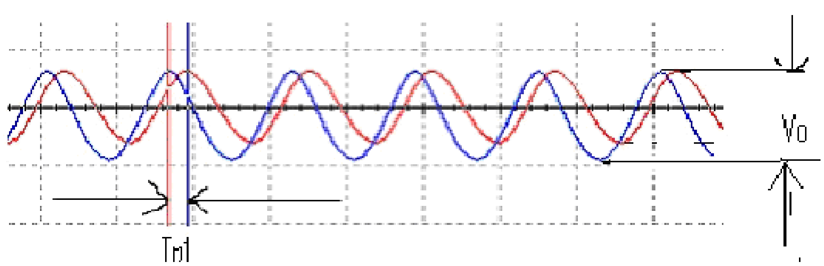
OBSERVATION TABLE:-

S.NO	Theoretical Frequency(Hz)	Practical Frequency(Hz)	% Error

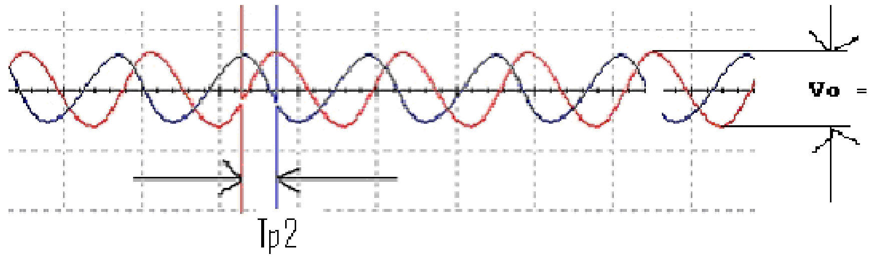
RESULT: - The frequency of RC Phase Shift Oscillator is determined



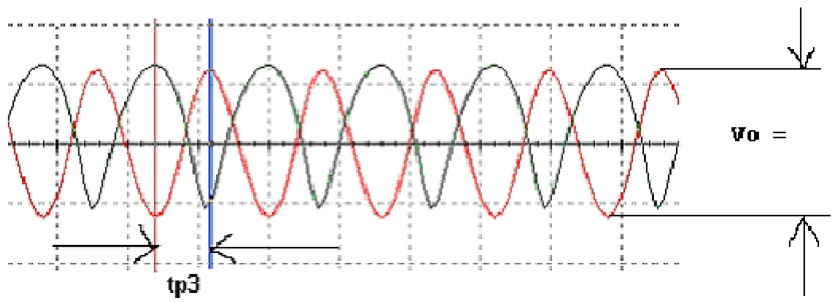
OUT PUT WAVE FORM : θ = 60



OUT PUT WAVE FORM : θ = 120



OUT PUT WAVE FORM : θ = 180



PRECAUTIONS: -1) All the connection should be tight.
2) The frequency should be slowly increased in steps.
3) The three terminals of the transistor should be carefully identify.
4) All the connections should be correct.
5) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.

EXPERIMENT No- 15

OBJECTIVE: - Setup the circuit and observe the action of bistable multivibrator & obtain the output Waveform.

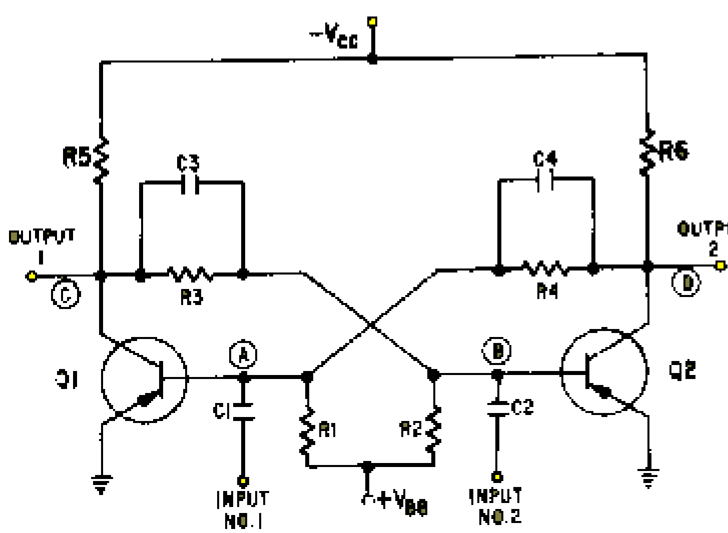
EQUIPMENT REQUIRED: - Experiment kit, connecting wire.

THEORY:- A multivibrator is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flops. A form of electronic circuit that employs positive feedback to cross-couple two devices so that two distinct states are possible, for example, one device ON and the other device OFF, and in which the states of the two devices can be interchanged either by use of external pulses or by internal capacitance coupling. When the circuit is switched between states, transition times are normally very short compared to the ON and OFF periods. Hence, the output waveforms are essentially rectangular in form.

Multivibrators may be classified as bistable, monostable, or astable. A bistable multivibrator, often referred to as a flip-flop, has two possible stable states, each with one device ON and the other OFF, and the states of the two devices can be interchanged only by the application of external pulses. As the name implies, the bistable multivibrator has two stable states. If a trigger of the correct polarity and amplitude is applied to the circuit, it will change states and remain there until triggered again. The trigger need not have a fixed prf; in fact, triggers from different sources, occurring at different times, can be used to switch this circuit.

If a sharp negative pulse is applied to the base of the ON transistor, its collector current decreases and its collector voltage rises. A fraction of this rise is applied to the base of the OFF transistor, causing some collector current to flow. The resultant drop in collector voltage, transferred to the base of the ON transistor, causes a further rise at its collector. The action is thus one of positive feedback, with nearly instantaneous transfer of conduction from one device to the other. There is one such reversal each time a pulse is applied to the gate of the ON transistor.

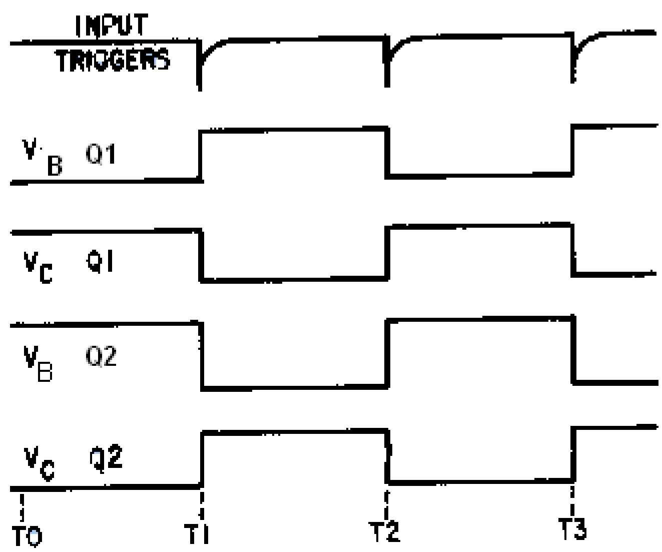
CIRCUIT DIAGRAM:-



PROCEDURE:-1) Set the bistable multivibrator circuit as in figure.

2) In this circuit, R1 and R7 are the collector load resistors. Voltage dividers R1, R2, and R5 provide forward bias for Q2; R7, R6, and R3 provide forward bias for Q1. These resistors also couple the collector signal from one transistor to the base of the other. Observe that this is direct coupling of feedback.
3) Both transistors use common emitter resistor R4 which provides emitter coupling. C1 and C2 couple the input triggers to the transistor bases.
4) If a sharp negative pulse is applied to the gate of the ON transistor, its drain current decreases and its drain voltage rises. A fraction of this rise is applied to the gate of the OFF transistor, causing some drain current to flow.
5) The resultant drop in drain voltage, transferred to the gate of the ON transistor, causes a further rise at its drain.
6) There is one such reversal each time a pulse is applied to the gate of the ON transistor. Normally pulses are applied to both transistors simultaneously so that whichever device is ON will be turned off by the action

OBSERVATION :- Observe the various waveform of bisatble multivibrater on the CRO.



RESULT:- By the observation we found that the bisatble circuit is in a stable state and will remain there until a trigger is applied to change the state.

PRECAUTIONS: -1) All the connection should be tight.
2) The three terminals of the transistor should be carefully identify.
3) All the connections should be correct.
4) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
5) Circuit should be handling carefully

EXPERIMENT No- 16

OBJECTIVE: -Setup the circuit and observe the action of monostable multivibrator & obtain the output waveform.

EQUIPMENT REQUIRED: - Experiment kit, connecting wire.

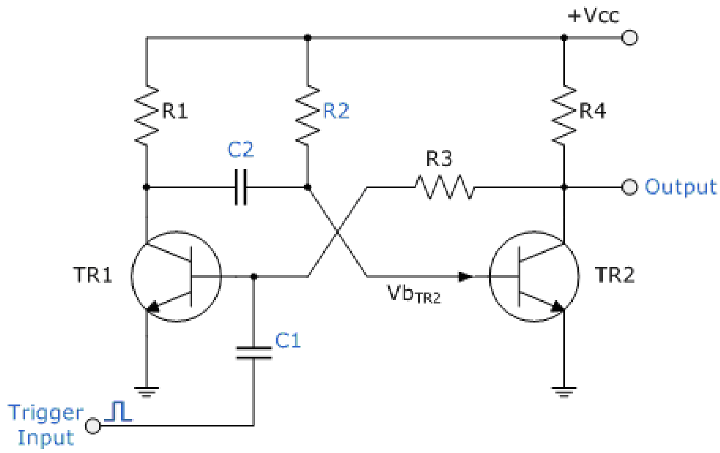
THEORY:- A multivibrator is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flops. A form of electronic circuit that employs positive feedback to cross-couple two devices so that two distinct states are possible, for example, one device ON and the other device OFF, and in which the states of the two devices can be interchanged either by use of external pulses or by internal capacitance coupling. When the circuit is switched between states, transition times are normally very short compared to the ON and OFF periods. Hence, the output waveforms are essentially rectangular in form.

Multivibrators may be classified as bistable, monostable, or astable. A monostable multivibrator, sometimes referred to as a one-shot, also has two possible states, only one of which is stable. If it is forced to the opposite state by an externally applied trigger, it will recover to the stable state in a period of time usually controlled by a resistance-capacitance (RC) coupling circuit.

A monostable or one-shot multivibrator has only one stable state. If one of the normally active devices is in the conducting state, it remains so until an external pulse is applied to make it nonconducting. The second device is thus made conducting and remains so for a duration dependent upon RC time constants within the circuit itself. Monostable multivibrators are available commercially in integrated chip form.

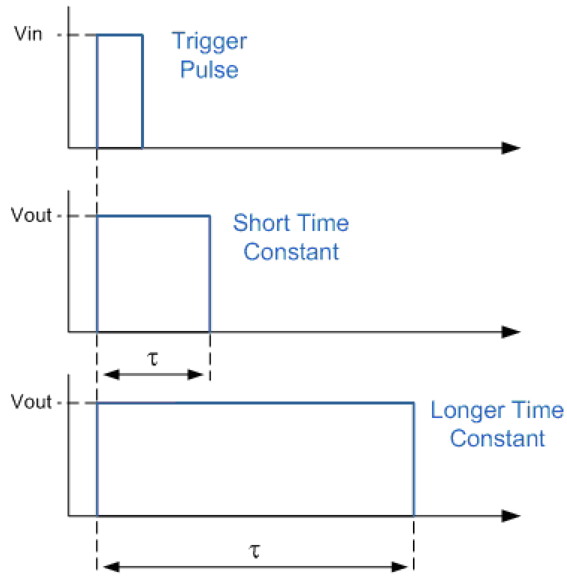
Monostable Multivibrators have only ONE stable state (hence there name: "Mono"), and they deliver a single output pulse when it is triggered externally only returning back to its first original and stable state after a period of time determined by the time constant of the RC coupled circuit. Monostable Multivibrators or "One-Shot Multivibrators" as they are sometimes called, are used to generate a single output pulse of a specified width, either "High" or "Low" when a suitable external trigger signal or pulse T is applied. This trigger signal initiates a timing cycle which causes the output of the monostable to change its state at the start of the timing cycle and remains in this second state, which is determined by the time constant of the Capacitor, C and the Resistor, R until it resets or returns itself back to its original (stable) state. It will remain in this stable state indefinitely until another input pulse or signal is received. Then, Monostable Multivibrators have only ONE stable state and go through a full cycle in response to a single triggering input pulse.

CIRCUIT DIAGRAM:-



PROCEDURE:-1) Make a circuit as the circuit diagram.
2) When power is firstly applied, the base of transistor TR2 is connected to Vcc via the biasing resistor, R2 thereby turning the transistor "fully-ON" and into saturation and at the same time turning TR1 "OFF" in the process.
3) The current flowing into the saturated Base terminal of TR2 will therefore be equal to Ib = (Vcc - 0.6)/R2.
4) If a trigger pulse is now applied at the input, the fast rising edge of the pulse will pass straight through capacitor, C1 to the Base of transistor, TR1 turning it "ON".
5) The Collector of TR1 which was previously at Vcc drops quickly to below zero volts effectively giving capacitor C2 a reverse charge of -0.6v across its plates. This results in transistor TR2 now having a Base voltage of -0.6v holding the transistor fully "OFF" at point Vb_{TR2}. This then represents the circuits second state, the "Unstable State" with an output voltage equal to Vcc.
6) Capacitor, C2 begins to discharge this -0.6v through resistor R2, attempting to charge up to the supply voltage Vcc. This negative voltage at the Base of transistor TR2 begins to decrease gradually at a rate determined by the time constant of the C2-R2 combination.
7) As the Base voltage of TR2 increases back up to Vcc, the transistor begins to conduct and doing so turns "OFF" again transistor TR1 which results in the monostable multivibrator automatically returning back to its original stable state awaiting a second trigger pulse to restart the process once again.

OBSERVATION:- Observe the various waveform of monosatble multivibrater on the CRO



RESULT:- Monostable Multivibrators are generally used to increase the width of a pulse or to produce a time delay within a circuit as the frequency of the output signal is always the same as that for the trigger pulse input, the only difference is the pulse width.Then to summarize, the Monostable Multivibrator circuit has only ONE stable state. When triggered by a short external trigger pulse it changes state and remains in this second state for an amount of time determined by the preset time period of the RC feedback components used. One this time period has passed the monostable automatically returns itself back to its original low state awaiting a second trigger pulse

PRECAUTIONS: -1) All the connection should be tight.
2) The three terminals of the transistor should be carefully identify.
3) All the connections should be correct.
4) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
5) Circuit should be handling carefully

EXPERIMENT No- 17

OBJECTIVE: - Setup the circuit and observe the action of astable multivibrators & obtain the output Waveform.

EQUIPMENT REQUIRED: - Experiment kit, connecting wire.

THEORY:- A multivibrator is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flops. A form of electronic circuit that employs positive feedback to cross-couple two devices so that two distinct states are possible, for example, one device ON and the other device OFF, and in which the states of the two devices can be interchanged either by use of external pulses or by internal capacitance coupling. When the circuit is switched between states, transition times are normally very short compared to the ON and OFF periods. Hence, the output waveforms are essentially rectangular in form.

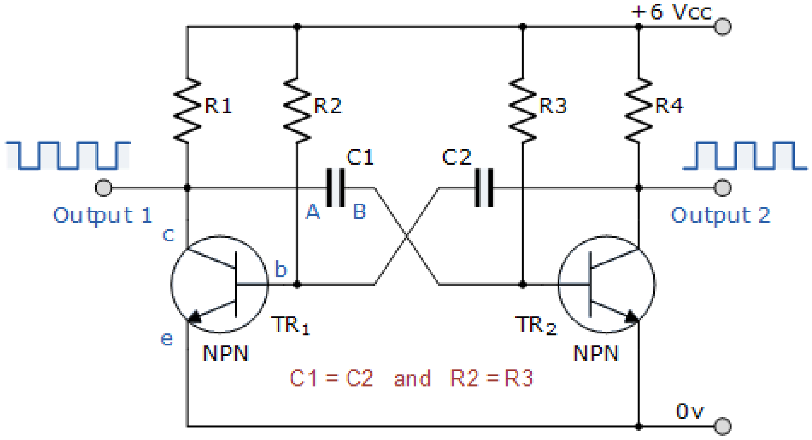
Multivibrators may be classified as bistable, monostable, or astable. An astable multivibrator has two possible states, neither of which is stable, and switches between the two states, usually controlled by two RC coupling time constants. The astable circuit is one form of relaxation oscillator, which generates recurrent waveforms at a controllable rate. The astable multivibrator has capacitance coupling between both of the active devices and therefore has no permanently stable state. Each of the two devices functions in a manner similar to that of the capacitance-coupled half of the monostable multivibrator. It will therefore generate a periodic rectangular waveform at the output with a period equal to the sum of the OFF periods of the two devices.

Astable multivibrators, although normally free-running, can be synchronized with input pulses recurrent at a rate slightly faster than the natural recurrence rate of the device itself. If the synchronizing pulses are of sufficient amplitude, they will bring the internal waveform to the conduction level at an earlier than normal time and will thereby determine the recurrence rate.

The basic transistor circuit for an Astable Multivibrator produces a square wave output from a pair of grounded emitter cross-coupled transistors. Both transistors either NPN or PNP, in the multivibrator are biased for linear operation and are operated as Common Emitter Amplifiers with 100% positive feedback. This configuration satisfies the condition for oscillation when: ($\beta A = 1\angle 0^o$). This results in one stage conducting "fully-ON" (Saturation) while the other is switched "fully-OFF" (cut-off) giving a very high level of mutual amplification between the two transistors.

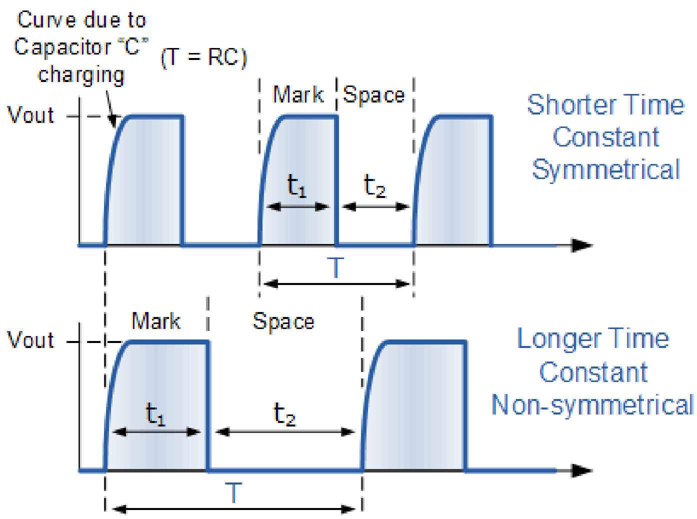
Unlike the Monostable Multivibrator and the Bistable Multivibrator we looked at in the previous tutorials that require an "external" trigger pulse for their operation, the Astable Multivibrator switches continuously between its two unstable states without the need for any external triggering.

CIRCUIT DIAGRAM:-



PROCEDURE:- 1) Make a circuit as the circuit diagram.
2) Assume that transistor, TR_1 has just switched "OFF" and its collector voltage is rising towards Vcc, meanwhile transistor TR_2 has just turned "ON".
3) Plate "A" of capacitor C1 is also rising towards the +6 volts supply rail of Vcc as it is connected to the collector of TR_1.
4) The instant that transistor, TR_1 switches "ON", plate "A" of the capacitor immediately falls to 0.6 volts. This fall of voltage on plate "A" causes an equal and instantaneous fall in voltage on plate "B" therefore plate "B" of the capacitor C1 is pulled down and this negative voltage turns transistor TR_2 hard "OFF". One unstable state.
5) Capacitor C1 now begins to charge in the opposite direction via resistor R3 which is also connected to the +6 volts supply rail, Vcc, thus the base of transistor TR_2 is moving upwards in a positive direction towards Vcc with a time constant equal to the C1.R3 combination.
6) Transistor TR_2 turns fully "ON" into saturation starting the whole process over again but now with capacitor C2 taking the base of transistor TR_1 , while charging up via resistor R2 and entering the second unstable state. This process will repeat itself over and over again as long as the supply voltage is present.
7) As the transistors are switching both "ON" and "OFF", the output at either collector will be a square wave with slightly rounded corners because of the current which charges the capacitors.

OBSERVATION:- Observe the various waveform of asatble multivibrater on the CRO



RESULT:- By the observation we found that Astable Multivibrator switches continuously between its two unstable states without the need for any external triggering. The basic transistor circuit for an Astable Multivibrator produces a square wave output. Astable Multivibrators can produce TWO very short square wave output waveforms from each transistor or a much longer rectangular shaped output either symmetrical or non-symmetrical depending upon the time constant of the RC network

PRECAUTIONS: - 1) All the connection should be tight.
2) The three terminals of the transistor should be carefully identify.
3) All the connections should be correct.
4) Always double check circuit wiring before applying power. Always have a single switch or button that will immediately remove power from the circuit in case of trouble.
5) Circuit should be handling carefully