# LABORATORY MANUAL

## ELECTRONIC DEVICES AND CIRCUITS

**B. Tech – II Year – I Sem**

**DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG.**

## BALAJI INSTITUTE OF TECHNOLOGY & SCIENCE

**Laknepally, Narsampet, Warangal**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**II Year B.Tech. EEE / ECE -I Sem**

# ELECTRONIC DEVICES AND CIRCUITS LAB

**PART A: (Only for Viva-voce Examination)**
**Electronic Workshop Practice (In 3 Lab Sessions):**

1. Identification, Specifications, Testing of R, L, C Components (Color Codes), Potentiometers, Switches (SPDT, DPDT, and DIP), Coils, Gang Condensers, Relays, Bread Boards, PCB's
2. Identification, Specifications and Testing of Active Devices, Diodes, BJT's, Low power JFET's, MOSFET's, Power Transistors, LED's, LCD's, SCR, UJT.
3. Study and operation of
   i. Multimeters (Analog and Digital)
   ii. Function Generator
   iii. Regulated Power Supplies
   iv. CRO.

**PART B: (For Laboratory Examination – Minimum of 10 experiments)**

1. Forward & Reverse Bias Characteristics of PN Junction Diode.
2. Zener diode characteristics and Zener as voltage Regulator.
3. Input & Output Characteristics of Transistor in CB Configuration and h-parameter calculations.
4. Input & Output Characteristics of Transistor in CE Configuration and h-parameter calculations.
5. Half Wave Rectifier with & without filters.
6. Full Wave Rectifier with & without filters.
7. FET characteristics.
8. Design of Self-bias circuit.
9. Frequency Response of CC Amplifier.
10. Frequency Response of CE Amplifier.
11. Frequency Response of Common Source FET amplifier .
12. SCR characteristics.
13. UJT Characteristics

**PART C: Equipment required for Laboratories:**

1. Regulated Power supplies (RPS) -0-30 V
2. CRO's -0-20 MHz.
3. Function Generators -0-1 MHz.
4. Multimeters
5. Decade Resistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analog or Digital) -0-20 µA, 0-50µA, 0-100µA, 0-200µA, 0-10 mA.
8. Voltmeters (Analog or Digital) -0-50V, 0-100V, 0-250V
9. Electronic Components -Resistors, Capacitors, BJTs, LCDs, SCRs, UJTs, FETs, LEDs, MOSFETs, Diodes – Ge & Si type, Transistors – NPN, PNP type)

**PART A:**

**Electronic Workshop Practice (In 3 Lab Sessions):**

1. Identification, Specifications, Testing of R, L, C Components (Color Codes), Potentiometers, Switches (SPDT, DPDT, and DIP), Coils, Gang Condensers, Relays, Bread Boards, PCB's
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3. Study and operation of
   - i. Multimeters (Analog and Digital)
   - ii. Function Generator
   - iii. Regulated Power Supplies
   - iv. CRO.

**Aim:**

1. To identify the different component symbols.
2. To study and operation of multimeter, function generator, and regulated power supply.
3. To observe front panel control knobs and to find amplitude, time period and frequency for given waveform.

**Apparatus:**

1. Resistors
2. Capacitors
3. Inductors
4. Transformers
5. Diodes
6. Transistors
7. Multimeter
8. Function generator
9. Regulated power supply
10. Cathode ray oscilloscope

**RESISTORS:**

Opposition to flow of currents is called resistance. The elements having resistance are called resistors. They are of two types

1. Fixed Resistor
2. Variable Resistor

**Specifications:**

1. Resistance value: This is the value of the resistance expressed in ohms. Ex: 10O, 1MO

2. Tolerance: This is the variation in the value of the resistance i.e. expected from exact indicated value usually tolerance is represented in % ex: 1%, 2%, 20%.

3. Power rating: The power rating is very important in the sense that it determines the maximum correct that a resistor can withstand without being destroyed. The power rating of resistor is specified as so many watts at a specific temperature such as one or two watts at 70 degree.

**CAPACITORS:**

A capacitor (originally known as condenser) is a passive two-terminal electrical component used to store energy in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction consists of metal foils separated by a thin layer of insulating film. Capacitors are widely used as parts of electrical circuits in many common electrical devices. They are of three types

1. Disk capacitor
2. Fixed capacitor
3. Variable capacitor

## INDUCTORS:

An inductor (also choke, coil, or reactor) is a passive two-terminal electrical component that stores energy in its magnetic field. For comparison, a capacitor stores energy in an electric field, and a resistor does not store energy but rather dissipates energy as heat.

Any conductor has inductance. An inductor is typically made of a wire or other conductor wound into a coil, to increase the magnetic field.

### Inductor value:

The inductance is defined as the ability of an inductor which opposes the change in current. It is denoted by the letter "L" and its unit is Henry (H).Ex:1H.2H…

### Mutual inductance:

It is the ability of a varying current in one inductor L1 induced voltage in another inductor L2 nearby. It is represented by Lm and is measured in Henry.

$M = K\sqrt{(L1XL2)}$ H

### Coefficient if coupling:

It is defined as the ratio of flux linkages between L1 and L2. To total flux produced by L1. It is represented by K and its typical value is 1.

$K = Lm/\sqrt{(L1XL2)}$

### Permeability:

It is denoted by micro's" and it is return as R = B/H. Where B = flux density, H = Flux intensity

## TRANSFORMERS:

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

1. Step up transformer
2. Step down transformer

## DIODES

In electronics, a diode is a two-terminal electronic component with an asymmetric transfer characteristic, with low (ideally zero) resistance to current flow in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. A vacuum tube diode is a vacuum tube with two electrodes, a plate (anode) and heated cathode.

1. P-N junction diode
2. Zener diode

**P N JUNCTION DIODE**

A p–n junction is a boundary or interface between two types of semiconductor material, p-type and n-type, inside a single crystal of semiconductor. It is created bydoping, for example by ion implantation, diffusion of dopants, or by epitaxy (growing a layer of crystal doped with one type of dopant on top of a layer of crystal doped with another type of dopant). If two separate pieces of material were used, this would introduce a grain boundary between the semiconductors that severely inhibits its utility by scattering the electrons and holes.

**ZENER DIODE**

A Zener diode is a diode which allows current to flow in the forward direction in the same manner as an ideal diode, but will also permit it to flow in the reverse direction when the voltage is above a certain value known as the breakdown voltage, "zener knee voltage", "zener voltage" or "avalanche point".

The device was named after Clarence Zener, who discovered this electrical property. Many diodes described as "zener" diodes rely instead on avalanche breakdown as the mechanism. Both types are used. Common applications include providing a reference voltage for voltage regulators, or to protect other semiconductor devices from momentary voltage pulses.

**TRANSISTORS**

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

The term transistor was coined by John R. Pierce as a portmanteau of the term "transfer resistor.

The transistor is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. Following its development in the early 1950s, the transistor revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things.

**Transistors types**

1. Bipolar Transistor Example: Bipolar junction transistor
2. Unipolar Transistor Example: Field effect transistor, Uni junction transistor

**Bipolar junction transistor**

A bipolar junction transistor (BJT or bipolar transistor) is a type of transistor that relies on the contact of two types of semiconductor for its operation

Bipolar transistors are so named because their operation involves both electrons and holes. These two kinds of charge carriers are characteristic of the two kinds of doped semiconductor material

Charge flow in a BJT is due to bidirectional diffusion of charge carriers across a junction between two regions of different charge concentrations. The regions of a BJT are called emitter, collector, and base.

A BJT consists of three differently doped semiconductor regions, the emitter region, the base region and the collector region. These regions are, respectively, p type, n type and p type in a PNP transistor, and n type, p type and n type in an NPN transistor. Each semiconductor region is connected to a terminal, appropriately labeled: emitter (E), base (B) and collector (C).

**Field effect transistor**

The field-effect transistor (FET) is a transistor that uses 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 can be majority-charge-carrier devices, in which the current is carried predominantly by majority carriers, or minority-charge-carrier devices, in which the current is mainly due to a flow of minority carriers. The device consists of an active channel through which charge carriers, electrons or holes, flow from the source to the drain. Source and drain terminal conductors are connected to the semiconductor through ohmic contacts. The conductivity of the channel is a function of the potential applied across the gate and source terminals.

The FET's three terminals are:

1. Source (S), through which the carriers enter the channel. Conventionally, current entering the channel at S is designated by $I_S$.
2. Drain (D), through which the carriers leave the channel. Conventionally, current entering the channel at D is designated by $I_D$. Drain to Source voltage is $V_{DS}$.
3. Gate (G), the terminal that modulates the channel conductivity. By applying voltage to G, one can control $I_D$.

**Types of FET**

1. Junction FET(JFET).

i) N-Channel JFET

ii) P-Channel JFET

2. Metal oxide semiconductor FET (MOSFET)

MOSFET types

1) Depletion MOSFET

i) N-Channel MOSFET

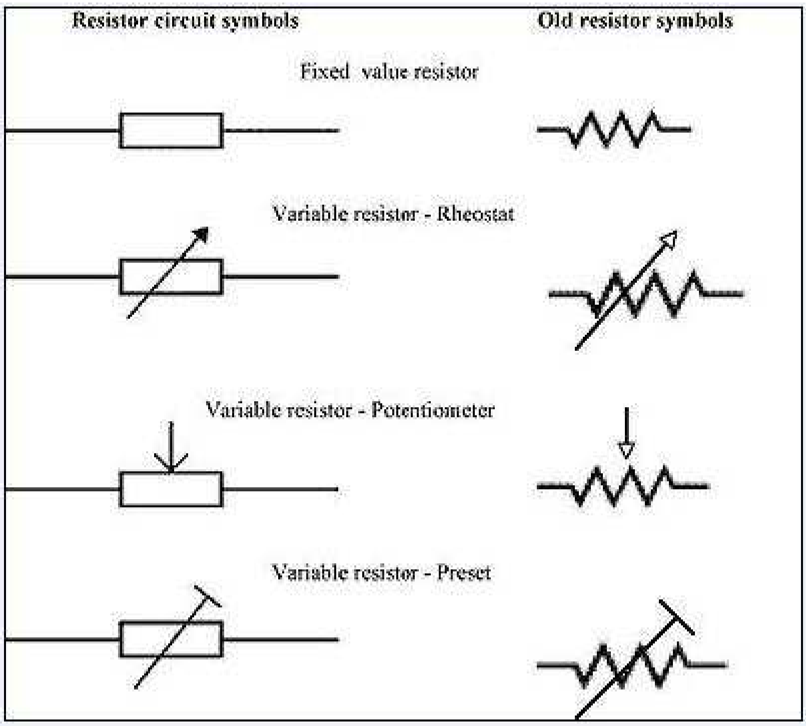
ii) P-Channel MOSFET

2) Enhancement MOSFET

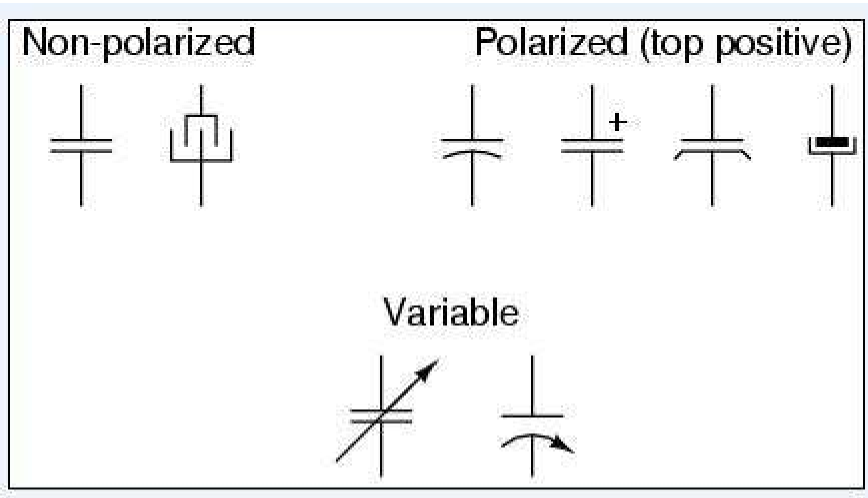
i) N-Channel MOSFET

ii) P-Channel MOSFET

**Resistor symbols**

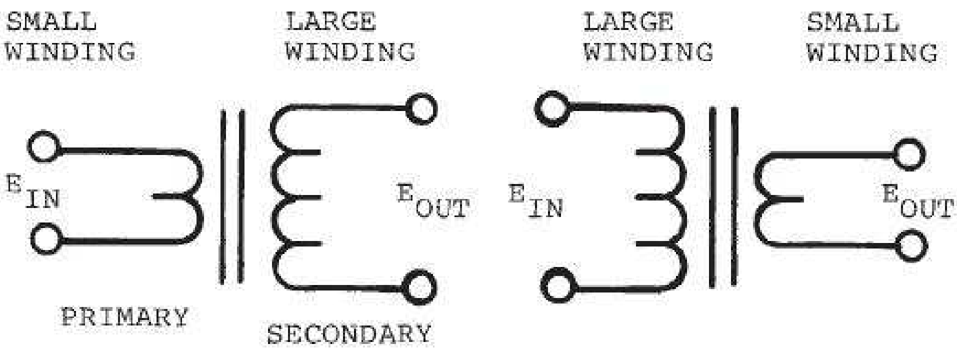



**Capacitor Symbols**

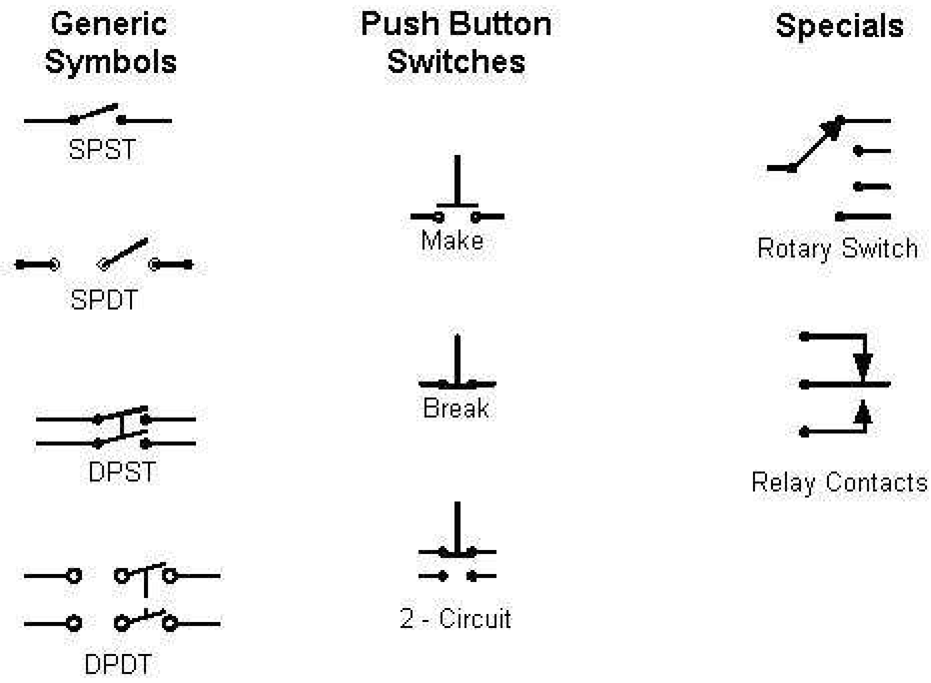



**Inductor symbols**

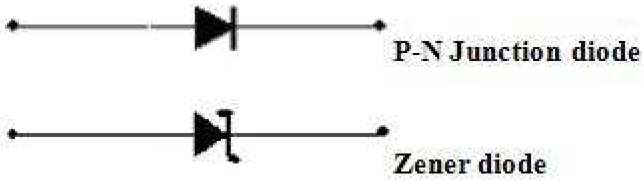

**Transformer symbols**



**Switches**

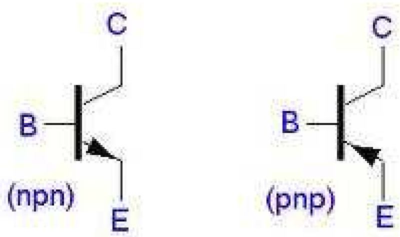



**Diodes symbols**

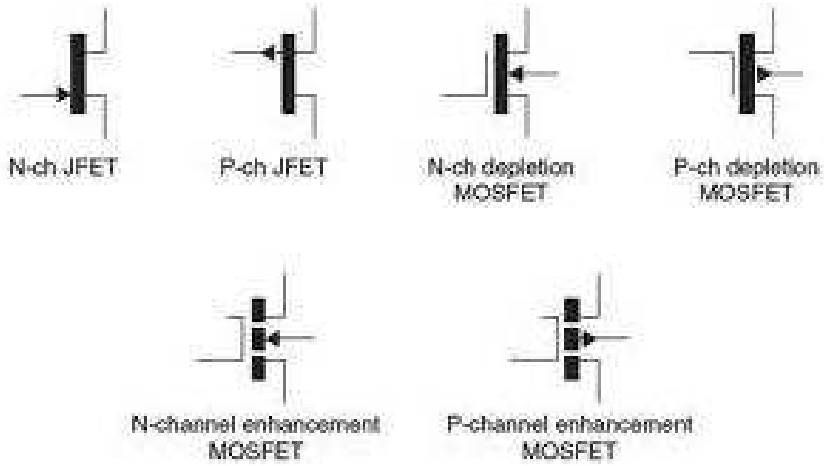



**Transistors symbols**

**BJT types**




**FET types**

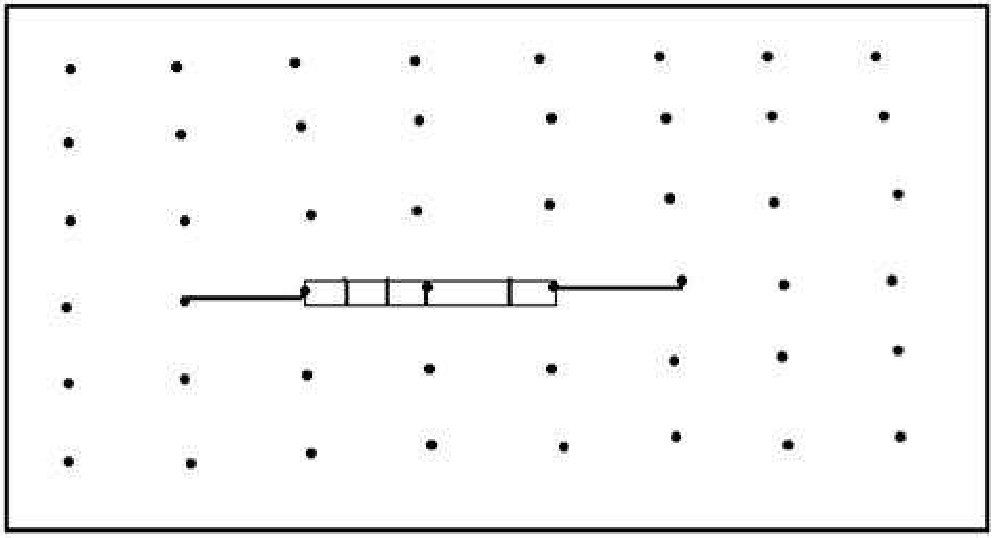


**BREADBOARD**

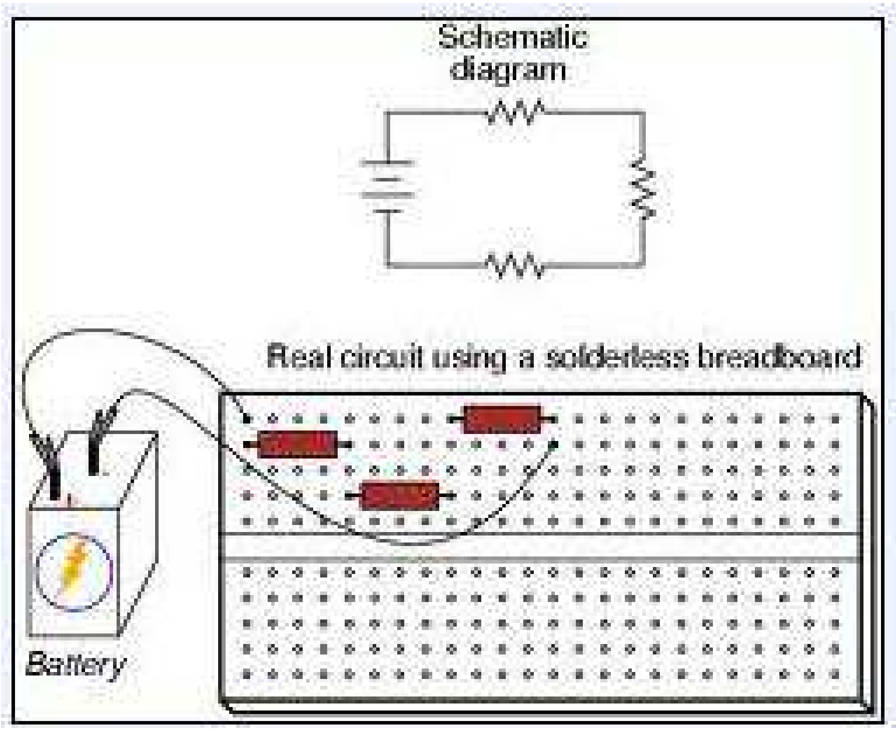
A breadboard (or protoboard) is a construction base for prototyping of electronics. The term "breadboard" is commonly used to refer to a solderless breadboard (plugboard).

Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. Older breadboard types did not have this property. A stripboard (veroboard) and similar prototypingprinted circuit boards, which are used to build permanent soldered prototypes or one-offs, cannot easily be reused. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units(CPUs).

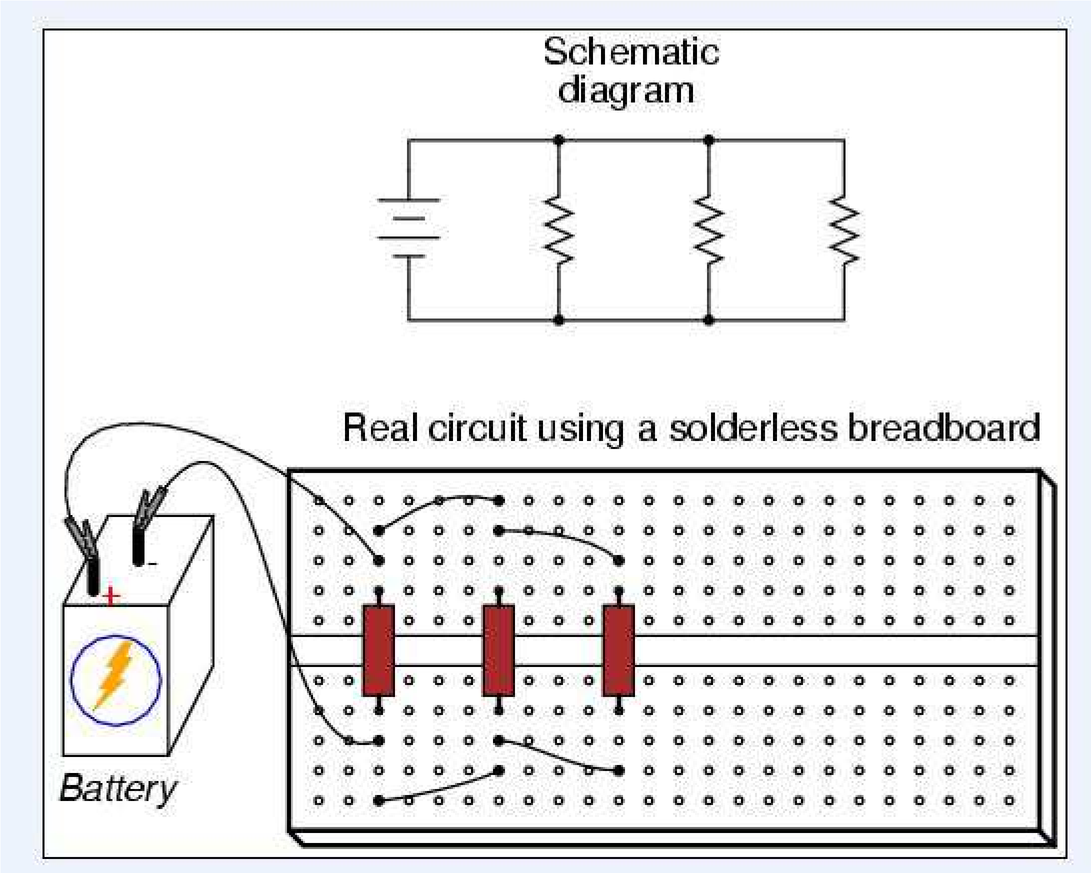
BREAD BOARD



**Series connection**



**Parallel connection**

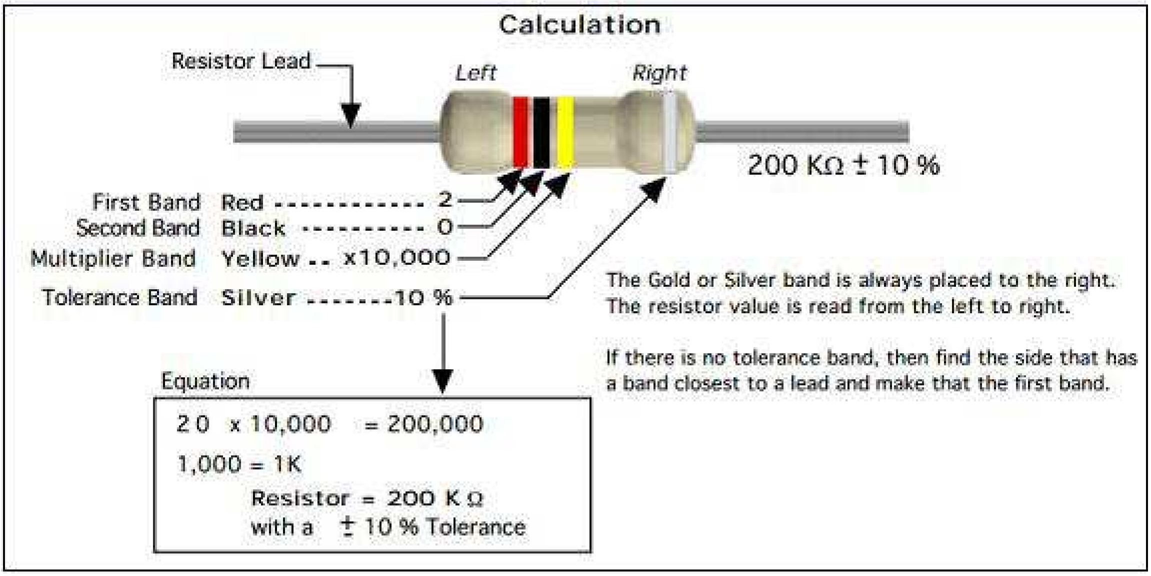



**RESISTOR COLOR CODE**

*The standard resistor color code table:*

| Color | Digit 1 | Digit 2 | Digit 3* | Multiplier | Tolerance | Temp. Coef. | Fail Rate |
|---|---|---|---|---|---|---|---|
| Black | 0 | 0 | 0 | $\times10^0$ | | | |
| Brown | 1 | 1 | 1 | $\times10^1$ | ±1% (F) | 100 ppm/K | 1% |
| Red | 2 | 2 | 2 | $\times10^2$ | ±2% (G) | 50 ppm/K | 0.1% |
| Orange | 3 | 3 | 3 | $\times10^3$ | | 15 ppm/K | 0.01% |
| Yellow | 4 | 4 | 4 | $\times10^4$ | | 25 ppm/K | 0.001% |
| Green | 5 | 5 | 5 | $\times10^5$ | ±0.5% (D) | | |
| Blue | 6 | 6 | 6 | $\times10^6$ | ±0.25% (C) | | |
| Violet | 7 | 7 | 7 | $\times10^7$ | ±0.1% (B) | | |
| Gray | 8 | 8 | 8 | $\times10^8$ | ±0.05% (A) | | |
| White | 9 | 9 | 9 | $\times10^9$ | | | |
| Gold | | | | ×0.1 | ±5% (J) | | |
| Silver | | | | ×0.01 | ±10% (K) | | |
| None | | | | | ±20% (M) | | |

** 3rd digit - only for 5-band resistors*




## CAPACITOR SPECIFICATIONS

When a capacitor is being discussed, it is referred to with certain "specifications" or characteristics. Capacitors are usually "specified" in the following manner-

- They are specified by type (tantalum, electrolytic, etc.)
- They are specified by package (axial, radial, as discussed above).
- They are specified by how to connect to them, their connection type (such as "snap in" or leaded or threaded screw holes, or surface mount).
- They are specified by capacitance value, e.g. in microfarads (µF).
- They are specified by voltage rating (i.e., 30 V). This indicates the maximum voltage under which it is safe to use the referenced capacitor.
- Some types, such as electrolytic capacitors, are specified by operating temperature (usually 80 or 120 °C), which reflects the maximum temperature that the capacitor can reach before failing. Note- common practice is to use capacitors well below their maximum operating voltage and temperature in order to ensure longevity.
- They can be specified by other parameters, including ESR or "equivalent series resistance" (explained above). Also, some capacitors can be specified by UL or other safety rating. A "X" type capacitor indicates that the capacitor meets certain standards one of which is that it is appropriate to be used with line-level voltages (such as 117 or 220 V) typically found from the wall outlet, as well as that it can withstand surges typically found in power distribution systems.
- They are specified in percentage accuracy, i.e., how much they are likely to deviate from their rated capacitance. Common ratings are + or - 20%.

## REGULATED POWER SUPPLY

A regulated power supply is an embedded circuit, or stand alone unit, the function of which is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC (Direct Current) .

The type of stabilization used may be restricted to ensuring that the output remains within certain limits under various load conditions, or it may also include compensation for variations in its own supply source.

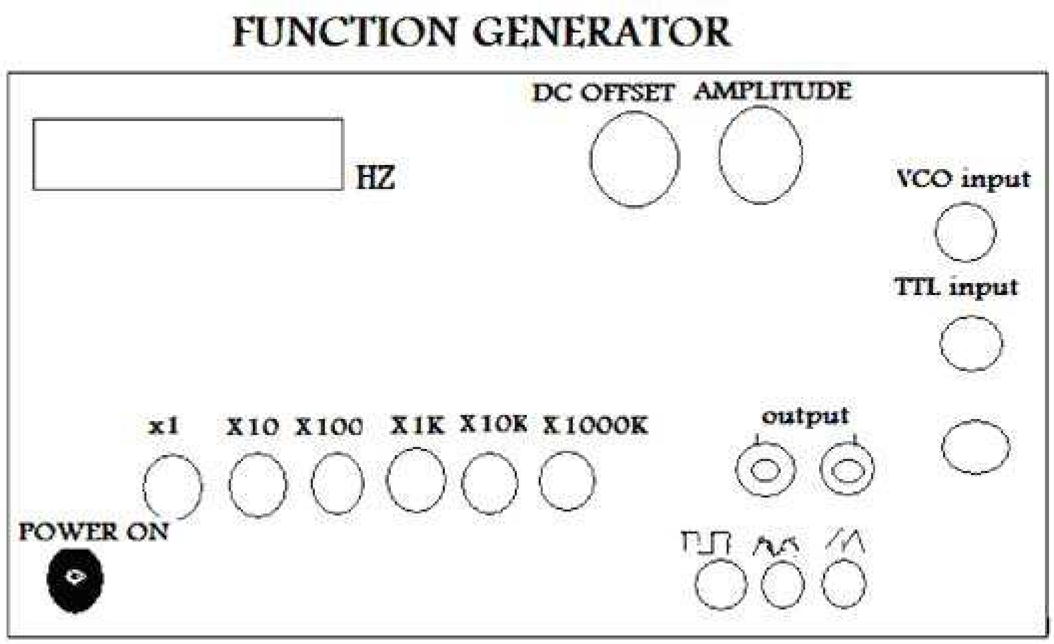
## FUNCTION GENERATOR

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

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

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

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




| Designation | Specification |
|---|---|
| Waveform | Sin, square and triangular |
| Amplitude | 0-20V |
| Frequency range | 0.1Hz to 1MHz |
| Offset | Continuously variable 10V |
| Output impedance | 600ohms,5% |

## DIGITAL MULTIMETER

A multimeter or a multitester, also known as a VOM (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic features such as the ability to measure voltage, current, and resistance. Analog multimeters use a microammeter whose pointer moves over a scale calibrated for all the different measurements that can be made. Digital multimeters (DMM, DVOM) display the measured value in numerals, and may also display a bar of a length proportional to the quantity being measured. Digital multimeters have all but replaced analog moving coil multimeters in most situations. Analog multimeters are still manufactured but by few manufacturers.

### Quantities measured

Contemporary multimeters can measure many quantities. The common ones are:

- Voltage, alternating and direct, in volts.
- Current, alternating and direct, in amperes.
- The frequency range for which AC measurements are accurate must be specified.
- Resistance in ohms.

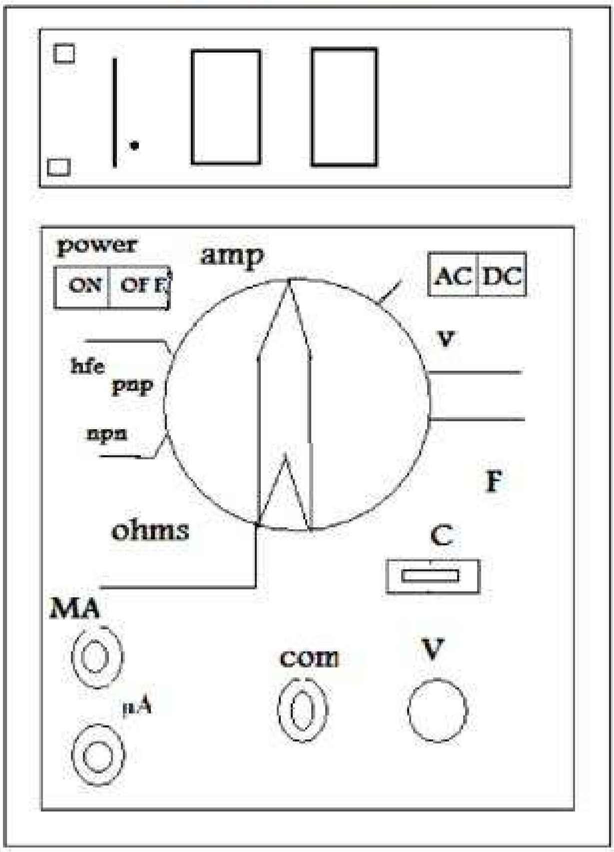
**Additionally, some multimeters measure:**

- Capacitance in Farads.
- Conductance in Siemens.
- Decibels.
- Duty cycle as a percentage.
- Frequency in Hertz.
- Inductance in Henrys.
- Temperature in degrees Celsius or Fahrenheit, with an appropriate temperature test probe, often a thermocouple.

**Digital multimeters may also include circuits for:**

- Continuity tester; sounds when a circuit conducts
- Diodes (measuring forward drop of diode junctions), and transistors (measuring current gain and other parameters)
- Battery checking for simple 1.5 volt and 9 volt batteries. This is a current loaded voltage scale which simulates in-use voltage measurement.

DIGITAL MULTIMETER




## CATHODE RAY OSCILLOSCOPE

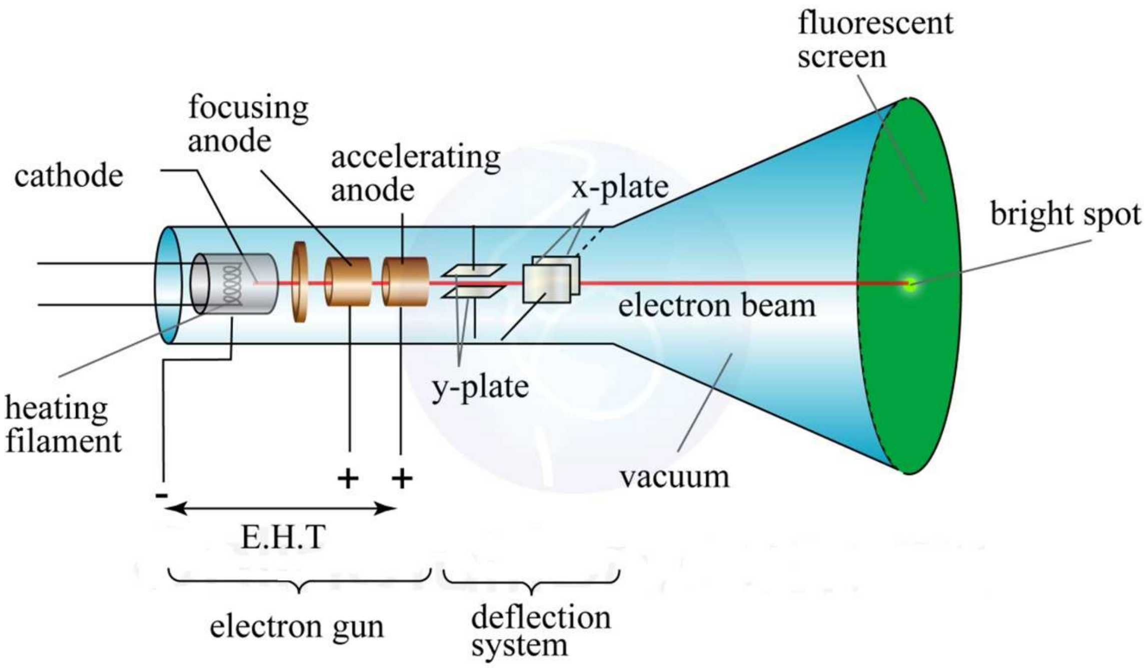
An oscilloscope, previously called an oscillograph, and informally known as a scope,CRO (for cathode-ray oscilloscope), or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that allows observation of constantly varying signal voltages, usually as a two-dimensional graph of one or more electrical potential differences using the vertical or y-axis, plotted as a function of time (horizontal or x-axis). Many signals can be converted to voltages and displayed this way. Signals are often periodic and repeat constantly, so that multiple samples of a signal which is actually varying with time are displayed as a steady picture. Many oscilloscopes (storage oscilloscopes) can also capture non-repeating waveforms for a specified time, and show a steady display of the captured segment.

Oscilloscopes are commonly used to observe the exact wave shape of an electrical signal. Oscilloscopes are usually calibrated so that voltage and time can be read as well as possible by the eye. This allows the measurement of peak-to-peak voltage of a waveform, the frequency of periodic signals, the time between pulses, the time taken for a signal to rise to full amplitude (rise time), and relative timing of several related signals.

Oscilloscopes are used in the sciences, medicine, engineering, and telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system, or to display the waveform of the heartbeat as an electrocardiogram. Some computer sound software allows the sound being listened to be displayed on the screen as by an oscilloscope.

Before the advent of digital electronics oscilloscopes used cathode ray tubes as their display element (hence were commonly referred to as CROs) and linear amplifiers for signal processing.

More advanced storage oscilloscopes used special storage CRTs to maintain a steady display of a single brief signal. CROs were later largely superseded by digital storage oscilloscopes (DSOs) with thin panel displays, fast analog-to-digital converters and digital signal processors. DSOs without integrated displays (sometimes known as digitisers) are available at lower cost, and use a general-purpose digital computer to process and display waveforms.




**CRO**

The main parts are

1. Electron gun: it is used to produce sharply focused beam of electron accelerated to very high velocity.
2. Deflection system: it deflects the electron both in horizontal and vertical plan.
3. Florescent screen: the screen which produces, spot of visible light . when beam of electrons are incident on it the other side of tube is coated with phosphorus material.

**FRONT PANNEL:**

**ON-POWER:** toggle switch for switching on power.

**INTENCITY**: controls trace intensity from zero to maximum.

**FOCUS:** It controls sharpness of trace a slight adugestement of focus is done after changing intensity of trace.

**AC-DC: GROUND:**

It selects coupling of ACDC ground signal to vertical amplifier.

**X-MAG:** It expands length of time base from 15 times continuously and to maximum time base to 40 ns/cm.

**SQUARE**: This provides square wave 2v (pP) amplitude and enables to check y calibration of scope.

**SAWTOOTH WAVE FORM:** This provides saw tooth wave form output coincident to sweep speed with an output of saw tooth wave (pp)

**VERTICAL SECTION:**

**y position**: This enables movement of display along y-axis.

**Y-INPUT:** It connects input signal to vertical amplifier through ACDC ground coupling switch

**CALIBRATION:** 15mv – 150mv dc signal depending on position selection is applied to vertical amplifier.

**DC BALANCE:** It is control on panel electrostatic ally in accordance with waveforms to be displayed.

**VOLTS/CM:** Switch adjusts sensitivity.

**HORIZANTAL SECTION:**

**X-POSITION:** This control enables movement of display along xaxis.

**TRIGGERING LEVEL:** It selects mode of triggering.

**TIMEBASE:** This controls or selects sweep speeds.

**VERNUIS:** This control the fine adjustments associated with time base sweep.

**SIGN SELECTOR:** It selects different options of INT/EXT, NORM/TO.

**STAB:** Present on panel

**EXITCAD**: It allows time base range to be extended.

**HORIZANTAL INPUT:** It connects external signal to horizontal amplifier.

**Ext SYN:** it connects external signal to trigger circuit for synchronization.

**OBSERVATIONS:**

Amplitude = no. of vertical divisions * Volts/div.

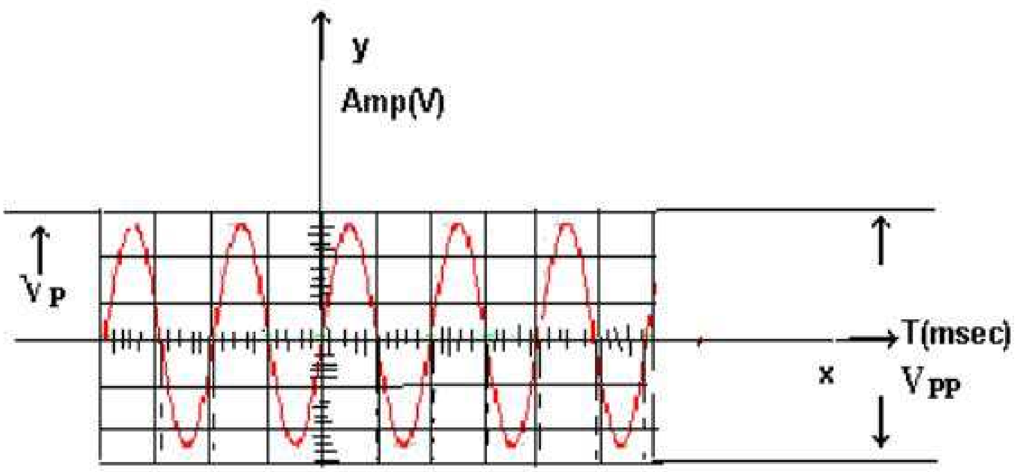
Time period = no. of horizontal divisions * Time/div.

Frequency = 1/T

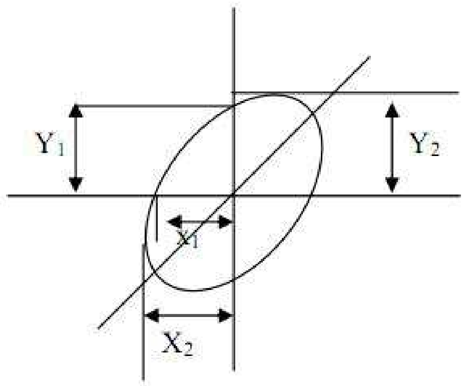
Amplitude taken on vertical section (y).

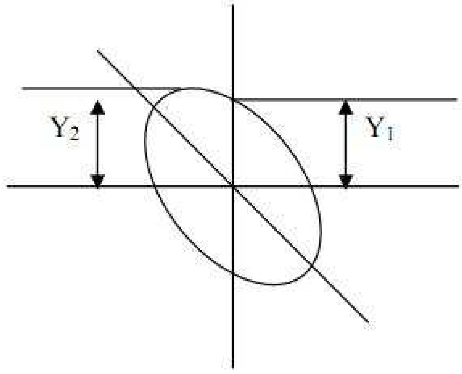
Time period taken on horizontal section(x)

**Model waveforms**



**Measurement of Phase**




$$\phi = \sin^{-1}\frac{Y_1}{Y_2} = \sin^{-1}\frac{X_1}{X_2}$$

$$\phi = 180 - \sin^{-1}\frac{Y_1}{Y_2}$$

# 1. FORWARD & REVERSE BIAS CHARACTERISTICS OF PN JUNCTION DIODE

**AIM:** To plot forward and reverse bias characteristics of P-N Junction Diode, to calculate the static resistance ($R_s$) and dynamic resistance ($r_d$).

**APPARATUS REQUIRED:**

1) Bread Board – 1No
2) Diode (Silicon -1N4007) – 1No
3) Resistor – 1 k Ω - 1No.
4) Digital Multi Meter – 1No.
5) DC Ammeters (0-20mA) – 1No.
6) DC Ammeters (0-200µA) – 1No.
7) Regulated Power Supply(0-30V) – 1No
8) Connecting wires

**CIRCUIT DIAGRAM: For Forward bias**

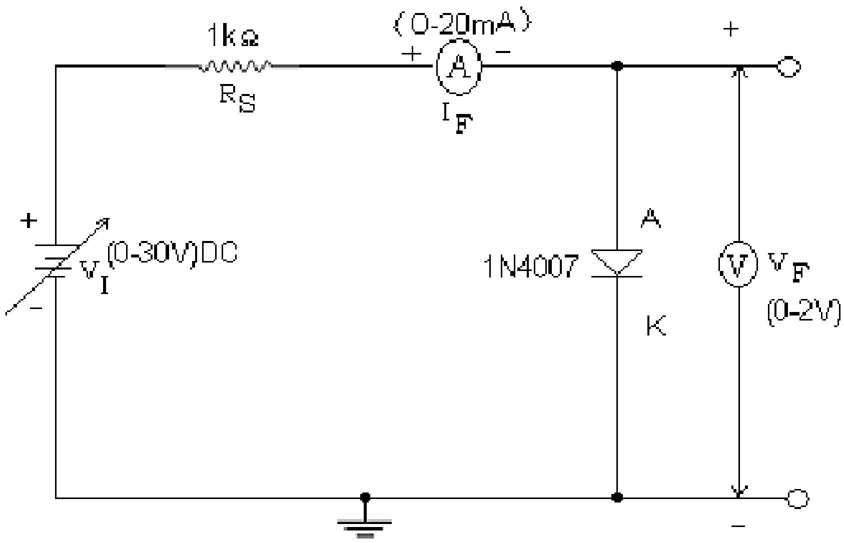



FIG-1
Forward bias

**PROCEDURE:**

**For Forward bias**

1. Make the connections as per the circuit diagram
2. Vary the input voltage (Vi) in steps and measure the voltage ($V_F$) across the diode using multimeter and current ($I_F$) through diode using Ammeter.
3. Tabulate the values of $V_F$ and $I_F$.

4. By using the values of $V_F$ and $I_F$, plot the forward bias characteristics.
5. At suitable operating point in the characteristics, calculate the static and dynamic resistance of diode given below

Static resistance $R_f = \frac{V_f}{I_f}$

Dynamic resistance $r_f = \frac{\Delta V_f}{\Delta I_f}$

**OBSERVATION TABLE:**

| S.No. | Forward Voltage $V_F$ (V) | Forward Current $I_F$ (mA) |
|---|---|---|
| | | |

**CIRCUIT DIAGRAM: For Reverse bias**

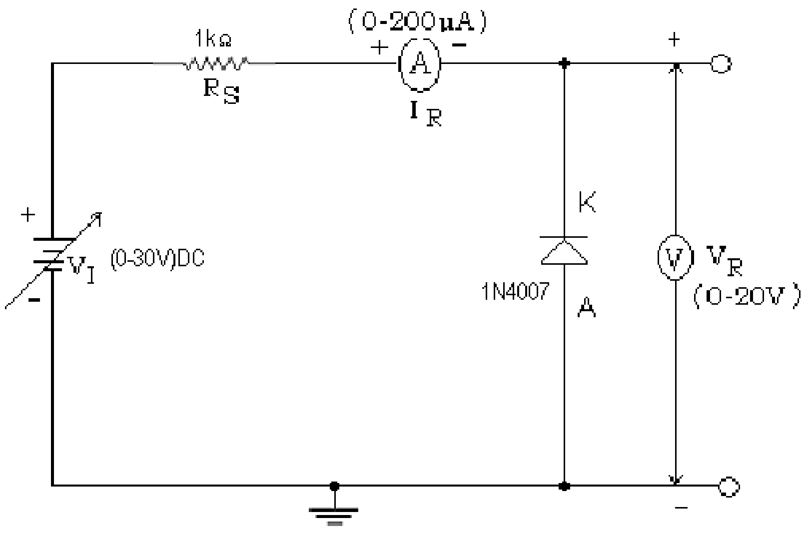



FIG-2

Reverse bias

**For Reverse bias**

1. Make the connections as per the circuit diagram
2. Vary the input voltage (Vi) in steps and measure the voltage ($V_R$) across the diode using multimeter and current ($I_R$) through diode using micro ammeter.
3. Tabulate the values of $V_R$ and $I_R$.
4. By using the values of $V_R$ and $I_R$, plot the reverse bias characteristics.
5. At suitable operating point in the characteristics, calculate the static and dynamic resistance of diode given below

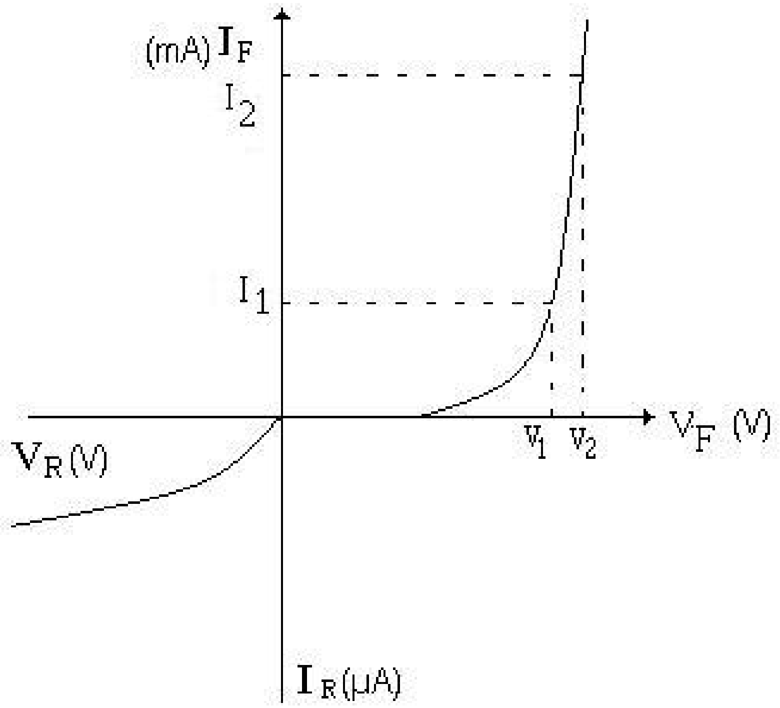
   Static resistance $R_r = \frac{V_r}{I_r}$

   Dynamic resistance $r_r = \frac{\Delta V_r}{\Delta I_r}$

**OBSERVATION TABLE:**

| S.No. | Reverse Voltage $V_R$ (V) | Reverse Current $I_R$ (μA) |
|---|---|---|
| | | |

**EXPECTED GRAPH:**




**CALCULATIONS FOR P–N JUNCTION DIODE:**

Forward Static resistance ($R_F$):

Forward Dynamic Resistance ($r_f$):

Reverse Static resistance ($R_R$):

Reverse Dynamic Resistance ($r_r$):

**RESULT:** V - I Characteristics of PN Junction diode are plotted. From the characteristics following parameters are calculated

# 2. ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR

**AIM:** To plot the V-I characteristics of Zener diode under forward bias and reverse bias conditions.

**APPARATUS REQUIRED:**

1) Bread Board – 1No
2) Zener Diodes - 1No.
3) Resistors –1kΩ – 1No.
4) Digital Multi Meter – 1No.
5) DC Ammeters (0-200mA) – 1No.
6) Regulated Power Supply(0-30V) – 1No
7) Connecting wires

**CIRCUIT DIAGRAM:**

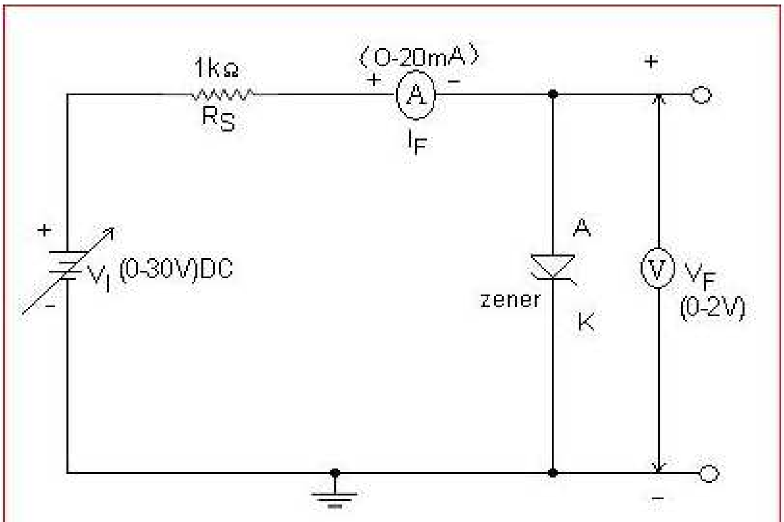



FIG-1
Forward bias

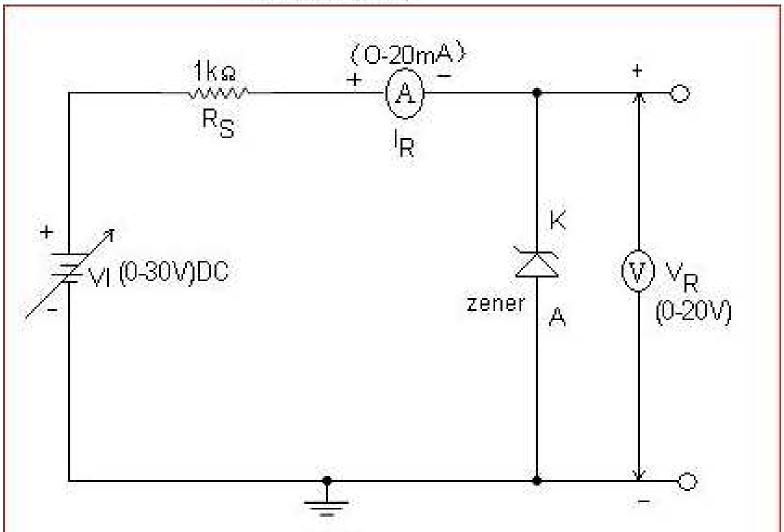



FIG-2
Reverse bias

**PROCEDURE: For Forward bias:**

1. Make the connections as per the circuit diagram
2. Vary the input voltage (Vi) in steps and measure the voltage ($V_F$) across the diode using multimeter and current ($I_F$) through diode using Ammeter.
3. Tabulate the values of $V_F$ and $I_F$.
4. By using the values of $V_F$ and $I_F$, plot the forward bias characteristics.

**OBSERVATION TABLE:**

**FOR ZENER DIODE:________ V**

| **FORWARD BIAS** | | |
|---|---|---|
| **S.No** | **$V_F$ (V)** | **$I_F$ (mA)** |
| | | |

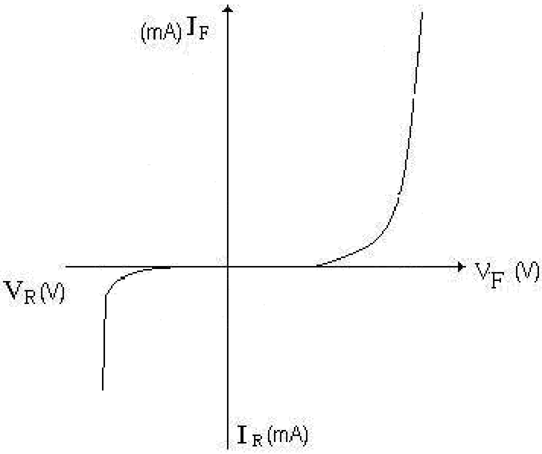
**For Reverse bias:**

1. Make the connections as per the circuit diagram
2. Vary the input voltage (Vi) in steps and measure the voltage ($V_R$) across the diode using multimeter and current ($I_R$) through diode using micro ammeter.
3. Tabulate the values of $V_R$ and $I_R$.
4. By using the values of $V_R$ and $I_R$, plot the reverse bias characteristics.

**OBSERVATION TABLE:** **FOR ZENER DIODE:________ V**

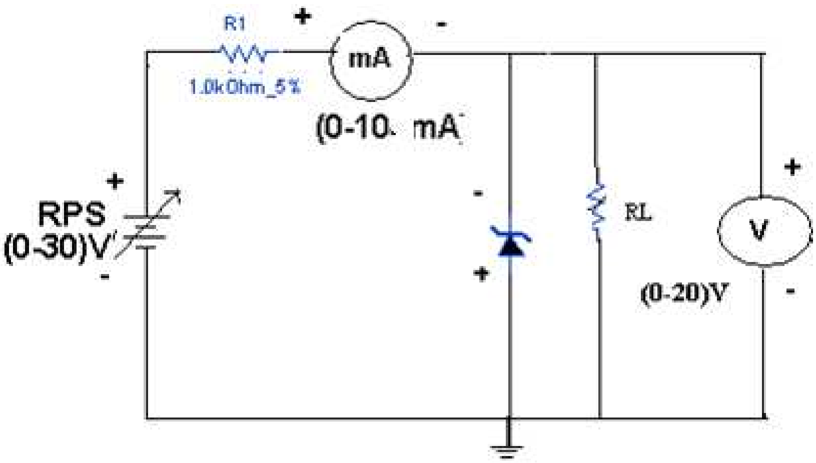
| **REVERSE BIAS** | | |
|---|---|---|
| **S.No** | **$V_R$ (V)** | **$I_R$ (mA)** |
| | | |

**EXPECTED GRAPH:**



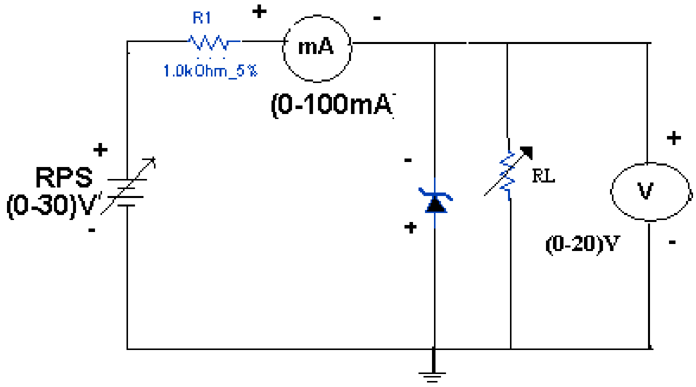

**LINE REGULATION CHARACTERISTICS:-**

1. Connections are made as per the circuit diagram
2. The load resistance is fixed to known value and vary the input voltage and measure the voltage ($V_L$) and current ($I_L$).
3. Draw the graph between voltage ($V_L$) and current ($I_L$).




**LOAD REGULATION CHARACTERISTICS:-**

1. Connections are made as per the circuit diagram
2. The input voltage is fixed to known value and vary the load resistance and measure the voltage ($V_L$) and current ($I_L$).
3. Draw the graph between voltage ($V_L$) and current ($I_L$).




**TABULAR FORM FOR LINE AND LOAD REGULATION:**

| LINE REGULATION | | | | LOAD REGULATION | | |
|---|---|---|---|---|---|---|
| INPUT VOLTAGE | LOAD VOLTAGE ($V_L$) | LOAD CURRENT ($I_L$) | | LOAD $R_L$ RESISTANCE | LOAD VOLTAGE ($V_L$) | LOAD CURRENT ($I_L$) |
| | | | | | | |

**VIVAQUESTIONS:-**

1. What type of temperature Coefficient does the zener diode have?
2. If the impurity concentration is increased, how the depletion width effected?
3. Does the dynamic impendence of a zener diode vary?
4. Explain briefly about avalanche and zener breakdowns?
5. Draw the zener equivalent circuit?
6. Differentiate between line regulation & load regulation?
7. In which region zener diode can be used as a regulator?
8. How the breakdown voltage of a particular diode can be controlled?
9. What type of temperature coefficient does the Avalanche breakdown has?

**RESULT:** The V-I Characteristics of Zener Diode are plotted.

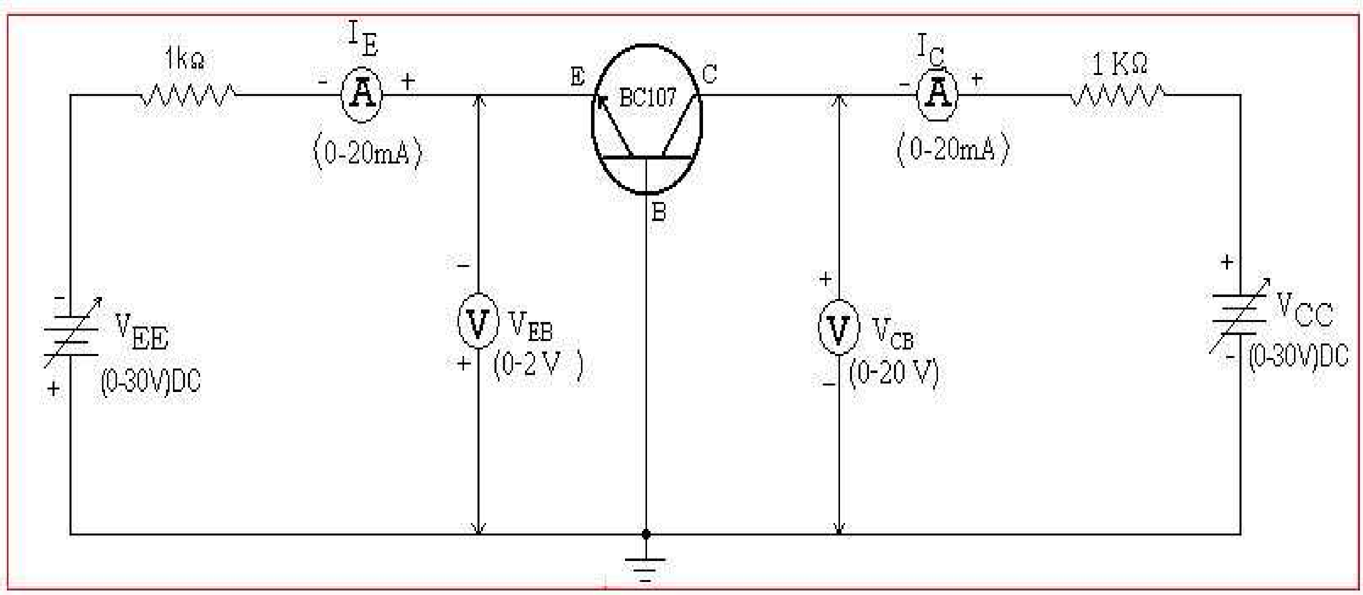
# 3. INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR IN COMMON BASE CONFIGURATION

**AIM:** To obtain the input and output static characteristics of a CB transistor configuration.

**APPARATUS REQUIRED:**

1. Bread board – 1No
2. Resistors 1k Ω – 2 No
3. Transistor BC107- 1No.
4. Digital multimeter – 2No.s
5. DC Ammeter – (0-20mA) – 2No.s
6. Regulated Power Supply (0-30V/1A) – 1No.
7. Connecting wires

**CIRCUIT DIAGRAM:**



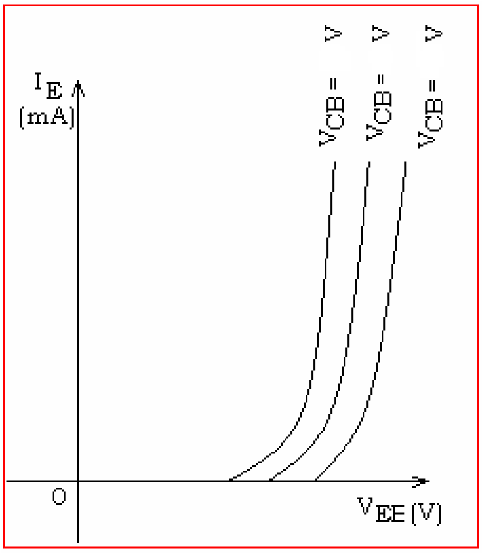

**PROCEDURE: Input characteristics:**

1. Make the connections as per the circuit diagram
2. First set the voltage $V_{CB}$ constant ($V_{CB}$ = 5V) by varying $V_{CC.}$
3. Now vary the supply voltage $V_{EE}$ in steps and note down the values of $I_E$ and $V_{EB}$ at each step.
4. Tabulate the values of $I_E$ and $V_{EB.}$
5. Repeat the above steps 2,3 and 4 for $V_{CB}$ = 15V.
6. From the values of $I_E$ and $V_{EB}$, plot the input characteristics.(i.e.,$V_{EB}$ Vs $I_E$ at constant $V_{CB}$)

**OBSERVATION TABLE: Input Characteristics:**

| $V_{CB}$ = 5V | | $V_{CB}$ = 10V | |
|---|---|---|---|
| $V_{EB}$ (V) | $I_E$ (mA) | $V_{EB}$ (V) | $I_E$ (mA) |
| | | | |

**EXPECTED GRAPH: INPUT CHARACTERISTICS**



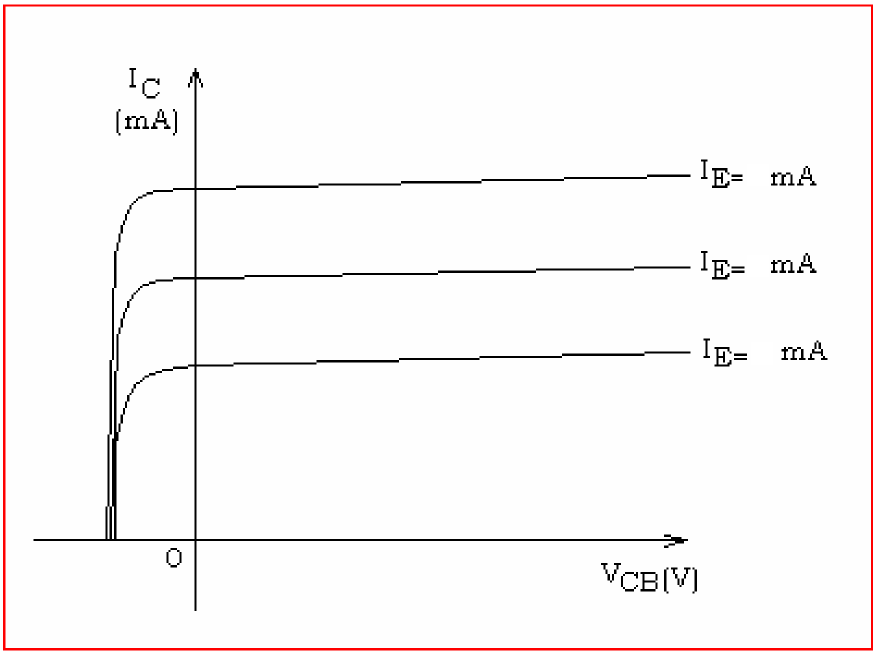

**PROCEDURE: Output characteristics:**

1. Make the connections as per the circuit diagram
2. First set the current $I_E$ constant ($I_E$ = 2mA) by varying $V_{EE}$.
3. Now vary the supply voltage $V_{CC}$ in steps and note the values of $I_C$ and $V_{CB}$ at each step.
4. Tabulate the values of $I_C$ and $V_{CB}$.
5. Repeat the above steps 2,3 and 4 for $I_C$ = 4mA and 6mA.
6. From the values of $I_C$ and $V_{CB}$, plot the output characteristics.(i.e., $V_{CB}$ Vs $I_C$ at constant $I_E$).

**OBSERVATION TABLE: Output characteristics:**

| $I_E$ = 2mA | | $I_E$ = 6mA | |
|---|---|---|---|
| $V_{CB}$ (V) | $I_C$ (mA) | $V_{CB}$ (V) | $I_C$ (mA) |
| | | | |

**EXPECTED GRAPH: OUTPUT CHARACTERISTICS**




**RESULT:** Input Characteristics for various Output Voltages and Output Characteristics for various Input Currents for the given Transistor in CB Configuration are plotted.

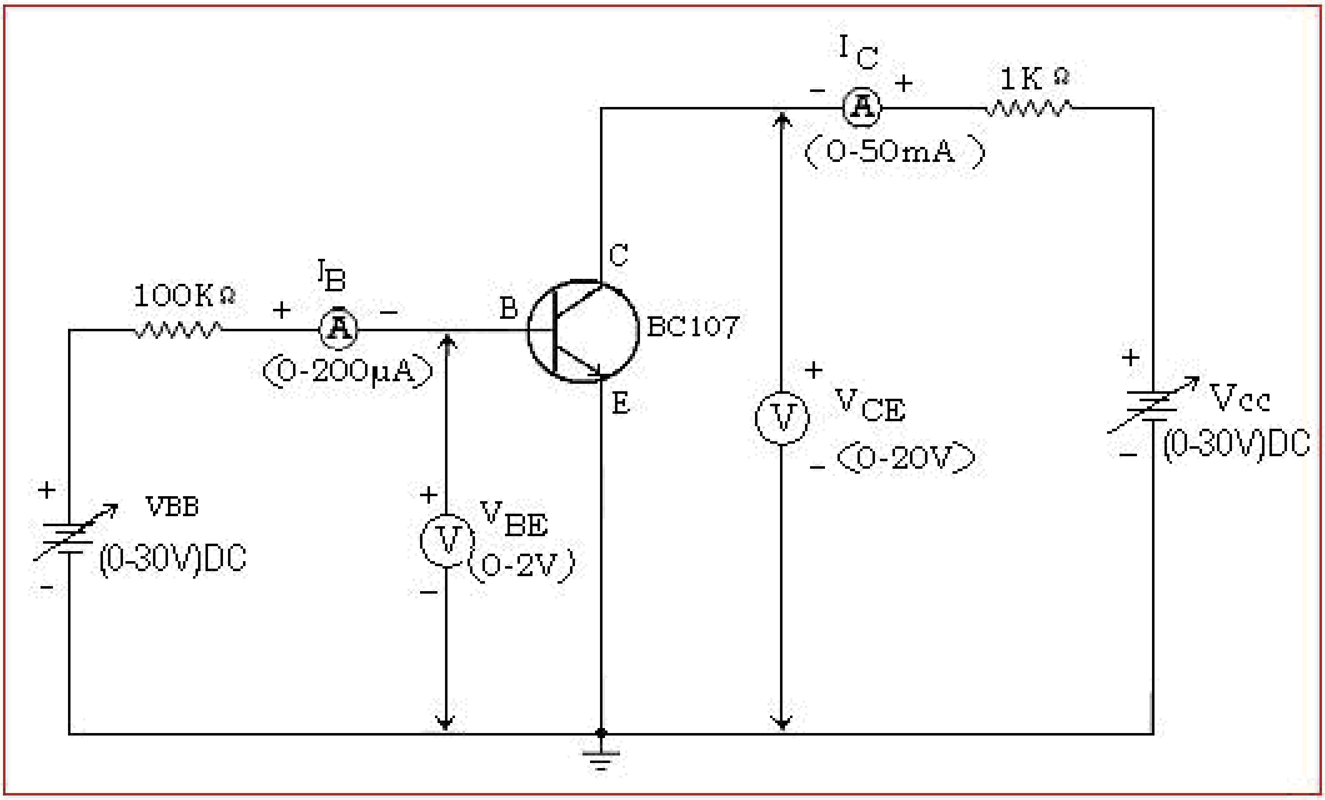
# 4. INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR IN COMMON EMITTER CONFIGURATION

**AIM:** To plot the input and output characteristics of CE-Transistor.

**APPARATUS REQUIRED:**

1. Bread board – 1No
2. BC 107 Transistor - 1No.
3. Regulated Power Supply (0 - 30V) – 1No
4. DC Ammeter (0-200 µA) – 1 No.
5. DC Ammeter (0-200 mA) – 1No.
6. Digital multimeter - 1No's.
7. Resistor 100KΩ and 1KΩ. each 1No
8. Connecting wires

**CIRCUIT DIAGRAM:**




**PROCEDURE: For Input characteristics:**

1. Make the connections as per the given circuit diagram.
2. First set the $V_{CE}$ constant(i.e., 2V) by varying the supply voltage $V_{CC}$.
3. Now vary the supply voltage $V_{BB}$ in steps and note down the values of $I_B$ and $V_{BE}$.

4. Tabulate the values of $I_B$ and $V_{BE.}$

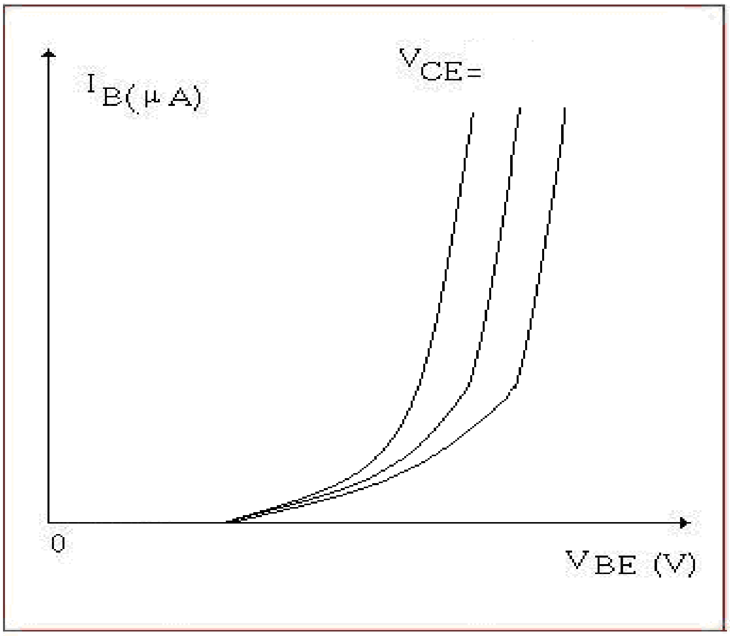
5. Repeat the above steps 2,3 and 4 for $V_{CE}$ = 6V.

6. From the values of $I_B$ and $V_{BE}$, plot the input characteristics($V_{BE}$ Vs $I_B$ at constant $V_{CE}$)

**OBSERVATION TABLE : Input Characteristics**

| **$V_{CE}$ = 2V** | | **$V_{CE}$ = 6V** | |
|---|---|---|---|
| **$V_{BE}$ (V)** | **$I_B$ (µA)** | **$V_{BE}$ (V)** | **$I_B$ (µA)** |
| | | | |

**EXPECTED GRAPH: Input Characteristics**




**For Output characteristics:**

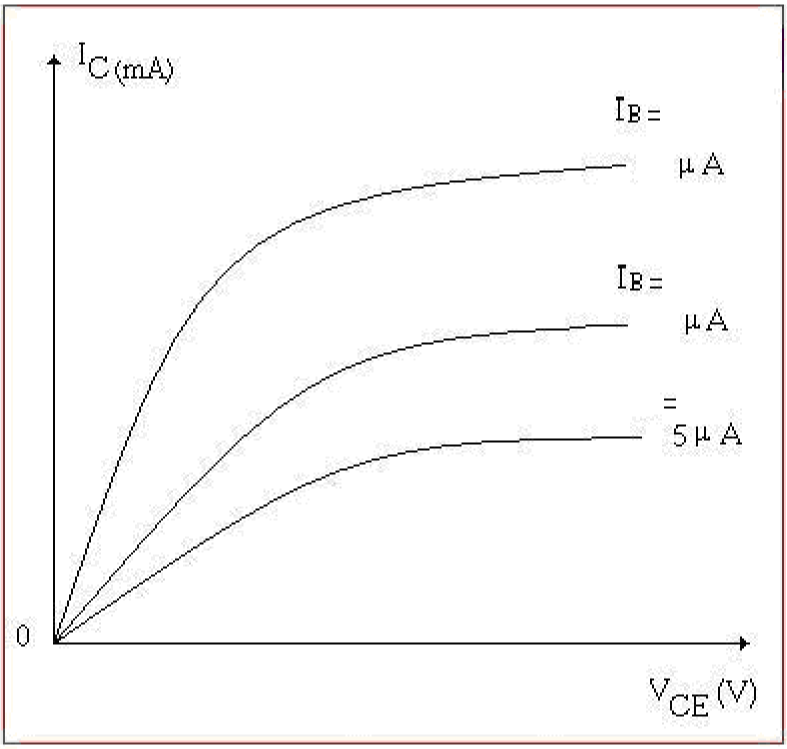
1. Make the connections as per the given circuit diagram.
2. First set the current $I_B$ constant (i.e., 20µA), by varying the supply voltage $V_{BB.}$
3. Now vary the supply voltage $V_{CC}$ in steps, and note the values of $I_C$ and $V_{CE}$.
4. Tabulate the values of $I_C$ and $V_{CE}$.
5. Repeat the above steps 2,3 and 3 for $I_B$=30 µA and 40 µA).

6. From the values of $I_C$ and $V_{CE}$ plot the output characteristics ( i.e.,$V_{CE}$ Vs $I_C$ at constant $I_B$)

**OBSERVATION TABLE : Output Characteristics**

| $I_B$ =20μA | | $I_B$ =40μA | | |
|---|---|---|---|---|
| $V_{CE}$ (V) | $I_C$ (mA) | $V_{CE}$(V) | $V_{CE}$(V) | $I_C$ (mA) |
| | | | | |

**EXPECTED GRAPH: Output Characteristics**




**RESULT:** Input Characteristics for various Output Voltages and Output Characteristics for various Input Currents for the given Transistor in CE Configuration are plotted.

## 5. HALF WAVE RECTIFIER WITH & WITHOUT FILTERS

**AIM:** To plot and examine the input and output wave forms and various parameters of half wave rectifiers with and without filters.

**APPARATUS REQUIRED:**

1. Bread board
2. Diodes 1N4007 – 1 No
3. Digital multi meters – 2 No's
4. Decade resistance box – 1 No.
5. Decade capacitance box – 1 No.
6. Decade inductance box – 1 No.
7. CRO with probes
8. Connecting wires
9. Transformer (15–0–15V/1A) – 1 No.

**CIRCUIT DIAGRAM:**

**Half Wave Rectifier without filter**

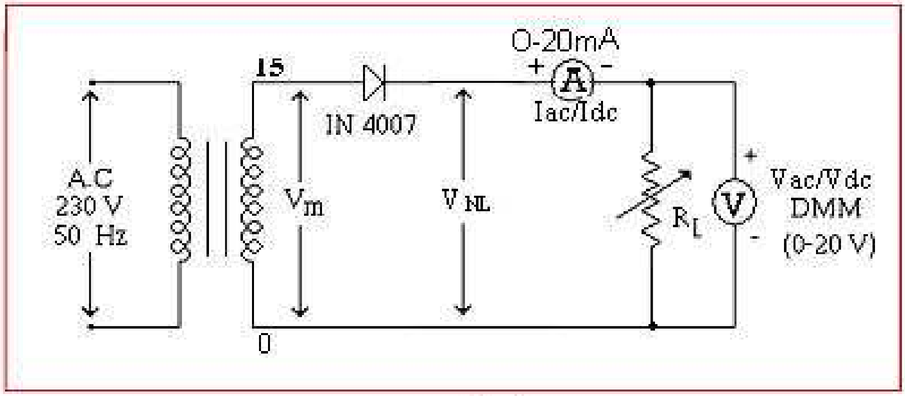
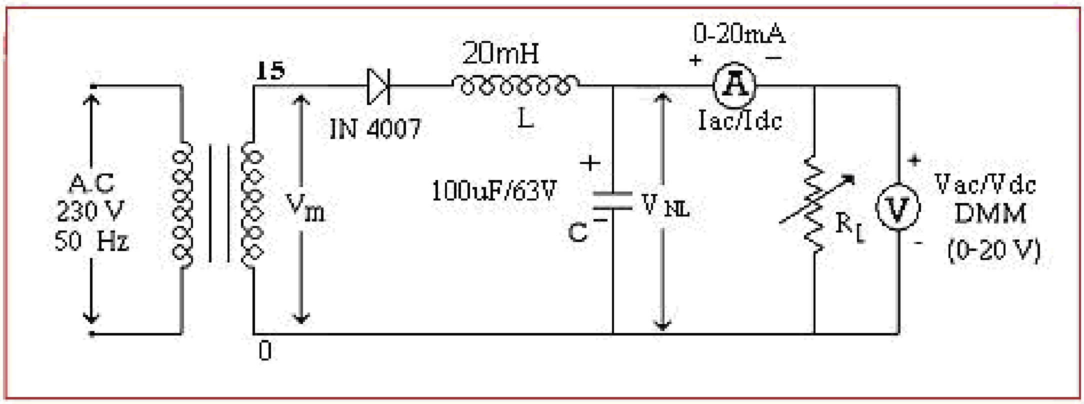
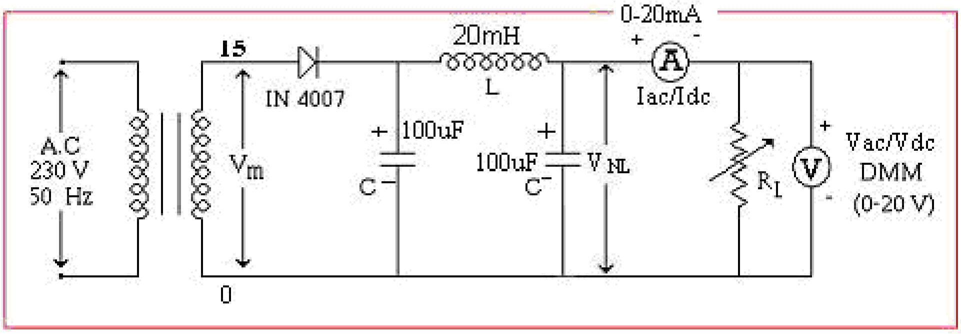



Fig-1

**Half Wave Rectifier with "L"- Section Filter**



**Half Wave Rectifier With "π" Section Filter**




**PROCEDURE: Procedure for without filter:**

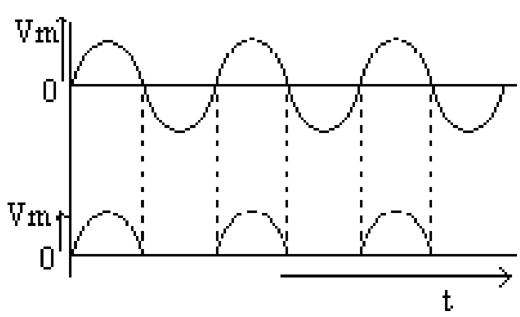
1. Connect the circuit as per the circuit diagram shown in fig.1.
2. Note down the $V_m$ (AC Volts) at the secondary of the transformer by using digital multimeter and also measure the no load voltage ($V_{NL}$ as DC Volts) by removing the load from the circuit.
3. Now connect the load of 1kΩ then measure the values of $I_{dc}$, $V_{dc}$, $I_{ac}$ and $V_{ac}$.
4. Take the above readings by varying the $R_L$ in steps of 1kΩ.
5. Observe the output wave forms of rectifiers by using CRO.
6. Draw the wave forms on the graph sheet.

**OBSERVATOIN TABLE: Half wave rectifier without filter**

**$V_m$ = V(AC)   $V_{NL}$ = V(DC)**

| $R_L$ | Vdc (V) | Idc (mA) | Vac (V) | $R_L$ = Vdc/Idc | Ripple Factor r = Vac/Vdc | %regulation = ($V_{NL}$-$V_{FL}$)x100 / $V_{FL}$ |
|---|---|---|---|---|---|---|
| | | | | | | |

**EXPECTED GRAPHS: Half Wave Rectifier without filter:**



**Procedure for with filter:**

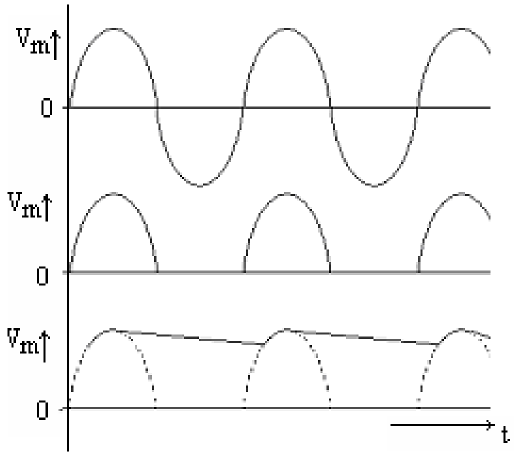
1. Connect the circuit L-Section filter to half wave rectifier as per the circuit diagram.
2. Note down the $V_m$ (AC Volts) at the secondary of the transformer by using digital multi meter and also measure the no load voltage ($V_{NL}$ as DC Volts) by removing the load from the circuit.
3. Now connect the load of 1kΩ then measure the values of Idc, Vdc, Iac and Vac.
4. Take the above readings by varying the $R_L$ in steps of 1kΩ.
5. Repeat the above steps 1, 2, 3 and 4 for ∏-section filter.
6. Observe the output wave forms of rectifiers by using CRO.
7. Draw the wave forms on the graph sheet.

**Half wave rectifier with filter**

**Vm =……..V(AC)** **$V_{NL}$ =……V (L-section)** **$V_{NL}$ = ……. V ( ∏- section )**

| Filter | $R_L$ | Vdc (V) | Idc (mA) | Vac (V) | $R_L$ = Vdc/ Idc | r = Vac/Vdc | %regulation = $(V_{NL}-V_{FL})$x100 / $V_{FL}$ |
|---|---|---|---|---|---|---|---|
| L-Section | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| ∏-section | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Half Wave Rectifier with ∏-filter**




**RESULT:** Input & Output Waveforms of Half Wave Rectifier with L & Π section filters are studied for various loads and observations are put in the tabular form.

## 6. FULLWAVE RECTIFIER WITH & WITHOUT FILTERS

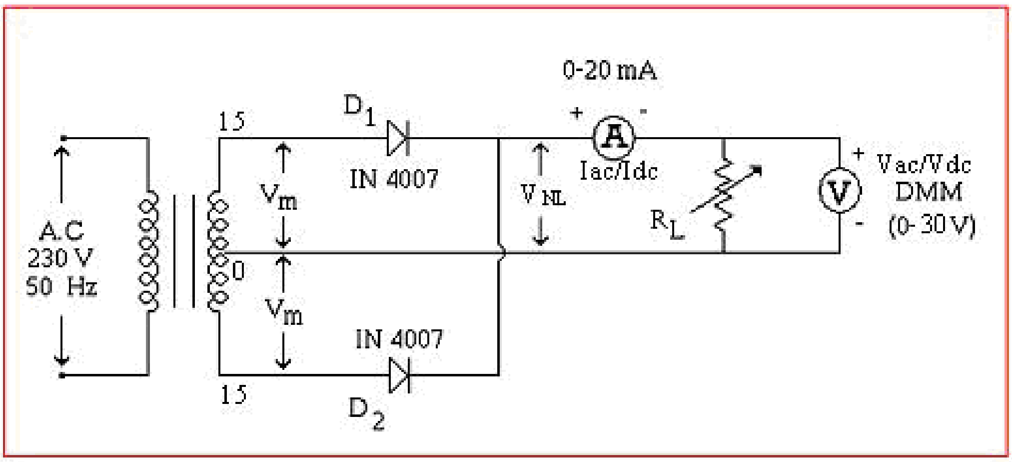
**AIM:** To plot and examine the input and output wave forms and various parameters of full wave rectifiers with and without filters.

**APPARATUS REQUIRED:**

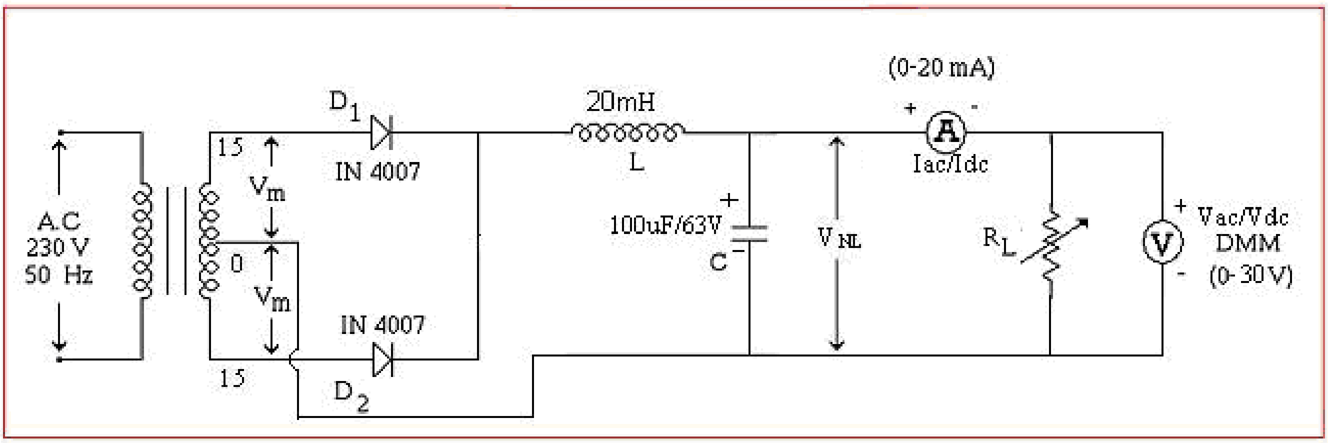
1. Bread board
2. Diodes 1N4007 – 4 No
3. Digital multi meters – 2 No's
4. Decade resistance box – 1 No.
5. Decade capacitance box – 1 No.
6. Decade inductance box – 1 No.
7. CRO with probes
8. Connecting wires
9. Transformer (15–0–15V/1A) – 1 No.

**CIRCUIT DIAGRAM:**

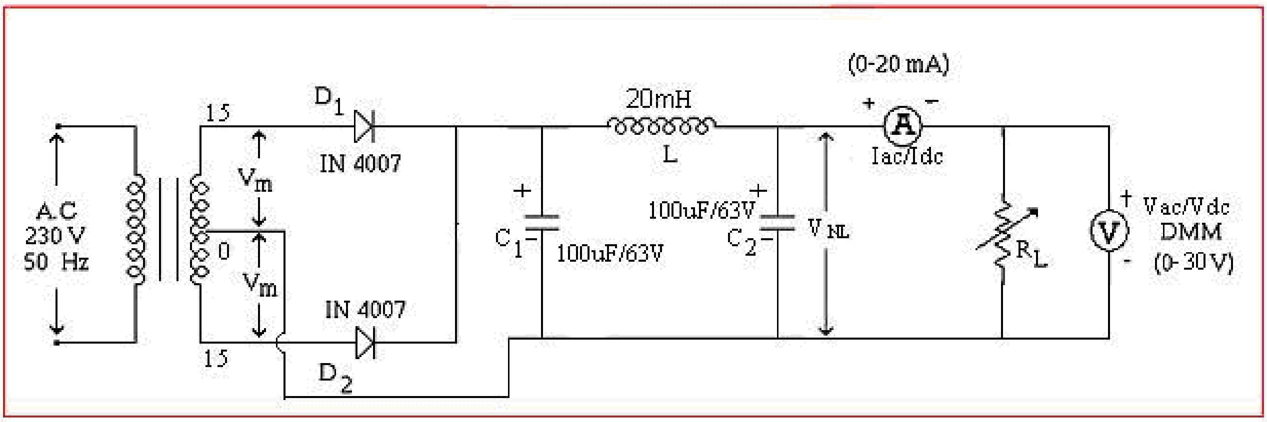
**Full Wave Rectifier without filter**




**Full Wave Rectifier with "L"- Section Filter:**



**Full Wave Rectifier with "Π" Section Filter:**




**PROCEDURE:** Procedure for without filter:

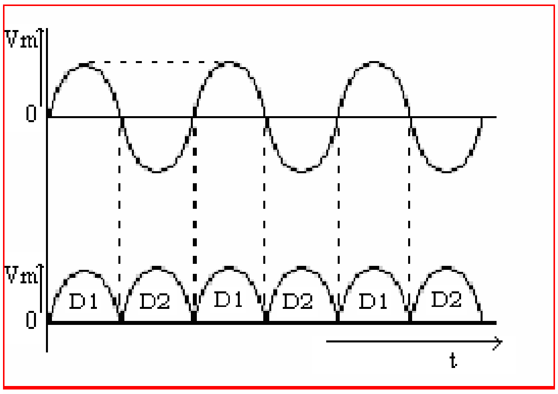
1. Make the connections as per the circuit diagram.
2. Note down the $V_m$ (AC Volts) at the secondary of the transformer by using digital multimeter and also measure the no load voltage ($V_{NL}$ as DC Volts) by removing the load from the circuit.
3. Now connect the load of 1kΩ then measure the values of $I_{dc}$, $V_{dc}$, $I_{ac}$ and $V_{ac}$.
4. Take the above readings by varying the $R_L$ in steps of 1kΩ.
5. Observe the output wave forms of rectifiers by using CRO.
6. Draw the wave forms on the graph sheet.

**OBSERVATOIN TABLE: Full wave rectifier without filter**

**$V_m$ = V(AC) $V_{NL}$ = V(DC)**

| $R_L$ | Vdc (V) | Idc (mA) | Vac (V) | $R_L$ = Vdc/Idc | Ripple Factor r = Vac/Vdc | %regulation = $(V_{NL}-V_{FL})$x100 / $V_{FL}$ |
|---|---|---|---|---|---|---|
| | | | | | | |

**EXPECTED GRAPHS: Full wave rectifier without filters:**



**Procedure for with filter:**

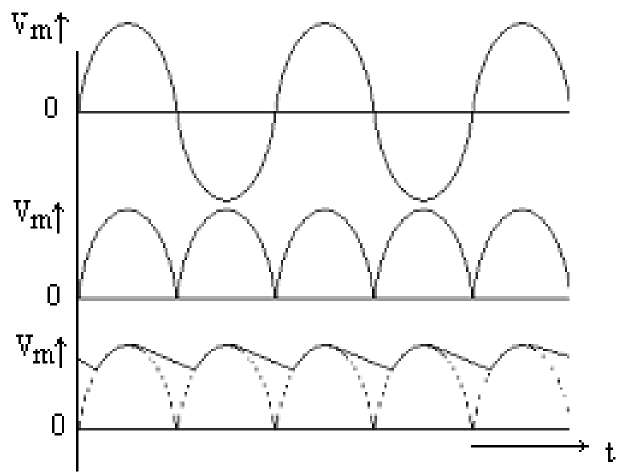
1. Connect the circuit L-Section filter to full wave rectifier as per the circuit diagram.
2. Note down the $V_m$ (AC Volts) at the secondary of the transformer by using digital multi meter and also measure the no load voltage ($V_{NL}$ as DC Volts) by removing the load from the circuit.
3. Now connect the load of 1kΩ then measure the values of Idc, Vdc, Iac and Vac.
4. Take the above readings by varying the $R_L$ in steps of 1kΩ.
5. Repeat the above steps 1, 2, 3 and 4 for ∏-section filter.
6. Observe the output wave forms of rectifiers by using CRO.
7. Draw the wave forms on the graph sheet.

**Full wave rectifier with filter**

**Vm =……..V(AC)** **$V_{NL}$ =…….V L-section** **$V_{NL}$ = ……. V ∏- section**

| Filter | $R_L$ | Vdc (V) | Idc (mA) | Vac (V) | $R_L$ = Vdc/ Idc | r = Vac/Vdc | %regulation = $(V_{NL}-V_{FL})$x100 / $V_{FL}$ |
|---|---|---|---|---|---|---|---|
| L- Section | | | | | | | |
| | | | | | | | |
| ∏- section | | | | | | | |
| | | | | | | | |

**Full wave Rectifier with ∏-filter**




**RESULT:** Input & Output Waveforms of Full Wave Rectifier with L & Π section filters are studied for various loads and observations are put in the tabular form.

# 7. FET CHARACTERISTICS

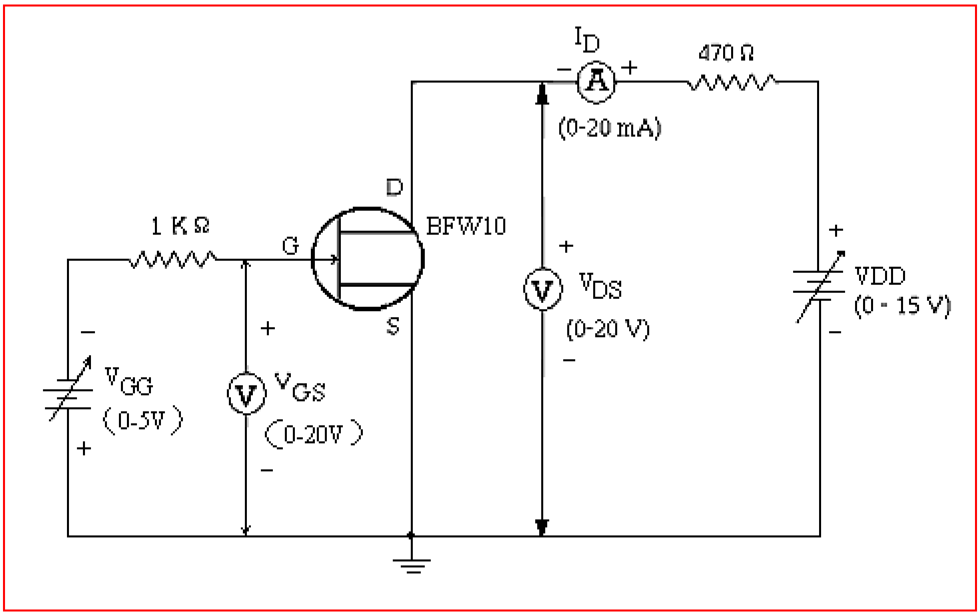
**AIM:** 1) To study JFET characteristics (Drain and Transfer)

2) To calculate drain resistance (rd), Transconductance (gm) and Amplification factor ( μ)

**APPARATUS REQUIRED:**

1. Bread Board
2. DC Ammeters (Digital) (0 - 20mA) - 1No
3. DC Voltmeters (Digital) (0 - 20V) - 2 No`S
4. Dual channel regulated dc power supply(0 - 30v)
5. FET-BFW10.
6. Resistors 1kohm, 470ohm.
7. Connecting wires.

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

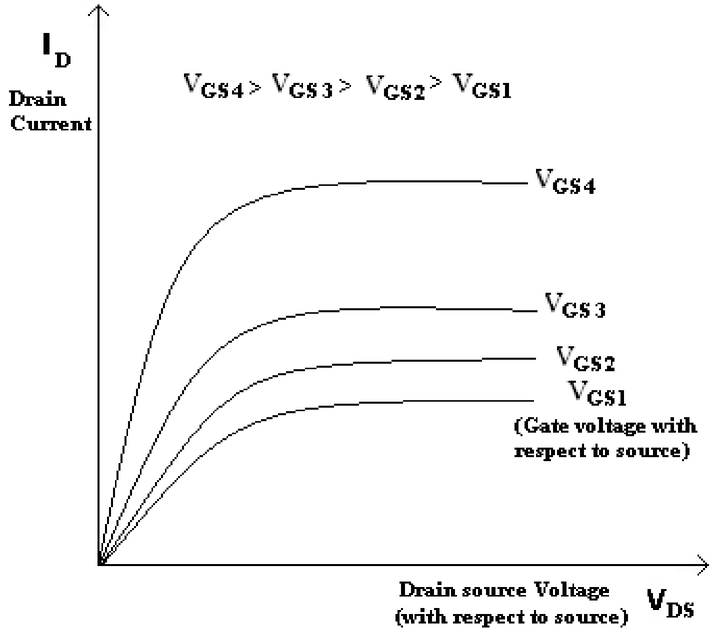
1. Connect the circuit as per circuit diagram.
2. Keep $V_G$s = 0, and measure $I_D$ by varying the $V_{DS.}$ (VDD from 0 - 15 V).
3. Repeat step-2 with $V_G$s = -0.5, -1.0 V as constants.

4. Plot the output characteristics from the graph determine the voltage at which the current variations stop abruptly. This voltage is called pinch-off voltage ($V_p$) and the limiting current ($I_{DS}$).
5. Set $V_{DS}$ = 4V and vary $V_{GG}$ (i.e. i/p supply voltage) over it full range and measure $I_D$.
6. Plot the transfer characteristics.
7. Evaluate rd, gm and "μ" from the graphs.

**OBSERVATION TABLE: O/P Characteristics (or) Drain Characteristics:**

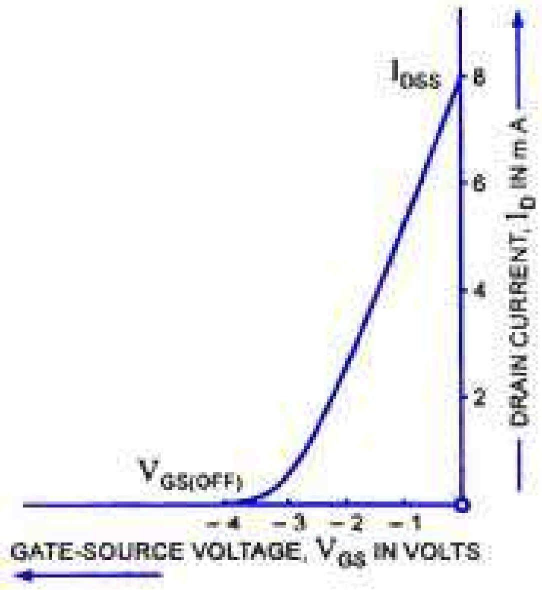
| $V_{GS}$= 0V | | $V_{GS}$ = -0.5V | | $V_{GS}$ = -1.0 V | |
|---|---|---|---|---|---|
| $V_{DS}$ (V) | $I_D$ (mA) | $V_{DS}$ (V) | $I_D$ (mA) | $V_{DS}$ (V) | $I_D$ (mA) |
| | | | | | |

**IDEAL CHARACTERISTICS:**



**Transfer Characteristics:**

| $V_{DS}$= 2V | | $V_{DS}$= 6V | | $V_{DS}$= 8V | |
|---|---|---|---|---|---|
| $V_{GS}$(V) | $I_D$ (mA) | $V_{GS}$(V) | $I_D$ (mA) | $V_{GS}$(V) | $I_D$ (mA) |
| | | | | | |




*JFET Transfer Characteristic*

**RESULT:** Input & Output Characteristics of JFET are plotted. From the Characteristics we calculated the following parameter

Drain resistance (rd) = (Vds/Id at Vgs constant)

Tran conductance (gm) = (Id/Vgs at Vds constant)

Amplification factor (u) = (rd x gm)

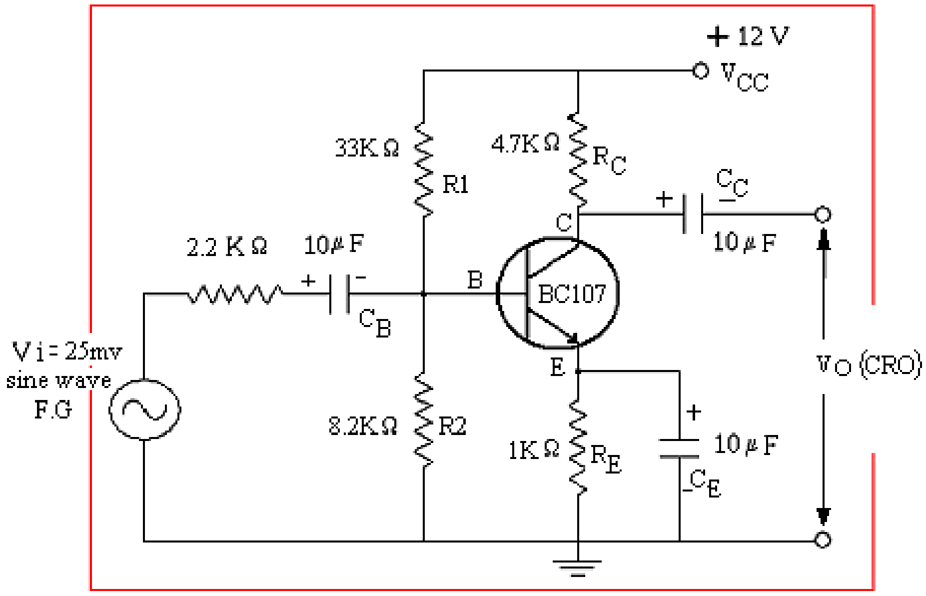
# 8. FREQUENCY RESPONSE OF CE AMPLIFIER

**AIM:** To study CE-Amplifier, to obtain the frequency response characteristics and the bandwidth of the amplifier.

**APPARATUS REQUIRED:**

1. Bread board
2. Function Generator
3. CRO with probe
4. Regulated DC power supply (0 - 30V) – 1No.
5. Resistors 2.2k, 33k, 8.2k, 4.7k, 1k Ohms.
6. Capacitors 10uF - 3No's.
7. Connecting wires.

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

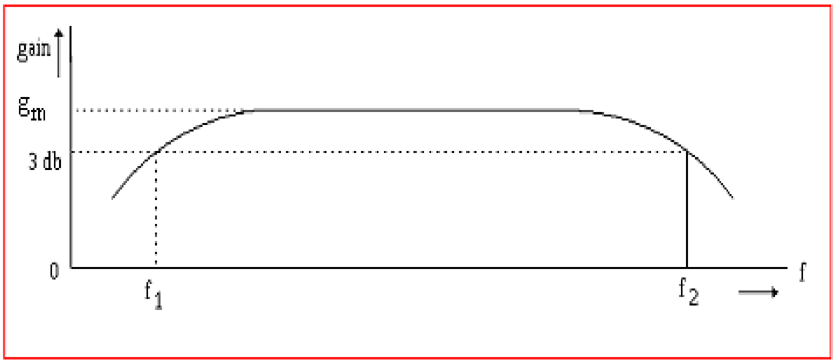
1. Connect the circuit as per circuit diagram.
2. First keep the input signal at 1 KHz (sine wave) with amplitude is equal to 25mv constant throughout the experiment.
3. Now vary the input signal frequency from 50 Hz to 1MHz in steps. For every value of input frequency note the output voltage.

4. Calculate the gain magnitude of the amplifier using the formula and gain in (dB) = 20log (Vo/Vi).
5. Plot a graph frequency versus gain (dB) of the amplifier.
6. Take 3dB I.e. 3 divisions below the constant voltage gain and mark the f1 and f2 from the graph.
7. Calculate the bandwidth f2 - f1 = BW.

**OBSERVATION TABLE:** At constant **Vi=200mv**

| **Freq(Hz)** | **Out put voltage(Vo) (p-p) X (volts/div)** | **Gain($A_V$)=$V_0$/Vi** | **Gain in dB= 20 log $A_V$** |
|---|---|---|---|
| | | | |

**EXPECTED GRAPH:**




**RESULT:** The frequency response of CE Amplifier is plotted and band width is calculated.

Band Width = $f_1 – f_2$ =

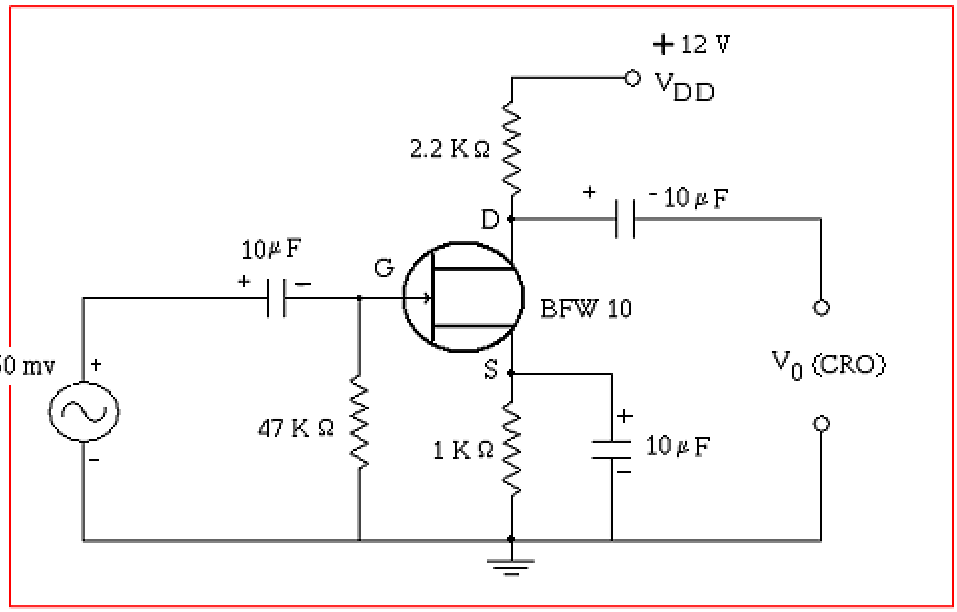
# 9. FREQUENCY RESPONSE OF COMMON SOURCE FET AMPLIFIER

**AIM:** To study the FET amplifier, to obtain the frequency response characteristics and the bandwidth of the amplifier

**APPARATUS REQUIRED:**

1. Bread Board.
2. FET (BFW 10 (or) BFW11).
3. Function Generator
4. CRO with probe
5. Resistors: 47 KΩ, 2.2 KΩ, 1KΩ.
6. Capacitors: 10µF/63V
7. Regulated Power Supply (0 - 30V) – 1No.
8. Connecting wires

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

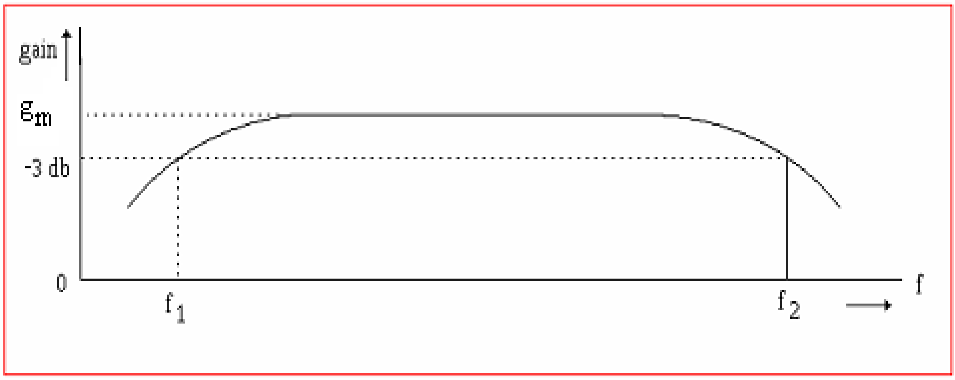
1. Connect the circuit as per the circuit diagram.
2. First keep the input signal at 1 KHz (sine wave) with amplitude is equal to 50mv constant throughout the experiment.
3. Now vary the input signal frequency from 50 Hz to 1MHz in steps. For every value of input frequency note the output voltage.

4. Calculate the gain magnitude of the amplifier using the formula and gain in (dB) = 20 log (Vo/Vi).
5. Plot a graph frequency versus gain (dB) of the amplifier.
6. Take 3dB I.e. 3 divisions below the constant voltage gain and mark the f1 and f2 from the graph.
7. Calculate the bandwidth f2 - f1 = BW.

**TABULAR FORM** At constant **Vi=200mv**

| **Freq(Hz)** | **Out put voltage(Vo) (p-p) X (volts/div)** | **Gain($A_V$)=$V_0$/Vi** | **Gain in dB= 20 log $A_V$** |
|---|---|---|---|
| | | | |

**EXPECTED GRAPH:**




**RESULT:** The frequency response of Common Source JFET Amplifier is plotted and band width is calculated.

Band Width = $f_1 - f_2$ =

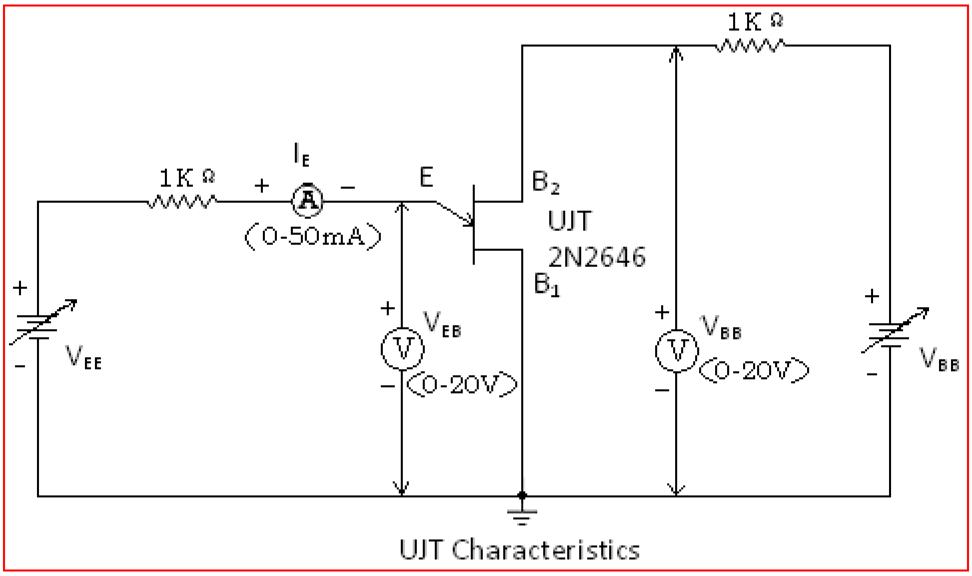
## 10. UJT CHARACTERISTICS

**AIM :** To draw and study characteristics of Uni Junction transistor (UJT).

**APPARATUS :**

1. Bread Board - 1No
2. UJT 2N2646 - 1No
3. Resistors 1KΩ, 2K2Ω, 220Ω - 1No each
4. Milliammeter (0-200mA) - 1No
5. Voltmeter (0 - 20V) - 1No
6. Connecting wires

**CIRCUIT DIAGRAM :**



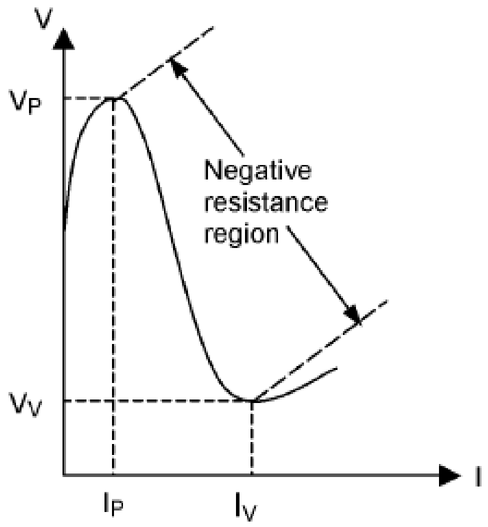

**PROCEDURE :**

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.

**OBSERVATIONS :**

| S. No | $V_{BE}$ (V) | $I_E$ (mA) |
|---|---|---|
| | | |

**EXPECTED GRAPH :**




**RESULT :** UJT Characteristics are plotted.

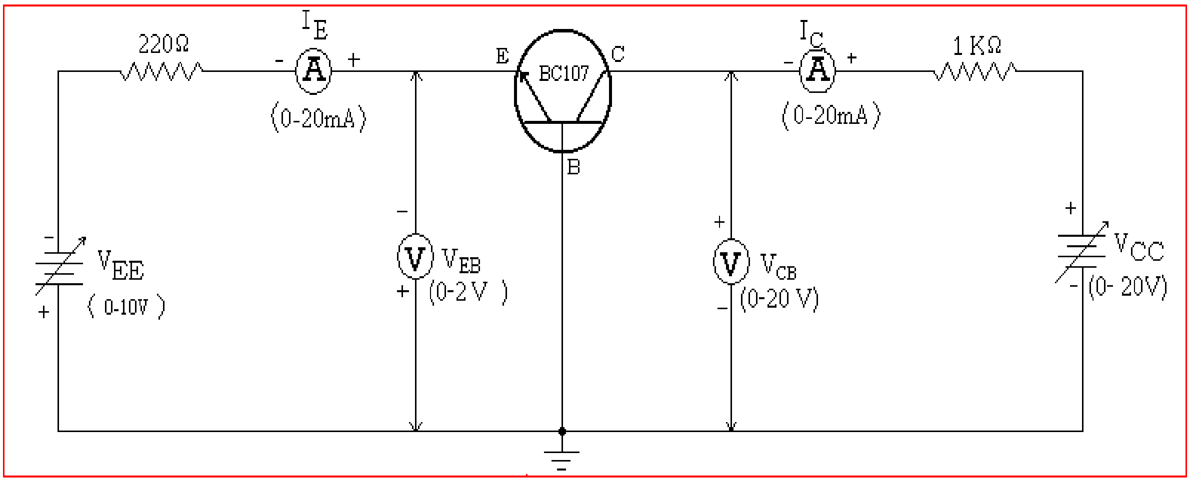
## 11. MEASUREMENT OF h- PARAMETERS OF TRANSISTOR IN CB, CE, CC CONFIGURATIONS

**AIM :** To calculate h – parameters of a given transistor in CB, CE & CC configurations.

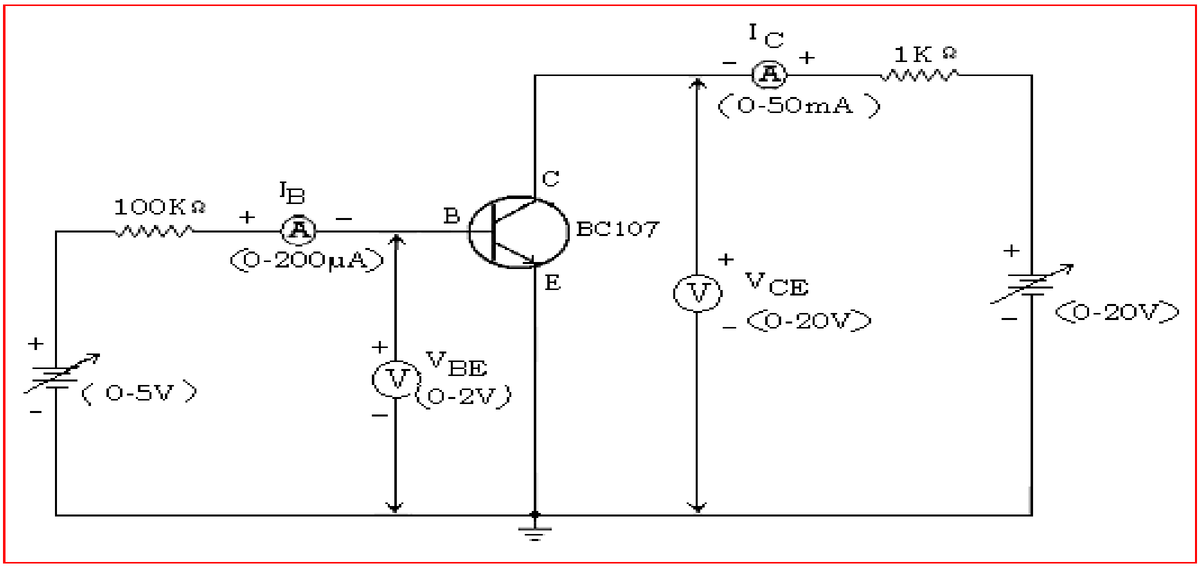
**APPARATUS:**

1. Bread Board
2. BC 107 Transistor
3. Dual channel variable regulated DC power supply (0-30V)
4. DC Ammeter (0 - 200 µA) – 1No. , (0 - 50 mA) – 1No.
5. DC Voltmeter (0 - 2V) - 1 No. , (0 - 20V) - 1 No.
6. Resistor 100KΩ and 1KΩ.
7. Connecting wires

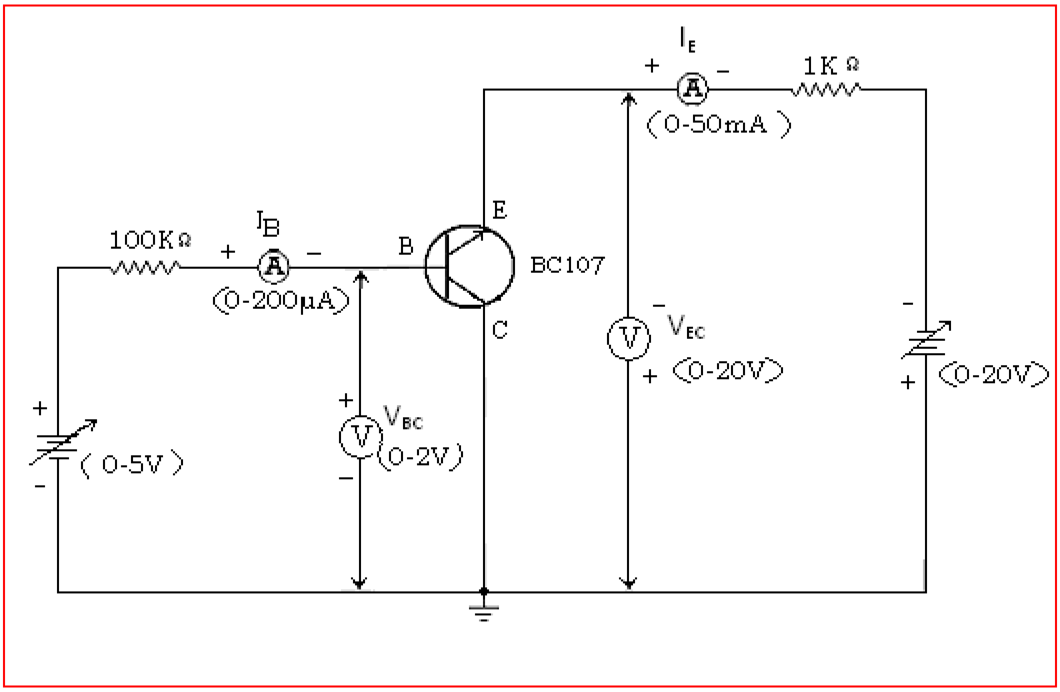
**CIRCUIT DIAGRAM :**




Common Base Configuration




Common Emmiter Configuration




Common Collector Configuration

**PROCEDURE:**

1. Plot the CB characteristics.
2. Now take the appropriate values from the graph and substitute them in the formulae of h - parameters and obtain the various h – parameters of the transistor in CB configuration.
3. Now continue steps 1 & 2 for CE & CC configurations also.

**General h – Parameters:**

In general, for a two port network h – Parameters are as follows,

$V_1 = h_i I_1 + h_r V_2$ - - - - - - - - (1)

$I_2 = h_f I_1 + h_o V_2$ - - - - - - - - (2)

In these equations

$h_i = V_1/I_1$ at $V_2$ = constant. Input resistance with output short circuited.

$h_r = V_1/V_2$ at $I_1$ = constant. Reverse voltage gain with input open.

$h_f = I_2/I_1$ at $V_2$ = constant. Forward current gain with output short circuited.

$h_o = I_2/V_2$ at $I_1$ = constant. Output admittance with input open.

**Formulae for h – Parameters for CB Configuration**

1. Input Resistance ($h_{ib}$) = $\Delta V_{EB}/\Delta I_E$ at $V_{CB}$ = Constant
2. Reverse Voltage Gain ($h_{rb}$) = $\Delta V_{EB}/\Delta V_{CE}$ at $I_E$ = Constant
3. Forward Current Gain ($h_{fb}$) = $\Delta I_C/\Delta I_E$ at $V_{CB}$ = Constant
4. Output Admittance ($h_{ob}$) = $\Delta I_C/\Delta V_{CB}$ at $I_E$ = Constant

**Formulae for h – Parameters for CE Configuration**

1. Input Resistance ($h_{ie}$) = $\Delta V_{BE}/\Delta I_B$ at $V_{CE}$ = Constant
2. Reverse Voltage Gain ($h_{re}$) = $\Delta V_{BE}/\Delta V_{CE}$ at $I_C$ = Constant
3. Forward Current Gain ($h_{fe}$) = $\Delta I_C/\Delta I_B$ at $V_{CE}$ = Constant
4. Output Admittance ($h_{oe}$) = $\Delta I_C/\Delta V_{CE}$ at $I_B$ = Constant

**Formulae for h – Parameters for CC Configuration**

1. Input Resistance ($h_{ic}$) = $\Delta V_{BC}/\Delta I_B$ at $V_{EC}$ = Constant
2. Reverse Voltage Gain ($h_{rc}$) = $\Delta V_{EC}/\Delta V_{BC}$ at $I_B$ = Constant
3. Forward Current Gain ($h_{fc}$) = $\Delta I_E/\Delta I_B$ at $V_{EC}$ = Constant
4. Output Admittance ($h_{oc}$) = $\Delta I_E/\Delta V_{EC}$ at $I_B$ = Constant

**RESULT:** h-parameter values for the given Transistor in CB, CE, CC Configurations are calculated

# 12. FREQUENCY RESPONSE OF CC AMPLIFIER

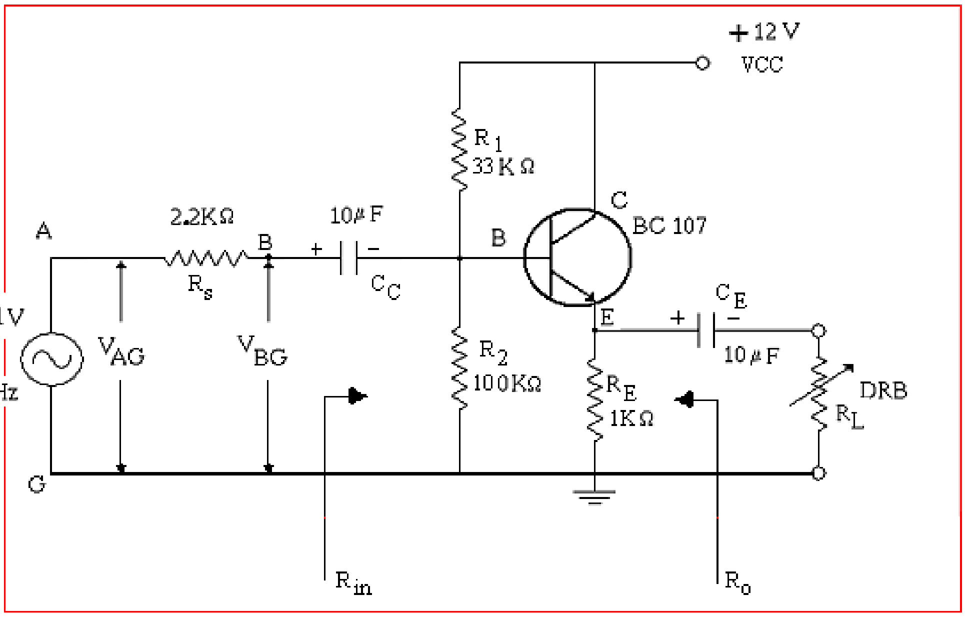
**AIM:** 1. To study the characteristics (i.e. Ri, Av, Ai, Ro) of common collector Amplifier circuit.

2. To calculate the voltage gain at Re.
3. To verify the theoretical values with practical values for Characteristics of common collector amplifier.

**APPRATUS REQUIRED:**

1. Bread board
2. CRO with probe
3. Function Generator
4. Decade Resistance Box - 1No
5. Dual mode Regulated DC power supply (0 - 30V) – 1No.
6. Resistors 2.2k, 33k, 100k, 1k
7. Capacitors 10uF - 2No's
8. Connecting wires

**CIRCUIT DIAGRAM:**



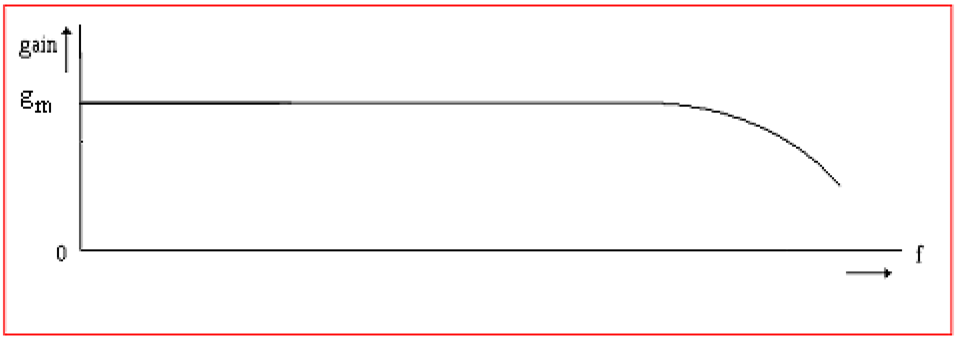
**PROCEDURE:**

1. Connections are made as shown circuit diagram.
2. Set a sine wave of 1V amplitude at 1 KHz from Function generator.
3. Give the output of Function generator to the input of the circuit. Take the output of the circuit across emitter terminal Re by CRO.
4. Observe the output of common collector amplifier (Vo) on CRO.
5. Compare input and output of the common collector amplifier with respect to its amplitude and phase.
6. Keep Re at 1k, measure the voltage between the points `A` and ground $V_{AG}$ and `B` and ground $V_{BG}$. The practical (Ri) = $V_{AG}$.Rs/ $V_{AG}$ - $V_{BG}$ ( Rs = 2.2k)
7. Calculate the gain of the common collector amplifier Av = Vo/Vi.
8. Connect a load resistor $R_L$(Rc DRB at 1k) parallel with emitter terminals. Measure Vo, calculate practical ($A_I$)=output current/input current =Vo.Rs/$R_L$`( $V_{AG}$ - $V_{BG}$)
9. Remove the load resistor ($R_L$) and measure Vo. Connect $R_L$ and adjust its value such that the output voltage Rs equal to Vo/2.This value of value of $R_L$ is equal to Ro practically.

**TABULAR FORM:**

| Input Resistance Ri ( T ) | Input Resistance Ri ( P ) | Voltage Gain Av ( T ) | Voltage Gain Av ( P ) | Current Gain Ai ( T ) | Current Gain Ai ( P ) | Output Resistance Ro ( T ) | Output Resistance Ro ( P ) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

**EXPECTED GRAPH:**




**THEORITICAL CALCULATIONS:**

Take $h_{ie}$ = 1100Ω, $h_{fe}$ = 275

1. Input resistance (T) = $h_{ie} + (1+h_{fe}) R_L'$, where $R_L' = Re/R_L$
2. Voltage gain ( T ) = $(1+h_{fe})R_L'/R_i$
3. Current gain (T ) = $1+h_{fe}$
4. Output resistance (T )= $R_s+h_{ie}/1+h_{fe}$

**RESULT:** Input & Output Characteristics of the given transistor are plotted.

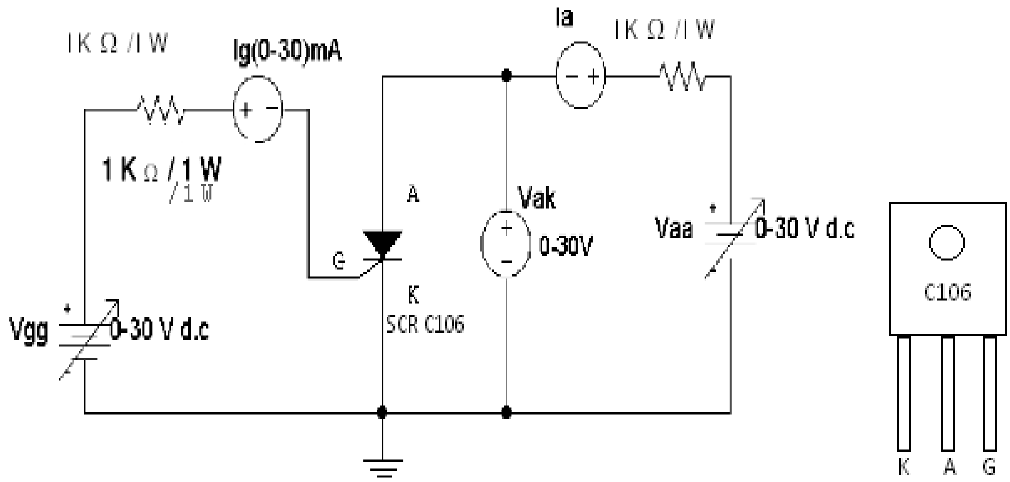
# 13. SCR CHARACTERISTICS

**AIM :** To study the V-I characteristics of SCR and determine the break over voltage, on state resistance, holding current & latching current

**APPARATUS :**

1. Bread Board - 1No
2. SCR C106 - 1No
3. Resistors 1KΩ/1W - 1No
4. Resistors 100Ω/20 or 30W - 1No
5. Voltmeter (0 - 50V) - 1No
6. Ammeter (0 - 50mA) - 1No
7. Ammeter (0 - 500mA) - 1No
8. Connecting Wires

**CIRCUIT DIAGRAM :**




**PROCEDURE :**

1. Connect the circuit as per the circuit diagram.
2. The value of gate current $I_G$ is set for convenient value using $V_{GG}$.
3. By varying the anode- cathode supply voltage $V_{AA}$ gradually in step-by- step, note down the corresponding values of $V_{AK}$ & $I_A$. Note down $V_{AK}$ & $I_A$ at the instant of firing of SCR and after firing (by reducing the voltmeter ranges and increasing the ammeter ranges) then increase the supply voltage $V_{AA}$. Note down corresponding values of $V_{AK}$ & $I_A$.
4. The point at which SCR fires, gives the value of break over voltage VBO.
5. A graph of $V_{AK}$ V/S $I_A$ is to be plotted.
6. The on state resistance can be calculated from the graph by using a formula.
7. The gate supply voltage VGG is to be switched off.

8. Observe the ammeter reading by reducing the anode-cathode supply voltage VAA. The point at which the ammeter reading suddenly goes to zero gives the value of Holding Current $I_H$.
9. Steps No.2, 3, 4, 5, 6, 7, 8 are repeated for another value of the gate current $I_G$

**OBSERVATIONS :**

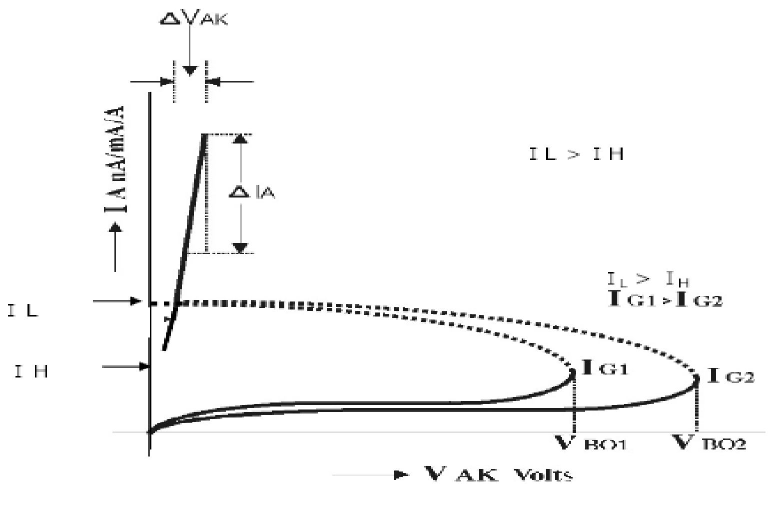
$I_G$ = ______mA

| S. No | $V_{AK}$ (V) | $I_A$ (mA) |
|---|---|---|
| | | |

$I_G$ = ______mA

| S. No | $V_{AK}$ (V) | $I_A$ (mA) |
|---|---|---|
| | | |

**EXPECTED GRAPH :**




**RESULT :** V-I Characteristics of given SCR are plotted.