ELECTRONIC DEVICES AND CIRCUITS LAB (2014-15)

PART –A

PART A: (Only for viva voce Examination)

ELECTRONIC WORKSHOP PRACTICE (in 3 lab sessions):

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and Relays), Coils, Gang Condensers, Relays, Bread Boards.
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
   - Multimeters (Analog and Digital)
   - Function Generator
   - Regulated Power Supplies
   - CRO

PART –A

Experiment 1: Identification, specification, testing of R, L, C components (Color codes), Potentiometer, switches (SPDT, DPDT and Relays), Coils, Gang Condensers, Relays and Bread Boards.

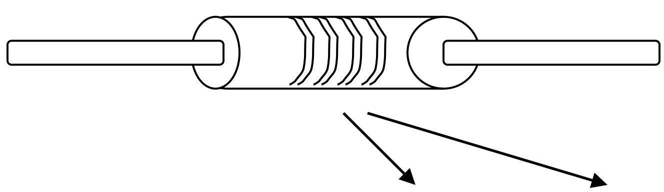
1.1 RESISTOR:

Resistor is an electronic component whose function is to limit the flow of current in an electric circuit. It is measured in units called ohms. The symbol for ohm is Ω (omega).

They are available in different values, shapes and sizes. Every material has some resistance. Some materials such as Rubber, Glass and air have very high opposition to current to flow .These materials are called insulators. Other materials such as Copper, Silver and Aluminum etc, has very low resistance, they are called Conductors.

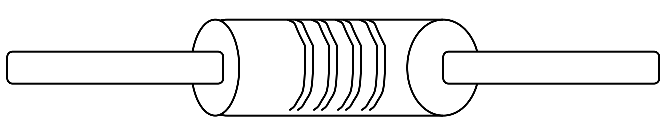
IDENTIFICATION:-

1) Color Coded Resistor(Carbon composition resistor)



Indicates Value multiplier Tolerance

2) Printed Resistor(Wire wound resistor)



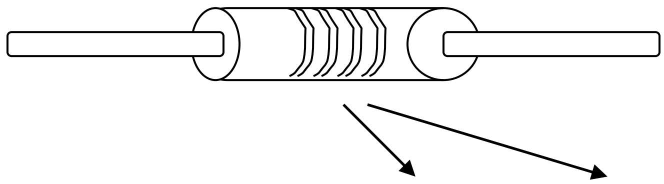
Color codes

The most common type has color bands to indicate its resistance. The code is a standard one adopted by manufactures through their trade association, the electronic Industries Association (EIA).

**Color code and its value, multipliers	Multipliers,Tolerance**

Bl -- Black → 0	10^0	Br --Brown →	± 1%
Br -- Brown→ 1	10^1	R -- Red →	± 2%
R -- Red→ 2	10^2	G -- Gold →	0.1, ± 5%
O -- Orange→ 3	10^3	S --Silver →	0.01, ± 10%
Y -- Yellow→ 4	10^4	No color →	± 20%
G -- Green→ 5	10^5	Pink→	High stability
B -- Blue → 6	10^6		
V -- Violet→ 7	10^7		
G -- Gray → 8	10^8		
W -- White→ 9	10^9		

Resistor



Indicates Value   multiplier   Tolerance

First color band tells the first significant figure of the resistors value.
Second color band indicates the second significant figure in the resistors value.
Third color band indicates the no. of zeros to be appended for the first two significant numbers often called as multiplier.
Fourth color band indicates the tolerance.

Estimation of resistance value using color code

Eg: A resistor has a color band of Brown, Green, and Orange with a tolerance band Gold

Then

Br → 1
G → 5
O → 3

First two colors is the value 15
Third color is multiplier, therefore x 10^3
i.e., 15 x 10^3 = 15000 → 15 kΩ
Fourth band Gold implies Tolerance of ± 5%
Therefore 15 kΩ ± (5% of 15k)

Note:

By tolerance we mean that acceptable deviation or the actual value of the resistor may be 5% more or less then the coded value.

If the resistor contains 5 color bands ,then the first three color bands indicates the first ,second and third significant figure in the resistors value , the fourth color band is the multiplier and the fifth color band indicates tolerance.

SPECIFICATIONS:

Carbon composition resistors are available from few ohms to several mega ohms.

Typical resistor wattage sizes are 1/8, 1/4, 1/2, 1, 2, 5, 10 and 20 (w) units, depending on thickness of leads Wattage of resistors can be decided.

In writing the values of resistors, the following designation are usedΩ, KΩ, MΩ

K → kilo → 10^3

M → Mega → 10^6

Commonly available wire wound Resistors have resistance values ranging from 1Ω to 100KΩ with power rating upto about 200W.

All resistance materials have a change in resistance with temperature.

$R_{T1}= R_{T2} [1 + \alpha (T1 – T2)]$

Where RT1 is resistance at T_1 ^{0}C

α is the temperature coefficient

R_{T2} is resistance at T_2 ^{0}C.

Temperature coefficient is important to designer so as to perform satisfactorily when the circuit is exposed to temperature variations.

Voltage coefficient: Resistances other than wire wound have a slight change with the applied voltage, generally it decreases with increase in voltage.

$$\text{Voltage coefficient In PPM (Parts Per Million)} = \frac{R1 - R2}{R2} * \frac{1}{(V1 - V2)} * 10^{6}$$

Testing:
Determine the resistance value of various resistors using color code and DMM .
Measure the resistance of each resistor and complete the below table.

S.NO	First band color	Second band color	Third band color	Fourth band color	Fifth band color	Actual resistance value(Ohm)	Max. resistance value(Ohm)	Min. resistance value(Ohm)	DMM reading (Ohm)

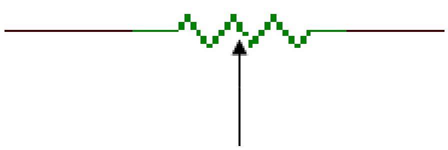
Note:
1) The measured Resistance and the color coded resistance should agree with in the the tolerance range of the resistor.
2) Do not touch both resistor leads while making the measurement, if you do so, DMM will measure your body resistance as well as the resistor.

APPLICATIONS:
It is widely used in electronic circuits to limit the current.

POTENTIOMETERS:

The variable resistors are usually called Rheostats and the smaller variable resistors commonly used in electronic circuits are called potentiometers called pot.

The symbol for pot is



The arrow indicates a movable contact on a continuous resistance element. A potentiometer can be either linear or non-linear.

APPLICATIONS:

Pots are used to change the volume of sound and brightness of picture.

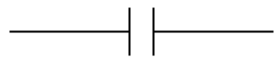
1.2 CAPACITORS:

It is a device which stores a charge. It does not pass direct current (dc) but will effectively allow the flow of alternating current (ac). The reactance of a capacitor 'Xc' is dependent on the freq of the ac signal and is given by

$$X_C = \frac{1}{2\pi fc}$$

A capacitor 'c' when charged to a voltage has a stored energy of $\frac{1}{2}$ CV^2 Joules. A capacitor essentially consists of two conducting plates separated by a dielectric medium.

Symbol:



Capacitance of a capacitor 'c' is given by

$$C = \frac{\in A}{d} F$$

The SI unit of capacitance is Farad (F)

The Farad is the capacitance of a capacitor that contains a charge of 1 Couloumb when the potential difference between its terminals is 1Volt and it stores energy, capacitor does not pass Direct current but allows the flow of alternating current.

IDENTIFICATION:

Capacitors dielectric is largely responsible for determining its most important characteristics. Hence capacitor is usually identified by the type of dielectric used.

Ex: Air capacitors, mica capacitor, ceramic capacitor, plastic film capacitor, electrolytic capacitor, and tantalum capacitors.
There are two types of capacitors
1) electrolytic
2) non-electrolytic
The electrolytic capacitors use insulation (dielectric) which is chemically active. The capacitor is marked with a +ve & -ve lead polarity.
<u>Note</u>: Be sure to connect any capacitor with marked plus & minus(-) leads to correct polarity.

Non electrolytic capacitors can be connected to the circuit with any polarity.

Note: 1) Charging of capacitor
When a capacitor is connected to a power source it is charged, and maintains the charge even after the power source is disconnected.
2) Discharging of capacitor
When capacitor leads are connected to a resistor or short circuited the stored charge results in current flow and when stored charge is removed the capacitor is said to be discharged.

Color code:

COLOR	SIGNIFICANT FIGURE	TOLERANCE (%)
Black	0	20
Brown	1	1
Red	2	2
Orange	3	3
Yellow	4	4
Green	5	5
Blue	6	6
Voilet	7	7
Grey	8	8
White	9	9
Silver	0.01	10
Gold	0.1	5
No band	----	20

SPECIFICATIONS:

Values of capacitors can be designated as μF, pF, nF

μF = micro farads = 10^{-6}F
pF = pico farads = 10^{-12}F
nF = nano farads = 10^{-9}F

1. The dielectric constant of the capacitor is a function of temperature, frequency & voltage of operation. The value decreases with frequency while the changes with temperature may be either +ve or –ve. The temperature co-efficient values for the various capacitor dielectrics are approximately given below
   Mica = 100 ppm/^{o} C
   Ceramic – low ε + 80 – 120 ppm/C
   Medium ε - 500 to -800 ppm/^{o}C

2. The power factor of a capacitor is theoretically zero, since p.f = R/Z & R is zero for a pure capacitor.

The various dielectric material & the ranges of values these dielectrics can provide are shown

Dielectric	**E**	**Capacitance in μF per cubic cm.**			**Available range μF**
		For 100V	500V	1000 V	
1.Natural Mica	6	0.004	0.001	0.0007	10 pF – 0.1μF
2.Ceramic	100-5000	0.2	0.02	0.007	10pF – 0.01μF
3.Electrolytic	7	08.	0.2	0.06	1 to 1000 μF

Testing for capacitance:

1. Determine the value and type of each capacitor from its colour code.
2. Measure the value of capacitance using DMM. And complete the below table.

S.NO	Capacitor type	ColorCoded Tolerance	Measured capacitance (using DMM)

APPLICATIONS:

1. In tuned circuits.
2. As bypass capacitors to by pass ac through it.
3. Blocking capacitor to block dc components.

Ganged Condensers:

In tuning circuits it is desired to change the value of capacitance readily, this is done by means of variable capacitors. The most common variable capacitor is the air ganged capacitor. By rotating the shaft, we can change the distance between movable and fixed sets of plates like that capacitance value is changed.

Applications:

Used in tuning circuits

1.3 <u>Inductors</u>:

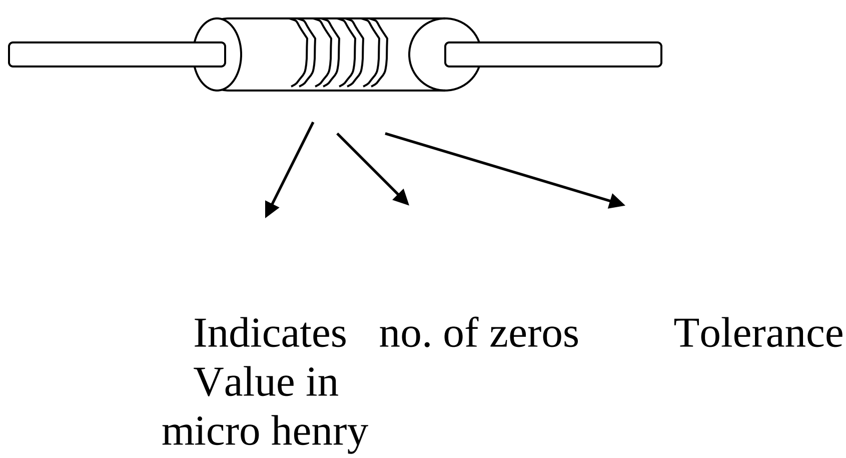
When current flow through a wire that has been coiled, it generates a MF which opposes any change in the current this keeps the current flow at a steady rate, its reaction of MF is known as inductance.

The electronic component producing inductance is called inductor. Inductance is measured in henry.

Identification:

Types of inductors are

1. air core
2. ferromagnetic core
3. molded inductors
4. thin film inductors



Color code:

COLOR	SIGNIFICANT FIGURE	TOLERANCE (%)
Black	0	
Brown	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Violet	7	
Grey	8	
White	9	
Silver		10
Gold	decimal point	5
No band		20

Specifications:
Typical values range from milli Henry to micro Henry.

Testing for inductor:
1. Identify the type of inductor.
2. Measure the inductance value.
3. complete the below table.

S.NO	inductor type	Value

Applications:

1. Filter chokes for smoothing and pulsating currents produced by rectifiers.
2. Audio frequency chokes, to provide high impedance at audio frequencies.

Switches:

A switch is a device which can connect two points in a circuit (or) disconnect two points. If the switch is acting so has to connect two points. It is said to be in ON position. If the switch is acting so has to disconnect two points. It is said to be in OFF position.

SPDT:- (Single Pole Double Throw):
If there are two independent circuits to be connected using two throws but still connecting one poll then it is called single pole double throw.

DPDT: (Double Pole Double Throw):
This switch is capable of connecting the receiver to either Antenna-I or Antenna-II at the same time and it connects two poles hence the DPDT switch.

RELAYS:

Switches closes its contacts by the mechanical activation of its lever, the relay do this by an electromagnetic coil pulling its contacts current and wound over a core of soft magnet. The moving armature of core causes the contact closure.

Relays can have several poles and several contacts. Types of Relays are

1. Reed Relays
2. Solid State Relays
3. Over load relays etc.

APPLICATIONS:

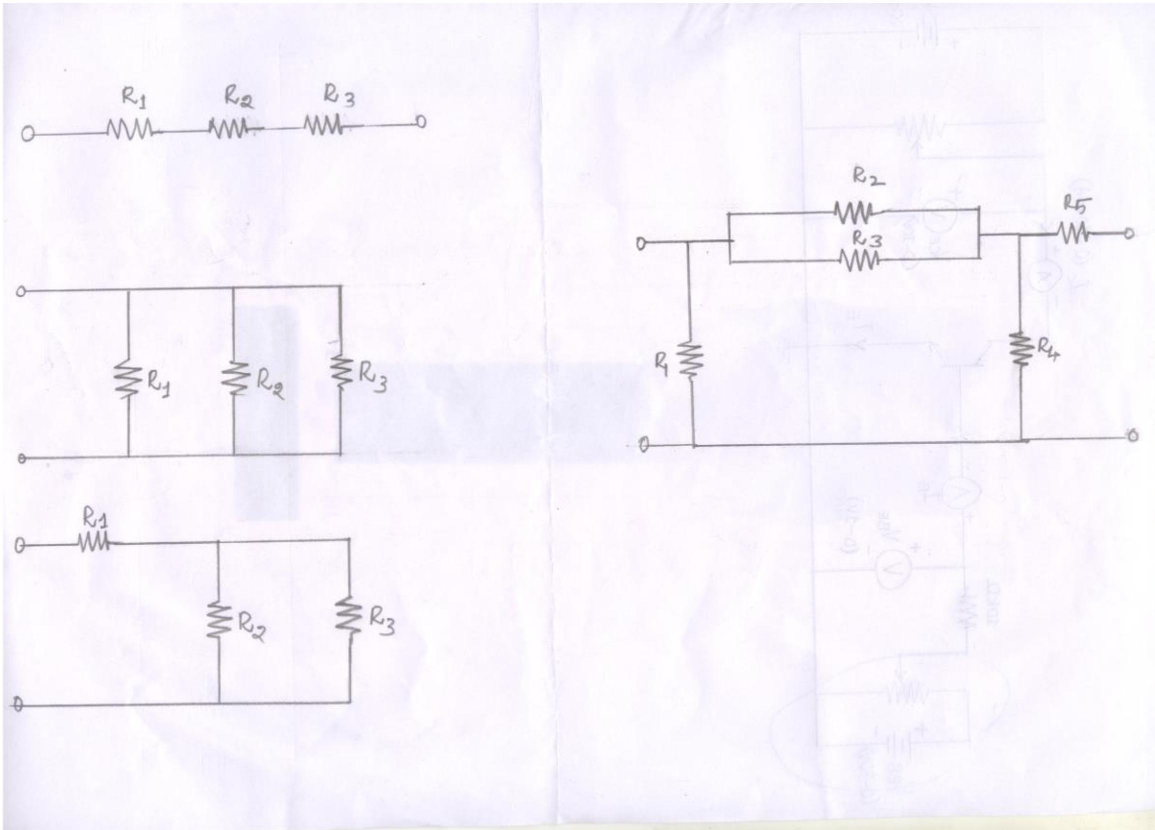
In telephone networks

Bread Boards:

This is the platform (or chasis) on which any circuit can be ringed up to provide inter connections between electronics components and devices.

The advantage of bread board is, the components can be connected (or) disconnected easily. It has holes both horizontally and vertically as shown in the figure.

The horizontal holes at the top and bottom are having internal shorts where as in the remaining part vertical holes are shorted internally


R1
R2
R3
R1
R2
R3
R1
R2
R3
R2
R3
R5
R1
R4

Experiment - 2

Identification, specifications and testing of active devices, diodes, BJTs, Low power JFETs, MOSFETs, Power transistors, LEDs, LCDs, Optoelectronic devices, SCR, UJT, DIACs, TRIACs, Linear and Digital Ics.

2.1 <u>Diode</u>: A popular semiconductor device called a diode is made by combining P & N type semiconductor materials. The doped regions meet to form a P-N junction. Diodes are unidirectional devices that allow current to flow through them in one direction only.

The schematic symbol for a semiconductor diode is shown in fig-1. The P-side of the diode is called the anode (A), while the N-side of the diode is called the cathode (K).

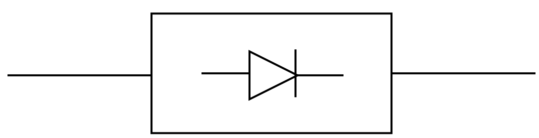


Fig-1 : symbol of P-N diode.

<u>Diode specifications:</u>

Breakdown voltage rating V_{BR}

The Breakdown voltage rating V_{BR} is the voltage at which avalanche occurs. This rating can be designed by any of the following: Peak Inverse Voltage (PIV); Peak Reverse Voltage (PRV); Break down voltage rating V_{BR}
Average forward – current rating, I_F

This important rating indicates the maximum allowable average current that the diode can handle safely, the average forward current rating is usually designated as I_F

Maximum reverse current, I_R

1N4007 silicon diode specifies a typical I_R of 0.05 μA for a diode junction. Temperature T_J of 25^0C and a reverse voltage V_R of 100 V.

The maximum rating of a diode should never be exceeded.

Testing of diode:

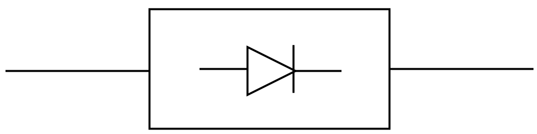
a) Using an ohmmeter to check a diode: when using an ohm meter, check the resistance of the diode in one direction, then reverse the meter leads and measure the resistance of the diode in the other direction. If the diode is good it should measure a very high resistance in one direction, and a low resistance in the other direction. For a silicon diode the ratio of reverse resistance R_R , to forward resistance R_F should be very large, such as 1000:1 or more.

Note: If the diode is shorted it will measure a low resistance in both the directions. If the diode is open, it will measure a high resistance in both the directions.

b) Using a DMM to check a diode: Most digital multimeters provide a special range for testing the diodes. This range is called the diode range. This is the only range setting on the DMM that can provide the proper amount of forward bias for the diode being tested. It is important to note that when the digital multimeter forward biases the diode being tested, the digital display will indicate the forward voltage dropped across the diode rather that the forward resistance, RF. A good silicon diode tested with the

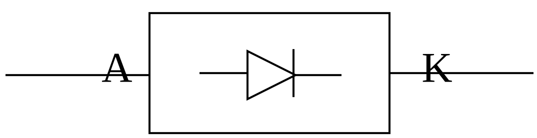
DMM should show a voltage somewhere between 0.6 – 0.7 V for one connection of the meter leads, and an over range condition for opposite connections of the leads. An open diode will show the over range condition for both connections of the meter leads, while a shorted diode will show a very low or zero reading for both connections of the meter leads.

Identification:



1N4007

Silver ring indicates the cathode and the other terminal indicates the Anode.



OA79

Black ring or dot near one end indicates cathode.

<u>APPLICATIONS:</u>

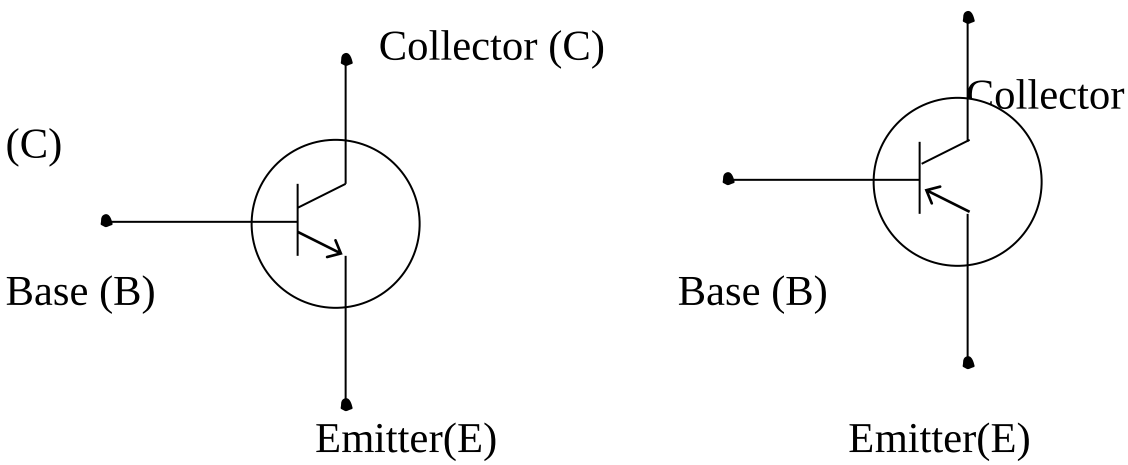
1. Rectifiers, Clippers and Clampers.
2. Signal detector.
3. Digital logic gates.

2.2 <u>Bipolar Junction transistor (BJT)</u>:

A transistor has three doped regions there are two types of transistors one is npn and other is pnp. Notice that for both types, the base is narrow region sandwiched between the larger collector and moderate emitter regions.

In npn transistors, the majority current carriers are free electrons in the emitter and collector, while the majority current carriers are holes in the base. The opposite is true in the pnp transistor where the majority current carriers are holes in the emitter and collector, and the majority current carriers are free electrons in the base.

1. Emitter 2. Base 3. Collector



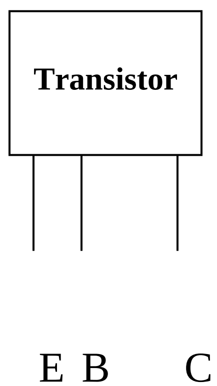
Schematic symbols for transistors (a) npn transistor (b) pnp transistor

In order for a transistor to function properly as an amplifier, the emitter-base junction must be forward biased and the collector base junctions must be reverse biased.

Identification:

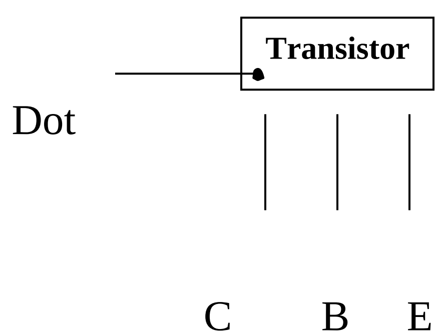
<u>Transistor lead Identification</u>:

There are three leads in a Transistor called collector, emitter and base. When a transistor is to be connected in a circuit it is necessary to identify the leads of transistor before connecting in a circuit. The identification of the leads of transistor varies with manufacturer. There are three systems in general.



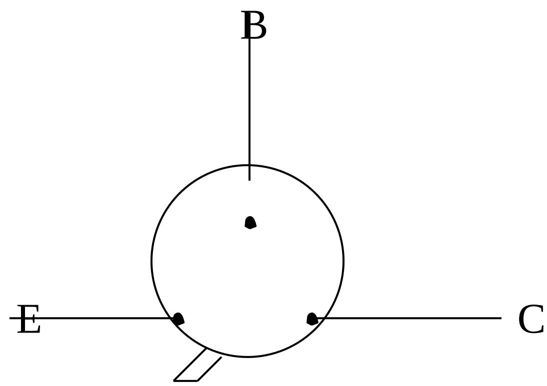
i) When the lead of a transistor is in the same plane and unevenly as in above fig., they are identified by the position and spacing of leads. The central lead is the base lead. The collector lead is identified by the large spacing existing between it and the base lead. The remaining is the emitter.

ii) When the leads of a transistor are in the same plane but evenly spaced, the central lead is the base, the lead identified by dot is the collector and the remaining lead is the emitter.



BC 547

iii) When the leads of a transistor are spaced around the circumference of a circle, the three leads are generally in E-B-C order clockwise from a notch.



BC107

SPECIFICATIONS:

In all cases, the maximum ratings are given for collector-base voltage, collector emitter voltage, emitter base voltage, collector current and power dissipation.

Power dissipation rating P_d (Max):

The product of V_{CE} and I_C gives the power dissipation, P_d of the transistor. The product of V_{CE} x I_C must not exceed the maximum power dissipation rating, P_d (Max) of the transistor is nearly 1Watt.

Derating factor:

Manufacturers usually supply derating factors for determining the power dissipation rating at any temperature above 25 ^{0}C. The derating factor is specified in Watt/^{0}C. For example if a transistor has a derating factor of 2 mW/^{0}C, then for each 10^{o}C rise in junction temperature the power rating of the transistor is reduced by 2 mW.

Breakdown voltage ratings;

A data sheet lists the breakdown voltage ratings for the emitter-base, collector-base, and collector-emitter junctions. Exceeding these voltage ratings can destroy the transistor.
BV_{CBO} is 60V, BV_{CEO} is 40V and BV_{EBO} is 6V.

Testing of BJTs:

(a)Checking a transistor with an ohmmeter:

To check the base-emitter junction of an npn transistor, first connect the ohmmeter and then reverse the ohmmeter leads. The resistance indicated by the ohmmeter should be low since the base emitter junction is forward biased. The resistance indicated by the ohmmeter should read high because the base emitter junction is reverse biased. For a good pn junction made of silicon the ration RR/RF should be equal to or greater than 1000:1.

To check the collector-base junction, repeat the process described for the base-emitter junction.

Shorted and open junctions:

A low resistance across the junction in both directions implies that the emitter-base or collector-base junctions are shorted. If the ohmmeter indicates a high resistance in both directions, then the junctions are open. In both cases the transistor is defective and must be replace.

b) Checking a transistor with a Digital Multimeter (DMM):

Insert the transistor in the provided slots, position the knob of DMM in h_{FE} mode and check the h_{FE} value.

Applications:

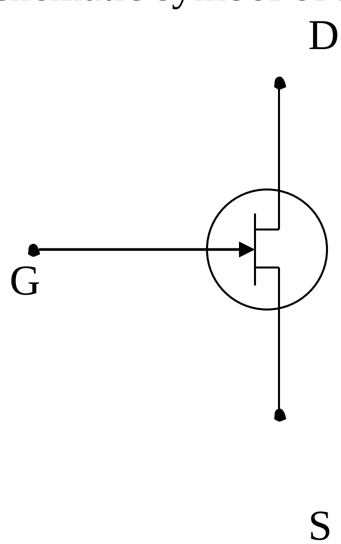
1. Amplifiers.
2. Oscillators.
3. Switches.

2.3 Field effect transistors (FETs):

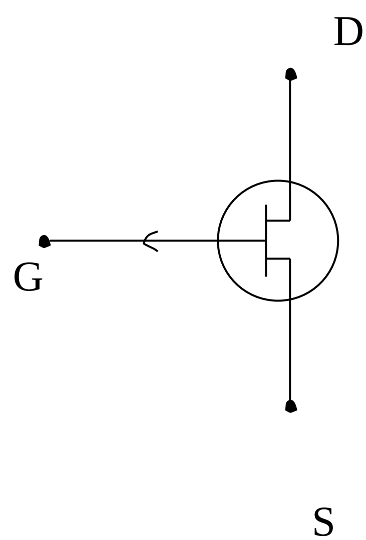
The field effect transistor (FET) is a three terminal device similar to the bipolar junction transistor. The FET, however, is a unipolar device, which depends on only one type of charge carriers; either electrons or holes. There are basically two types of FETs. The junction field effect transistor, abbreviated JFET, and the metal oxide semiconductor field effect transistor, abbreviated MOSFET.

A junction field effect Transistor is a three terminal semiconductor device in which current conduction is by one type of carriers i.e., electrons or holes.
There are two basic types of FET's
(i) Junction field effect transistor (JFET)
(ii) Metal oxide field effect transistor (MOSFET)

Schematic symbol of JFET

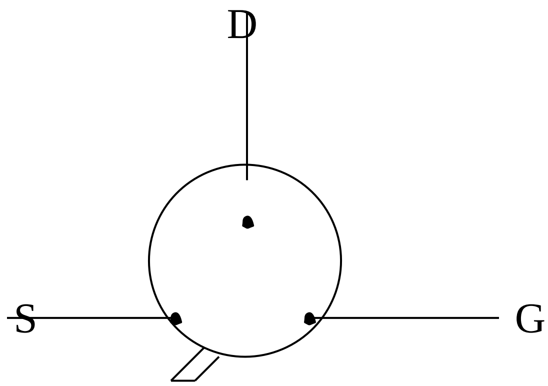


n-channel JFET



p-channel JFET

Identification:



BFW10

When the leads of FET are spaced around the circumference of a circle the three leads are generally Source, Drain and Gate order clockwise from a notch.

Specifications:

i. A.C. drain resistance (r_d): Drain resistance has a large value, ranging from 10kΩ to 1MΩ
ii. Transconductance (g_m): It is expressed in mA/V
iii. Amplification factor (μ): It is product of A.C drain resistance and transconductance.

S.No	Parameters	BFW10	BFW11
1	I_{DSS}	8-20mA	4-10mA
2	V_{GS}	4-8V	2-4V
3	g_m	3.2mA/V	3.2 mA/V

Note: 1) When $V_{GS} = 0$, $I_D = I_{DSS}$ (max drain current)
2) When $V_{GS(off)}$ is a certain value then $I_D=0$ (min drain current)

VDS = 30 V(max)
Gate source voltage with drain open $V_{GS} = 30$ V
Drain current at $V_{ds} = 15$ V and $V_{GS} = 0$
8 ma < I_{DSS} < 20 mA
Gate source cutoff voltage when $I_D = 0.5$ mA and $V_{DS} = 15$ V
V(P) < 8 V

Pinch off voltage:

The value V_p is the start of the interval V_P to V_{DS} max during which I_D remain constant.

As V_{DS} is increased from 0V to Vp called the pinch off voltage, I_D increases from 0 to the maximum drain current that can be attained without destroying the JFET, the voltage I_{DSS}.

VGS(off):

Maximum drain current flows when VGS = 0 and minimum drain current when VGS = VGS (off).

Testing:

1. In case of FET, drain to source should be a fixed resistance in either direction.
2. Gate to drain or gate to source should be an open circuit or a very high resistance.

Applications:

1. Used in tuners of radio and TV receivers
2. Amplifiers and Voltage variable resistor.

MOSFETs:

The metal-oxide semiconductor field effect transistor has a gate, source and drain just like JFET. Like a JFET, the drain current in a MOSFET is controlled by the gate-source voltage VGS. There are two basic types of MOSFETs. The enhancement type and depletion type. The enhancement type MOSFET is usually referred to as an E-MOSFET and the depletion type MOSFET is referred to as a D-MOSFET.

The key difference between JFETs and MOSFETs is that the gate terminal in a MOSFET is insulated from the channel. Because of this, MOSFETs are sometimes referred to as insulated gate FETs or IGFETs. Because of the insulated gate, the input impedance of a MOSFET is many times higher that that of a JFET.

Types of MOSFET'S:

(a) n-channel D- MOSFET (b) P-channel D-MOSFET
(c) n-channel E-MOSFET (d) p-channel E-MOSFET

Specifications:

A typical MOSFET is the 3N200 made by BEL. It has two independent gates against only one in a common MOSFET. Its specifications are drain to source voltage VDS= 0.2V to 20 V.
Gate 1 to source voltage V G1S = 0.6 V to +3 V
Gate 2 to source voltage V G2S = 0.6 V to +6 V
Drain to gate 2 voltage VDG2 = +20V
Drain current ID = 50 mA

Transistor dissipation PT = 330 mw
Derating = 2.2 m2/0C

Testing:

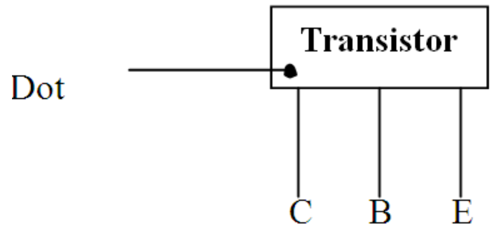
1. In case of MOSFET, drain to source should be a fixed resistance in either direction
2. Gate to drain or gate to source should be an open circuit or a very high resistance (greater than FET).

The device under test in the given circuit is a depletion type N-channel JFET, with the gate circuit kept open, the magnitude of the drain current is sufficient to make the ID R2 drop large enough. So that the BJT is forward biased and driven into its ON state. Therefore the lamp glows. The switch SW is now closed. The bias on the FET gate then causes depletion of its channel. This lowers the IDR2 drop to the point where conduction through the BJT output circuit fails to keep the bulb glowing. All this will happen if the FET is in good condition. On the other hand, a short circuited FET will deep the lamp On in either position of switch SW, while an open FET will fail to switch the indicator lamp ON.

Power Transistors:

The two types of power transistors made with of the alloy junction type and the silicon planar type. However, large power means a high current circulating through the device, requiring bigger areas for a given current density, the active emitter and collector areas can be over 10 mm2.

Identification:



SL100

Specifications:

One way to distinguish transistors is by the number marked on them. Thus low frequency, low power transistors bears the numbers AC125, AC126, BC147 and BC148. An example of a high frequency, low power transistor is BF115; power transistors are BD138, AD149, 2N3055 etc. Similarly, germanium and silicon transistors are distinguished by the first letters A and B respectively.

Absolute Maximum Ratings

Type	**BVcbo**	**BVceo**	**BVebo**	**Ic**	**Maximum Collector Dissipation at 25° C**	**β**	**Vce**	**Ic**	**Icbo**
2N696 Medium level	60	40	5	0.3	0.6	20-60	10	150	1

BV_{CEO} : maximum value of voltage across collector-emitter circuit with base open.
BV_{CBO} : maximum value of voltage across collector-base circuit with emitter open.
BV_{EBO} : maximum value of voltage across emitter-base circuit with collector open.

I_{Cmax} : maximum value of DC collector current.
P_T : max. power dissipation in absence of heat sinks at ambient temperature.
F_T : gain bandwidth
I_{CBO}: leakage current.

Testing:

Follow the same procedure as the ordinary BJT-testing using multimeter.

The characteristics of a BJT under different configurations can be observed directly on a CRT screen. The transistors leads are simply inserted in the three sockets of a device called a curve tracer.

Light emitting diodes LEDs:

As opposed to other diodes that give off heat when conducting, LEDs emit light. In the latter, the recombination of charge carriers across the PN junction releases optical energy when the electrons fall from the conduction to the valence band. The heat emission is negligible in light emitting materials like gallium arsenic phosphide and gallium phosphoide.
LEDs must, of course, be covered in a transparent or translucent material. The wavelength of the radiation for a given colour is given by the relation λ = 1.23/Eg. Where Eg is the energy gap between conduction and valence bands. Its value is 1.45 ev for GaAs, 3 ev for GaAsP and 2.25 ev for Gap. The colours obtained from these materials are red, yellow and green respectively.

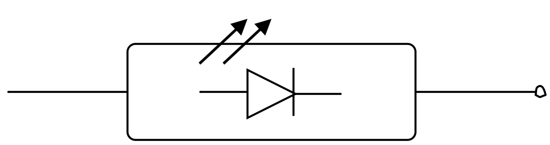
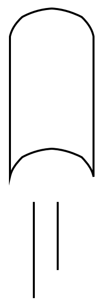


Fig (1) symbol of LED.

Identification:



K A

Longer terminal is cathode and the other is Anode.

Specifications:

1. VF operating : 1.3 v to 2.5 v
2. Forward voltage(max): 5 v.
3. Forward current 5 mA to 15 mA
4. Reverse breakdown : 10 v to 12 V
5. Operating life : 100,000 hours.
6. Turn on time : 10-20 nsec.
7. Turn off time: 80-100 nsec.

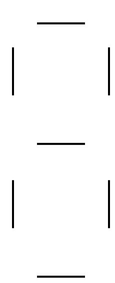
Testing:

The diode is simply put across a multimeter to see if the reading is different when the polarity is reversed. The LED will glow and show a resistance between 30 ohms and 50 ohms when forward biased.

2-h : Liquid crystal display (LCD):

As the name implies, liquid crystals are materials which have the properties of both liquids and solids crystals. Instead of a melting poing, they have a temperature range called a mesophase with in which the molecules are mobile as in a liquid although remaining grouped as in a solid. When thin layers of these materials are subjected to light radiation under the influence of an electric field, it is possible to change opaque areas into transparent ones and vise-versa.

Identification:



Specifications of a dynamic light scattering LCD:

1. Operating voltage: 15 V to 30 V
2. Frequency range: 50 Hz to 60 Hz
3. Current required: 60 μA.
4. Rise time = 25×10^{3} S
5. Contrast ratio: 20 :1

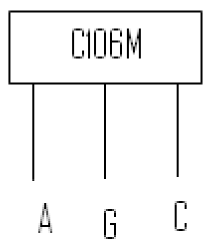
Specification of twisted nematic field effect LCD:

1. Operating voltage: 3 V
2. Operating frequency: 30 Hz to 1500 Hz
3. Effective current : 5 μA to 6 μA
4. Rise time = 100×10^{3} S
5. Contrast ratio: 50 :

SCR

The basic structure and circuit symbol of SCR is shown below. It is a four layer three terminal device in which the end P-layer acts as anode the end N-layer acts as cathode and P-layer nearer to cathode acts as a gate. As leakage current in silicon is very small compared to Germanium SCRs are made of silicon and not Germanium.

Identification:



When the leads of the SCR are in the same plane but evenly spaced the central lead is the Gate, left side of the gate is Anode and the other is Cathode.

Specifications:

The following is a list of some important SCR specifications:

1. Latching Current (I_L):
Latching current is the minimum current required to latch or trigger the device from its OFF-state to its ON-state.

2. Holding Current (I_H):
Holding current is the minimum value of current to hold the device in ON-state. For turning the device OFF, the anode current should be lowered below I_H by increasing the external circuit resistance.

3. Gate Current (Ig):

Gate current is the current applied to the gate of the device for control purposes. The minimum gate current is the minimum value of current required at the gate for triggering the device the maximum gate current is the maximum value of current applied to the device without damaging the gate. Move the gate current earlier is the triggering of the device and vice versa.

Voltage safety factor (Vf) voltage safety factor Vf is a ratio which is related to the PIV, the RMS value of the normal operating voltage as

$$Vf = \frac{Peakinversevoltage(PIV)}{\sqrt{2}XRMSvalueoftheoperatingvalue}$$

The value of Vf normally lies between 2 and 2.7 for a safe operation, the normal working voltage of the device is much below its PIV.

Testing:

1. The SCR should be switched on and voltage measured between anode and cathode, which should be approximately volt and the voltage between gate and cathode should be 0.7 volt.

2. An ohmmeter can also be used to test SCR the gate –cathode of a thyristor has a similar characteristic to a diode with the gate positive with respect to the cathode, a low resistance (typically below 100Ω) should be indicated on the other hand with the gate negative with respect to the cathode a high resistance (greater than 100kΩ) will be indicated. A high resistance is indicated in either direction for the anode to cathode connections.

Applications:

These are used in power control applications such as lamp dimmers motor speed control, temperature control and invertors. They are also employed for over voltage protection in DC power supplies.

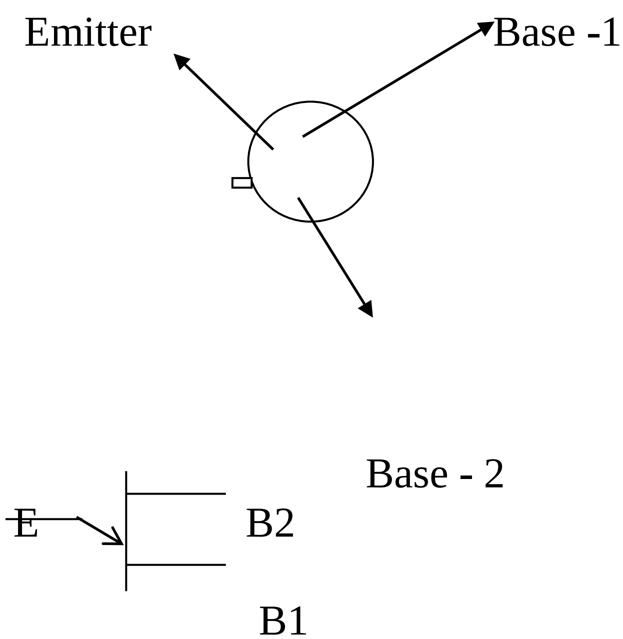
UJT

IDENTIFICATION:

UJT is a three terminal semiconductor switching device. As it has only one PN junction and three leads it is commonly called as uni-junction transistors.

The basic structure of UJT is as shown below.

PICTURE



Specifications:

Intrinsic standoff ratio: It is a ratio given by $\frac{R_{B1}}{R_{B1} + R_{B2}}$ and is usually designated as ς (eta). Typical values of ηrange from 0.47 to about 0.85.

Inter base resistance: It is the resistance of the n type silicon bar it is designated by R_{BB}. The value of R_{BB} is dependent upon the doping level and physical dimensions of the si bar. If emitter E is open, then the voltage V_{BB} between B1 and B2 will get divided across R_{B1} and R_{B2}.

The voltage V_1 across R_{B1} will be $V_1 = \frac{R_{B1}}{R_{B1}+R_{B2}} V_{BB}$

$$= n\, V_{BB}$$

Testing:

1. In case of UJT, emitter to base, (cont1) and emitter to base2 (confg2) should be exhibit a typical diode characteristics except that the diode resistance in forward and reverse cases is different for the two configurations.

2. The resistance across base1 to base2 should be fixed resistance in either direction.

Applications:

UJT can be used as relaxation oscillator and phase control circuit.

<u>Linear and Digital ICs:</u>

Identification:

The desire to miniaturize an electronic circuit in a single chip which contains AC transistors, diodes, resistors all connected internally with only outside terminals has given to rise to the concept of integrated circuit. Basically integrated circuits can be classified into Linear and Digital ICs. Linear ICs are also called as Analog ICs. Here operating points are very accurate output levels are fixed. In case of digital ICs accurate operating points are not necessary.

The ICs are represented in one of the two methods.

i) IC is represented by a rectangle with pin numbers shown along with each pin. The identification number of the IC is listed on the schematic.

Representation of the IC in terms of its simple logic elements. For example, IC 742574 is Q and 2-input and gate and when it is represented as ¼ 742508.

An IC can be identified from the information given on the IC itself. The numbering system through has been standardized has some variations from manufacturer to manufacturers usually an IC has the following markings on its surface.

Core Number: Identifies the logic family and its functions in 742551 the first two numbers indicate that the IC is a member of the 7400 series IC family. Last letters give the function of the IC. Letters inserted in the centre of the core number show the logic subfamily.

The same numbered ICs in each family perform the same function and have the same pin numbers.

Prefix to the core number identifies the manufacturer.

Suffix to the core number indicates package type at least range etc.

Specifications:
The number of pins their working and applications are specified along with the data sheet for the IC.

Testing:
The ICs are tested by a linear IC tester or digital IC tester.

Applications:
ICs have a wide range of applications from gates to microprocessors.

SOLDERING TECHNIQUES

Soldering Practical, simple circuits using active and passive components

Soldering is required to ensure permanent electric connections. Wires and terminals are wrapped or twisted together, and then solder is melted into the heated joint. When the heat is removed, the solder and wire cool making the soldered joint look like a solid piece of metal.

Solder is an alloy of lead and tin. It has a low melting point and comes in wire form for electronic use. Electronic solder is made-up of 60% tin and 40% lead, though the composition may vary for certain applications.

Rosin-core and resin-core solders are used for soldering electronic components. Rosin and resin are fluxes which flow onto circuit being soldered. A flux is a cleaning agent which helps to clean the surface to be soldered, ensuring a more perfect union.
Proper soldering requires the following:-

1. Clean metallic surfaces.
2. Sufficient heat applied to the joint to melt solder when solder is applied to the heated wire surface.

The solder must not come in direct contact with the tip of the soldering iron or gun because it will melt rapidly. If the wires or terminals to be soldered have not been preheated sufficiently, the melten solder will not stick to their surface.

Soldering in printed circuits :

The network of inter connecting conductive paths on a PCB consists of thin copper strips and pads bonded to the plastic board. Leads of components mounted on the board are inserted through holes in the board and the conductive copper. These leads are soldered to the copper at the end of the hole through which they emerge. If the excessive heat is applied to the copper, it may lift from the board, or the miniature components mounted on the board may be damaged.

A 30w soldering pencil is therefore used to heat the junction. This low voltage iron provides an effective means of controlling heat. Components leads should be cleaned and tinned prior to soldering. Avoid excess solder to prevent bridging the gap between two copper paths. Excess solder should be avoided in hard-wired circuits.

Rules for soldering :

Good soldering is part of technician's skills. Solder connections must be mechanically strong, joints mechanically secure, so that they will not slake loose and cause loss of signal and possible damage to parts. Electrically solder contacts must have low resistance to current flow for proper signal transfer.

Some basic soldering rules are :

1. Soldering tip must be tinned and clean.
2. Metals to be soldered must be clean.
3. Support the joint mechanically where possible.
4. Tin large areas before soldering them together.

5. Apply solder to joint, not to gun or iron tip, solder must flow freely and have a shiny, smooth appearance.
6. Use only enough solder to make a solid connection.
7. Where additional flux is used, apply to joint, not to soldering tip. Use only rosin or resin flux.
8. Solder rapidly and do not permit components or insulation to burn or overheat

Single layer and multi layer PCBs

A PCB interconnects electronic components using conductive traces laminated onto a nonconductive substrate. Alternate names are printed using board or etched wiring board.
A PCB consists of a conductors attached to a sheet of insulator. The conductive path ways are called traces or tracks. The insulator is substrate. The vast majority of PCB are made by adhering a layer of topper over the entire substrate sometimes on both the sides then removing unwanted copper after applying temperature mask leaving only the desired copper traces. A few PCB's are made by adding traces to the bare substrate usually by complex process of multiple electroplating. Some PCB's have traces layers inside the PCB and are called multiplier PCB's . These are formed by bonding together separately etched thin boards, after the circuit boards has been manufactured, components are connected to traces by soldering them to the board.

PCB design is a specialized skill. There are numerous techniques and standards used to design a PCB that is easy to manufacture and yet small and inexpensive. Most PCB's have between 1 and 16 conductive layers laminated together.

Surface mount technology was developed in 1960's and became widely used in late 1980's. Components were mechanically resigned nto have small metal tabs or end caps that could be directly soldered to the surface of PCB. Components became much smaller and component placement on both sides of the board became far more common with surface mounting leads itself well to a high degree of automation.

Experiment 3

Study and operation of

a. **Multimeters (analog and digital)**
b. **Function generators**
c. **Regulated power supplies**
d. **CRO**

MULTIMETRES & Regulated power supply :

AIM: To accurately read voltages using analog voltmeter and DMM from Regulated power supply.

APPARATUS: DMM
Analog voltmeter
Regulated Power supply
Connecting wires.

THEORY: Analog Voltmeter:

Although digital meters are used extensively through out the electronic industry. There are many analog meters also in use. The DC voltage scales on analog voltmeter are linear that is the distance between equal values (adjacent divisions) marked on the meter scale are of same length.
Ex:- If the scale is from 0V to 10V then there are 10 equally spaced divisions between these two values each division represents 0.2V.

Zero adjustment:-
Before use make any measurement with the voltmeter, be certain that the meter indication 0V.

In analog voltmeter, control (screw) is placed on the front panel of the meter for the purpose of zeroing the meter.

Parallex error:

It results when the person making the measurement is not directly viewing the meter pointer.

DMM (DIGITAL MULTIMETER):

THEORY:

Digital multimeter is abbreviated as DMM. It has 3 ½ Digital LCD (liquid crystal display)
½ digit means it will display '0' or '1'.
3 digits reads any number in the range of 000 to 999.

DMM can read AC, DC voltages and currents in many ranges. It can also check diode polarities, read β value of transistor. Measuring the value of capacitance and resistance

DMM can be used for checking continuity of multimeter probes, test leads, power chords and cables etc.

REGULATED POWER SUPPLY:
This power supply unit is specially developed with low ripple, noise and high voltage regulation is maintained. Both the voltage and current is indicated by the panel meter. The outputs are floating, current limited, self recovery on removal of fault.

The unit operates on supply voltage of 230V, 50Hz single phase A.C. The output voltage can be set to desired level by adjusting Coarse and Fine controls on the front panel without connecting the load.

Procedure

1. Turn on the Regulated power supply, set the voltage control for a maximum of 30V.
2. Connect analog voltmeter across the output terminals of regulated DC power supply.
3. Measure and record the power supply built in meter reading and analog voltmeter reading.
4. Gradually reduce the supply voltages in steps of 5V and record the values in the following table.
5. Repeat the above steps using DMM and record the measurements in table2.

Observation Table 1:

S.No	Power supply built in meter reading	Analog voltmeter reading	error (2-3)

Table 2:

S.No	Power supply built in meter reading	DMM voltage reading	error (2-3)

RESULT: Accurately the voltage readings can be measured through DMM.

CRO (Cathode Ray Oscillation)&FUNCTION GENERATOR

1. AIM:

1. To study the front panel controls of the CRO and Function generator.

2. To use the CRO to measure.

i. D.C voltages ii. AC voltages iii. Frequency and iv. Phase angle by Lissajous figures.

2. EQUIPMENT AND COMPONENTS:

i. Apparatus:

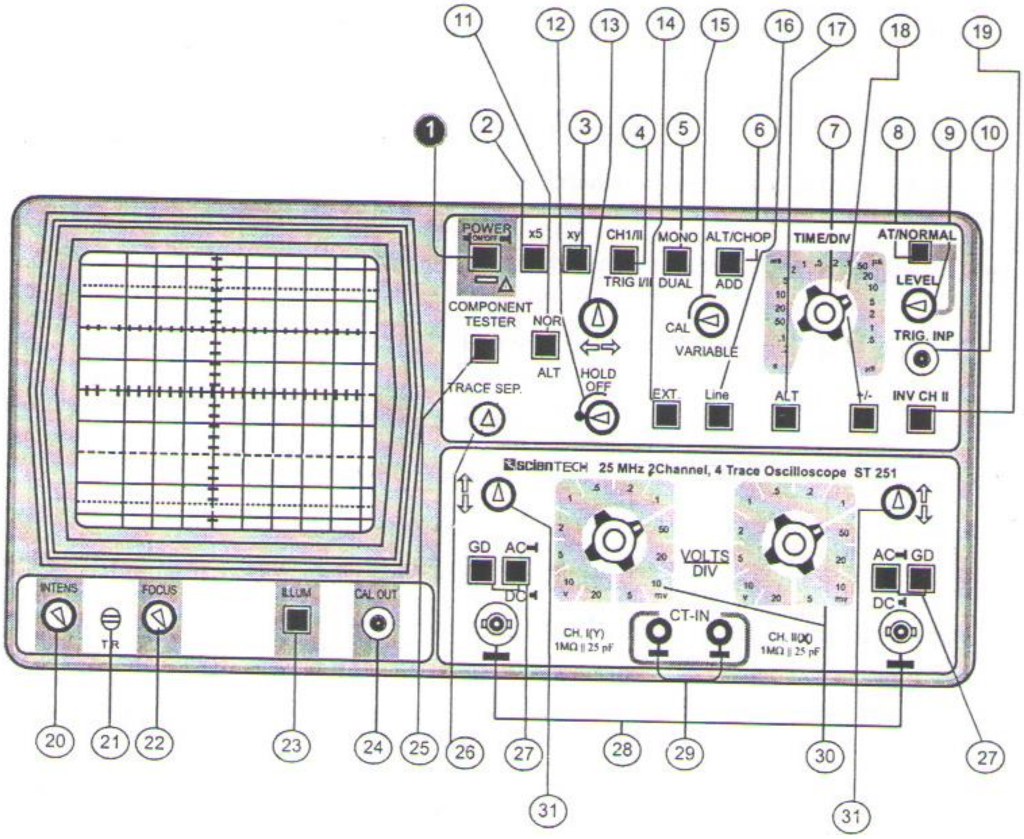
1. DC regulated power supply 0-30v DC/1Amp – 1 No.
2. Signal Generator 100 KHz (Sine Wave) - 1 No.
3. Capacitor 1μf – 1 No.
4. Decode Resistance Box (DRB) – 1 No.

3. THEORY:-

CRO is one of the most widely used measuring device in electronic and testing lab oratories CRO gives visual display of an input signal current or voltages). This enables not only measurement of the quantity, but also analysis and manipulation of its waveform.

Lissajous patters:

If two sine waves are applied simultaneously to the vertical and horizontal deflection plates of CRO, the light spot on the screen would trace definite patterns depending on the frequencies, amplitude and phase difference. These patterns are termed as lissajous figures.



CRO Front Panel

1	POWER ON/OFF	:	Push button switch for supplying power to instrument.
2	X5	:	Switch when pushed inwards gives 5 times magnification of the X signal.
3	XY	:	Switch when pressed cuts off the time base & allows access the Ext. Horizontal signal to be fed through CH II (used for X-Y Display).
4	CH-I/CH-II/ TRIG I/ TRIG II	:	Switch when out selects & triggers CH - I and when pressed selects & triggers CH II.
5	MONO/ DUAL	:	Switch selects the Dual operation.
6	ALT/ CHOP/ ADD	:	Switch selects Alternate or chopped in DUAL mode. If mono is selected then this switch enable Addition or subtraction of Channel i.e. CH I ± CH II.
7	TIME/DIV.	:	Switch selects Timebase speeds
8	AT/NORM	:	Switch selects Auto/Normal position. Auto is used to get trace when no signal is fed at the input. In NORM the trigger level can be varied from the positive peak to negative peak with LEVEL Control.
9	LEVEL	:	Controls the trigger level from peak to peak amplitude of signal.

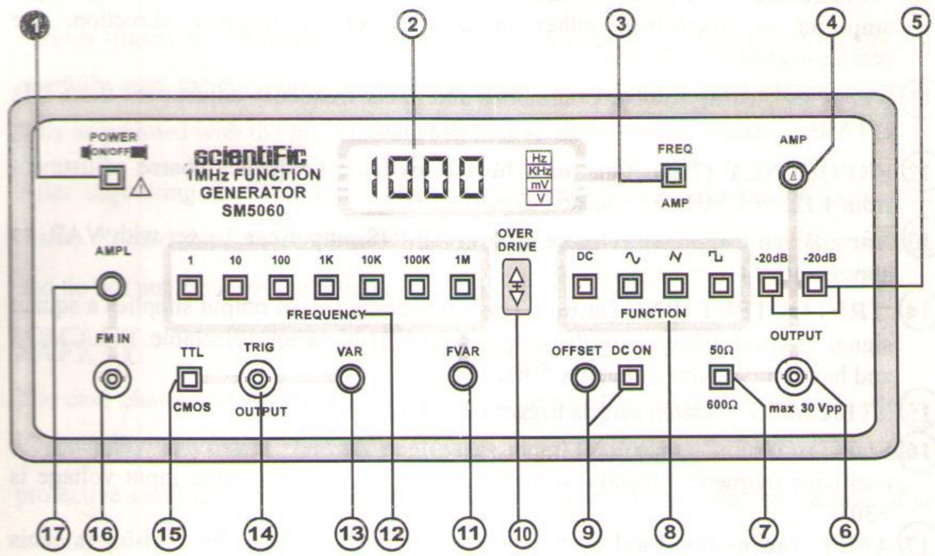
(10)	TRIG. INP	:	Socket provided to feed external trigger signal in EXT. mode.
(11)	NOR / ALT	:	Switch selects NOR (X1) or ALT (X1 & X5 simultaneously) Operation
(12)	HOLD OFF	:	Controls hold off time between sweeps. At Normal position (full counter clockwise)
(13)	X-POS	:	Controls Horizontal position of the trace.
(14)	EXT.	:	Switch when pressed allows External triggering signal to be fed from the socket marked TRIG. INP.
(15)	VARIABLE	:	Controls the time speed in between two steps of TIME/DIV switch. For calibration put this fully anticlockwise. (at CAL pos.).
(16)	LINE	:	Switch when pressed displayed signal gets synchronized with mains/line frequency
(17)	ALT	:	Selects alternate trigger mode from Ch I & Ch II
(18)	+/-	:	Switch selects the slope of triggering, whether positive going or negative going.
(19)	INV CH. II	:	Switch when pressed invert the CH II.
(20)	INTENS	:	Controls the brightness of the trace.
(21)	TR	:	Controls the alignment of the trace with graticule (Screw driver adjustment)
(22)	FOCUS	:	Controls the sharpness of the trace.
(23)	ILLUM.	:	For switching ON/Off graticule Illumination.
(24)	CALOUT	:	Socket provided for square wave output 200 mV; used for probe compensation and checking vertical sensitivity, etc.
(25)	COMPONENT TESTER	:	Switch when pressed starts CT operation
(26)	TRACE SEP.	:	Separates traces X1 & X5 in ALT Operation.
(27)	DC/AC/ GD	:	Input coupling switch for each channel. In AC the signal is coupled through 0.1 MFD capacitor.
(28)	CH. I(Y) & CH. II (X)	:	BNC connectors serve as input connection for CH. I & CH. II. Channel II input connector also serves as Horizontal external signal.
(29)	CT-IN	:	To test any components in the CT mode, put one test probe in this socket and connect the other test probe in ground socket.
(30)	VOLTS/ DIV	:	Switches select the sensitivity of each channel.
(31)	Y POS I & II	:	Controls provided for vertical deflection of trace for each channel.

Back Panel Controls

Fuse	:	350 mA fuse is provided at the back panel. Spare fuses are provided inside the instrument.
Z mod	:	Banana socket provided for modulating signal input i.e. Z-modulation.
⩘	:	Banana socket provided for sawtooth output of 5Vpp.

FUNCTION GENERATOR:

Function generator makes it a versatile signal source useful for most measurement and test applications. Frequencies are read out on a 4 digit LED display. A variable frequency control facilitates accurate frequency adjustments.



(1) **POWER :** Push button switch for supplying power to instrument.

(2) **DIGITAL DISPLAY (7-segment LED) :** 4-digit frequency / amplitude meter. LED indicators for Hz, KHz, mV & V.

(3) **FREQ/AMP** : Selects display of Frequency or amplitude

(4) **AMP (adjusting knob):** Continuous adjustment of the output amplitude from 0 to -20dB when terminated with 50Ω.

(5) **-20dB, -20dB (Pushbutton):** Two fixed attenuators, -20dB each. They can be used separately. When both pushbuttons are activated, a total attenuation of -40dB results. Including the amplitude control (4) the max. attenuation amounts to -60dB (factor 1000).

(6) **OUTPUT (BNC connector) :** Short-circuit-proof signal output of the generator. The output impedance is 50 Ω switch selectable. Max. output amplitude is 30 V_{pp} (o.c.) or 15V_{pp} respectively when terminated with 50 Ω.

Attention ! Do not apply* any DC *voltage to the output socket.

(7) **50 Ω / 600 Ω** : Push button when pressed selects 600 Ω else 50 Ω in released position.

(8) **FUNCTION (4 position push button switch) :** Mode selection : DC- Sine-Triangle-Square.

(9) **DC (On), OFFSET (adjusting knob) :** Adjustment of the positive or negative offset voltage. This DC voltage can be superimposed on the output signal. The max. offset voltage is ± 15V (o.c.) or ± 7.5V respectively when terminated with 50 Ω. This voltage is also available in DC mode.

(10) **OVERDRIVE (LEDs) :** When working in the offset mode, and the output amplifier is overdriven either in positive or in negative direction, the corresponding LED lit up.

(11) **FVAR (adjusting knob):** Continuous and linear frequency adjustment from 1Hz to l MHz in steps, selected with frequency range.

(12) **FREQUENCY (7 position push button switch):** Frequency coarse adjustment from 1 Hz to 1 MHz in 7 decade steps.

(13) **Var** : When trigger output is selected in CMOS output can be set with VAR, to approx. 15 V_p

(14) **TRIG OUTPUT (BNC conn.) :** This short-circuit-proof output supplies a square signal in synchronous with the output signal. 1t is switch selectable TTL/CMOS and has a duty-factor of approx.50%.

(15) **TTL/CMOS** : Switch selects trigger output TTL or CMOS

(16) **FM IN (BNC Connector):** Applying a DC voltage to this input will vary the oscillator frequency linearly to max. 1:100. The max. allowable input voltage is +30V.

(17) **AMPL (adjusting knob):** Attenuation of input voltage for FM-input. This permits the user to change the sweep width.

4. PROCEDURE:

i. Measurement of D.C Voltages:

1. Set the CRO to lead high frequency (small time base period)
2. Align the horizontal trace with one of the horizontal time.
3. Apply the unknown DC voltage to one of the channels keeping the CRO in DC mode.
4. Measure the No. of vertical divisions shifted by the beam from the reference horizontal line.
5. Repeat the same for 4 to 5 unknown DC voltage values and note the readings in a tabular form in table 1 and find out the voltage

Sl.No.	Applied voltage from RPS (volts)	No. of divisions deflected (D)	Vertical scale of CRO (S)	Measured voltage in (volts) V = D.S

ii. Measurement of AC voltages:

1. Keep the signal generator in 1 KHz.
2. Set the oscilloscope horizontal time base to read 1 KHz signal.
3. Now apply an unknown amplitude A.C signal to one channel.
4. Measure the No. of divisions between peak to peak of the A.C signal and tabulate the readings.
5. Note the vertical scale of C.R.O(Volt/div).
6. Now the voltage of unknown amplitude is obtained by multiplying the No. of divisions by the vertical scale used.
7. Repeat the above by giving 4 to 5 unknown amplitudes of the AC signal from the signal generator and tabulate the readings.

Table 2

S.No.	No. of vertical divisions between peak to peak (A)	Vertical scale of the channel(B)	Measured value of the AC signal (p.p) in volts = AxB

iii. Measurement of frequency (Time Period)

1. Apply a signal of unknown frequency for the signal generator to one of the channels of the CRO.
2. Set horizontal time base scale to observe at least 4 cycles of the signals.
3. Measure the No of horizontal divisions between two successive peaks of the signal on the CRO screen.
4. Note the time base scale used.
5. Now the time period (T) in seconds of the signal is obtained by multiplying the horizontal divisions by the time base scale in seconds.
6. The frequency of unknown signal f = 1/T (Hz)
7. Repeat the above 4 to 5 unknown frequencies of the signal for the signal generator and tabulate the readings in table 3.

Sl.No.	Frequency set (Hz)	No. of divisions Between 2 peaks (A)	Time scale of the time base in set(B)	Time period T = A.B	Measured frequency in Hz

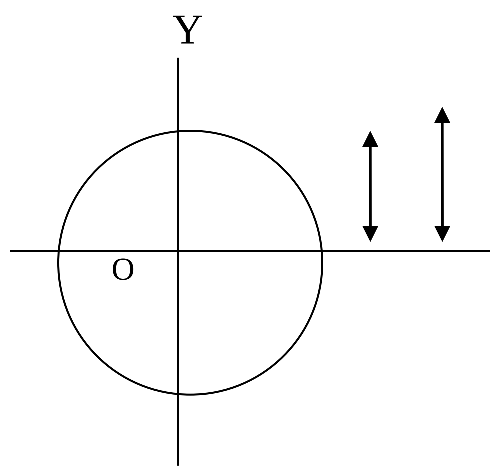
iv. Measurement of phase angle by Lissajeous figures

1. Draw the RC network by using the formula tan θ = 1/WRC. For this f = 1 KHz, C = 1 µf.
   θ = 45 degrees for R.

2. Connect the circuit diagram as shown in fig.1

3. Keep the CRO in XY mode. Bring the spot of the CRO to centre of the screen with zero signal on both the channels and apply signals to both the channels as Shown in the figure – 1.

4. We will get an elliptical trace as shown in fig 2



5. Measure A & B.
6. The phase difference between the applied two signals is measured as $\theta = \sin^{-1}(B/A)$.
7. Repeat the above experiment with different resistance (R) values and compute the resulting phase difference by tabulating the readings in table 4.

Table – 4

S.No.	Resistance value in ohms	A (Divisions)	B (Divisions)	$\theta = \sin^{-1}$ (B/A)

8. **GRAPH:**

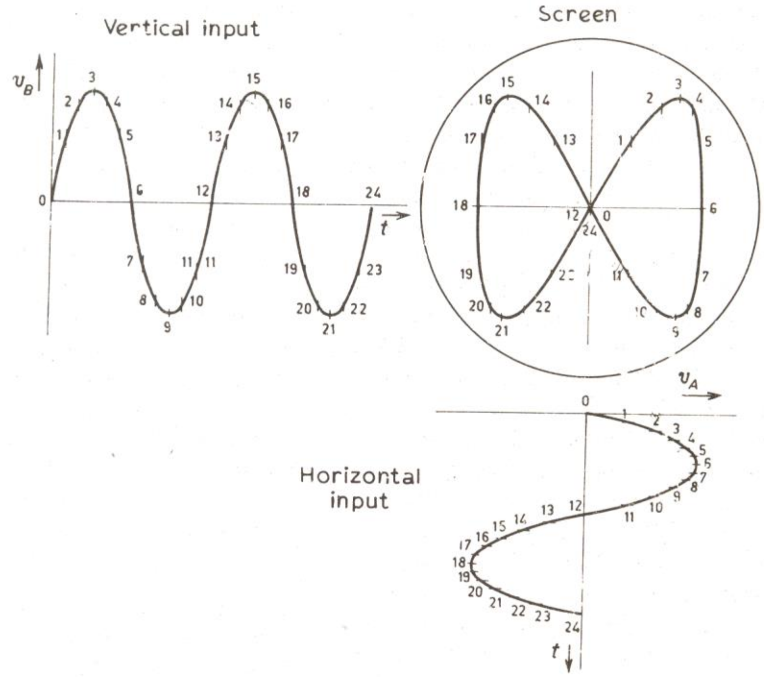


Fig. 14.28 Graphical construction of Lissajous pattern, when the ratio of frequencies is 1 : 2

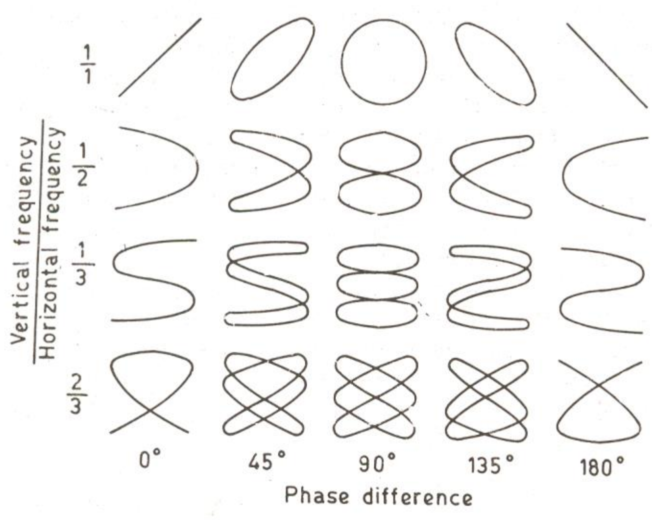


Fig. 14.29 Lissajous pattern for different frequency ratios and phase differences

9. RESULT:

Using CRO the following are measured 1. D.C voltage 2. AC voltage 3. Frequency 4. Phase angle by Lissajous patterns.

10. INFERENCES:

For Lissajous figures for different angles between two sinusoidal signals, different patterns are obtained.

If θ = 0 degree, we get set line
If θ = 30 degrees, we get ellipse
If θ = 90 degrees, we get circle
If θ = 150 degrees, we get ellipse
If θ = 180 degrees, we get straight line

11. PRECAUTIONS:

1. Content wires must be checked before use.
2. All contacts must be in tact.
3. The readings must be taken accurately.

12. APPLICATIONS:

1. It is mainly used for studying the waveforms of currents and voltages.
2. It can also be used for measuring the frequency, amplitude, and phase and time period of a voltage or current.

13. EXTENSION:

Electronic components can be tested using C.R.O

14. TROUBLE SHOOTING:

If trace is not visible on screen then press ground button and keep X and
Y- position knobs in center.

15. <u>QUESTIONS</u>:

1. Define deflection sensitivity in relation to CRO.
2. What is a storage Oscilloscope?
3. What are lissajous figures?
4. What are the different patterns obtained for different phase differences between two sinusoidal signals?
5. If three loops are obtained then what is the relation between frequency of reference wave and unknown wave?

PART B :

(For Laboratory Examination – Minimum of 10experiments)

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.
4. Input & output characteristics of Transistor in CE configuration.
5. Half wave rectifier with & without filters.
6. Full wave rectifier with & without filters.
7. FET characteristics
8. Self Bias Circuit
9. Frequency response of CE amplifier
10. Frequency response of CC amplifier
11. Frequency response of common source FET amplifier
12. SCR characteristics.
13. UJT characteristics.

PART – B :

1. Forward & Reverse Bias characteristics of P-N Junction Diode

1. AIM

1. Study of semiconductor diode characteristics under forward and reverse bias condition
2. To find the static and dynamic resistance

2. i. EQUIPMENT

1. Regulated dual power supply (0 – 30 V) – 1 No.
2. Moving coil ammeter (0 – 30)mA – 1 No.
3. Moving coil voltmeter (0-1)V, (0-300)V – 1 No. each
4. Bread board – 1 No.
5. Single strand connecting wires

ii. DESCRIPTION OF EQUIPMENT

1. Regulated dual power supply:

Regulated power supply is used to obtain stabilized dc voltage variable from 0 V to 30 V. Input to the system is 230 V AC, 50 Hz, single phase. Coarse and fine controls of voltage are used to set the required output dc voltage. Short circuit protection is inbuilt in the system. Ripples less than 1 mV rms are the maximum in any practical system.

2. Moving coil meters:

Moving coil panel meters are based on d'Arsonavel movement of coils. These panel meters are used to measure dc currents and voltages. The terminals are marked + and - . Depending on the needle deflection, the currents and voltages are measured. Meters with a full scale deflection accuracy of ± 1.5% are common in practical systems.

3. Bread Board:

Wire connections are usually carried out using a system called Bread Board. It is a rectangular array of holes with internal connections divided into a number of nodes. The rigging up of the circuit becomes easier, and diagnosis of faults can be made comfortably using bread board. In some practical systems, along with the rectangular array, function generators and regulated power supplies are also provided.

iii. COMPONENTS

1. 1N4148 - 1 No.
2. OA79 - 1 No.
3. 1 kΩ Resistor - 1 No. (1/2 W, carbon)

iv. DESCRIPTION OF COMPONENTS

1. 1N4148:

It is a silicon pn junction diode. It is a point contact diode which can be used for small signal applications. The peak inverse voltage is 30 V. Break down in the reverse bias occurs around 30 V. Maximum current permissible is 20 mA.

2. OA79:

It is a germanium pn junction diode. It is a point contact diode which can be used for small signal applications. The peak inverse voltage is 40 V. Break down in the reverse bias occurs around 40 V. Maximum current permissible is 30 mA.

3. 1kΩ Resistor:

It is a carbon resistor with a power rating of ¼ watt.
Tolerance is ±5%.

3. THEORY

A p-type semiconductor in contact with an n-type semiconductor constitutes a p-n junction. p-n junction is a p-n diode which permits the easy flow of current in one direction but restrains the flow in opposite direction.

In forward bias condition, the positive terminal of the battery is connected to the p-side of the diode and negative terminal to the n side. In forward bias, when the applied voltage is increased from zero, hardly any current flows through the diode in the beginning. It is so because the external voltage is being opposed by the barrier voltage V_B whose value is 0.7 volts for silicon and 0.3 volts for germanium. As soon as V_B is neutralized, current through the diode increases rapidly with increase of applied voltage. Here, the current is in the order of mA

When the diode is in reverse bias, the majority carriers are blocked, and only a small current due to minority carriers flows through the diode. As the reverse voltage is increased from zero, the reverse current increases and reaches a maximum saturation value I_o, which is also known as reverse saturation current. This is in the order of nA for silicon and μA for germanium.

The current I flowing through the diode is related to the applied voltage by the following equation whether the diode is in forward bias or in reverse bias.

$$I = I_O\left(e^{V/\eta V_T} - 1\right)$$

I_O= Reverse saturation current

V = applied voltage

I = current for the applied voltage V

η = 1 for Ge and 2 for Si

V_T = T/ 11600 volts

4. CIRCUIT DIAGRAM

i. Forward bias

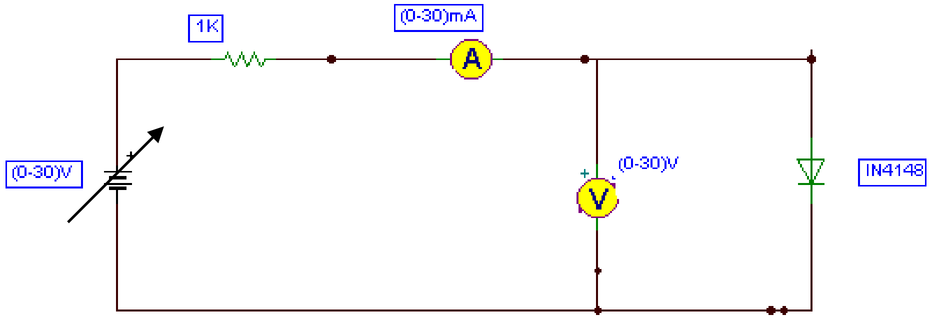


Figure.1

ii. Reverse bias

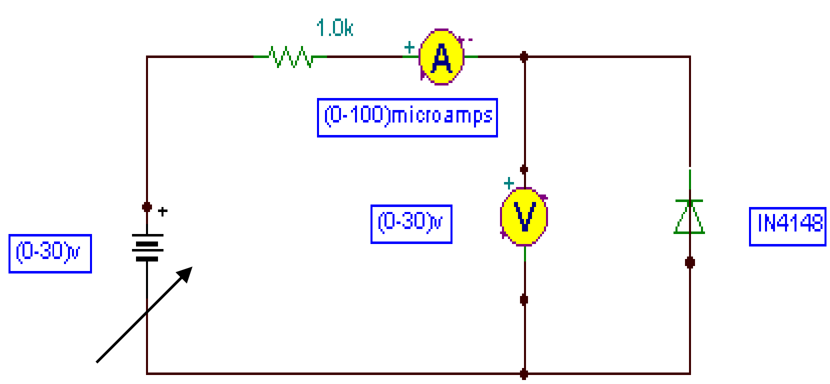


Figure. 2

5. PROCEDURE

i. Forward Bias condition

1. Connect the circuit as per the given circuit diagram shown in figure:1
2. Vary the power supply voltage in such a way that the voltmeter reading is 0.1V. Note the corresponding current reading in Ammeter.
3. Repeat step-2 by increasing the voltage in steps of 0.1V, till 1.0V.
4. Plot a graph taking voltage (V) on X axis and current (I) on Y axis
5. Draw a vertical line at 0.7 V, note down the corresponding current value.

   Static Resistance $r_{dc} = \frac{0.7}{I}$

6. Draw the vertical line at 0.75V, note down the corresponding current value.

   Dynamic Resistance $\gamma_{ac} = \frac{\Delta V}{\Delta I}$ = $(0.75 – 0.7)/(I_2 – I_1)$

   Where, I_1 and I_2 are the corresponding values of current at 0.7 and 0.75 V.

ii. Reverse bias condition

1. Connect the circuit as per the circuit diagram shown in figure:2
2. Vary the power supply voltage in such a way that the volt meter reading is 1V. Note the corresponding current reading in Ammeter.
3. Repeat step-2 by increasing the voltage in steps of 1V, till 20V.
4. Plot a graph taking the voltage (V) on X-axis and current (I) on Y-axis.

5. Draw the vertical line at -4V, note down the corresponding current values.

6. Reverse dc Resistance $R_R = \frac{\text{Reverse voltage}}{\text{Reverse current}} = 4/I$

iii. Repeat (i) and (ii) replacing 1N4007 by OA79.

6. OBSERVATIONS

i. Forward Bias

V_D (volts)	I_D (mA)
0	
0.1	
0.2	
..	
..	
..	
..	
1	

ii. Reverse Bias

V_D (volts)	I_D (μA)
0	
1	
2	
..	
..	
..	
..	
20	

7. CALCULATIONS

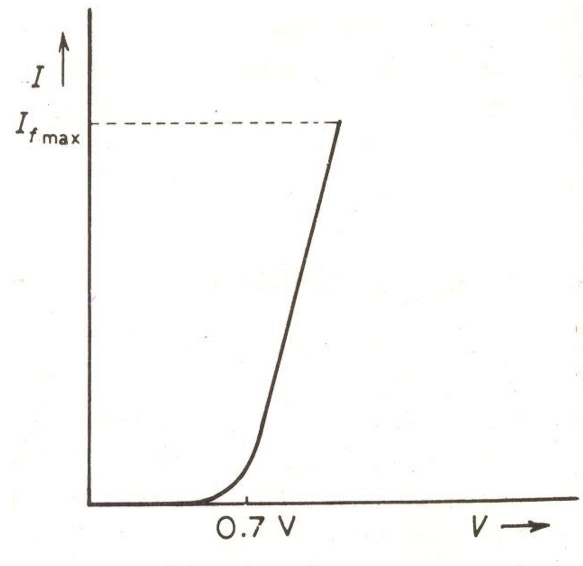
Forward Bias

Dynamic Resistance = $\frac{\Delta V_D}{\Delta I_D}$

Static Resistance = $\frac{V_D}{I_D} = \frac{0.7}{I_D}$

Reverse Resistance = R_R = $\frac{\text{Reverse voltage}}{\text{Reverse current}}$

8. GRAPH



Forward characteristics of a silicon diode

9. RESULT

Dynamic Resistance =

IN4148 _______________ OA79_____________

Static Resistance =

IN4148 _______________ OA79_____________

Reverse Resistance =

IN4148 _______________ OA79_____________

10. INFERENCE

The current in the forward bias is observed in the order of mA. The current in the reverse bias is observed in the order of µA for Ge and mA for Si diode. Usually, the forward resistance range is 0 Ω to 100 Ω and in the reverse bias, it is in the order of MΩ. Therefore the characteristics of pn junction diode are verified.

11. PRECAUTIONS

1. Maximum forward current should not exceed the value which is given in the datasheet. If the forward current in a pn junction is more than this rating, the junction will be destroyed due to overheating

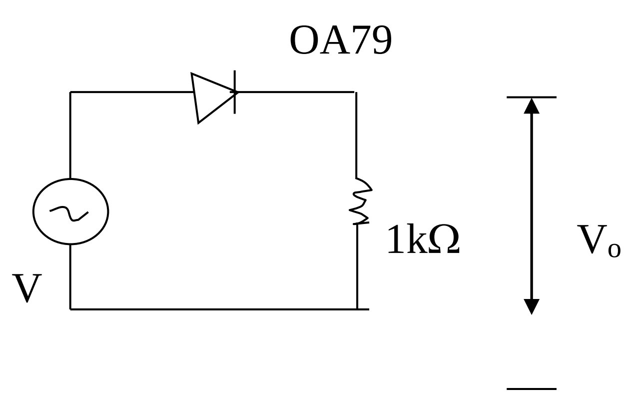
2. Reverse voltage across the diode should not exceed peak inverse voltage (PIV). PIV is the max. reverse voltage that can be applied to a pn junction without any damage to the junction.

12. APPLICATIONS

1. It is used in several Electronic circuits like rectifiers etc.
2. It is used in communication circuits for modulation and demodulation of high frequency signals.
3. It is used in logic circuits that are fundamental building blocks of computers.
4. It is used in wave shaping circuits like clippers and clampers.

13. EXTENSION

Rig up the circuit shown below.



Connect the output of a function generator set for sinusoidal signal of 2V (peak to peak), 1 kHz., in place of v in the circuit. Observe the voltage across 1kΩ resistor using CRO. Note the waveform displayed on the screen of CRO.

14. TROUBLE SHOOTING

S.No.	Fault	Diagnosis
1	No reading in the Ammeter	Check the diode for any open circuit
2	No reading in Voltmeter	Check the diode for any short circuit
3	No increase in the power supply voltage	Check the current limit in RPS. Increase the current limit, if required

15. QUESTIONS

1. What is cut-in voltage for germanium diode?
2. What is cut-in voltage for silicon diode?
3. What is meant by PIV?
4. What is reverse saturation current?
5. What are the reasons for the development of potential barrier across a pn junction?
6. What is meant by depletion region?
7. Mention the materials used for doping an intrinsic semi conductor material?
8. What are the majority carriers and minority carriers in Extrinsic semiconductor?
9. Describe the effect of increasing the reverse bias voltage to high values?
10. What are essential differences between Ge and Si diode?

2. Zener Diode characteristics and Zener as voltage Regulator.

1. AIM:

1. To plot the V-I characteristics of ZENER diode under forward and reverse bias conditions.
2. To find ZENER voltage, forward bias resistance & reverse bias resistance after ZENER Breakdown.

2. i. EQUIPMENTS REQUIRED:

1. Bread Board
2. Connecting wires
3. Volt meter (0 - 20V)
4. Ammeter (0 - 20 mA), (0 - 200µA)
5. Regulator DC power supply.

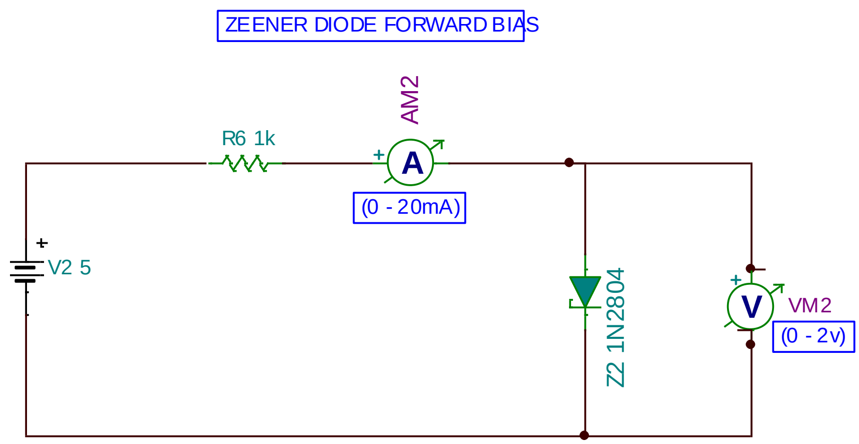
ii. COMPONENTS REQUIRED:

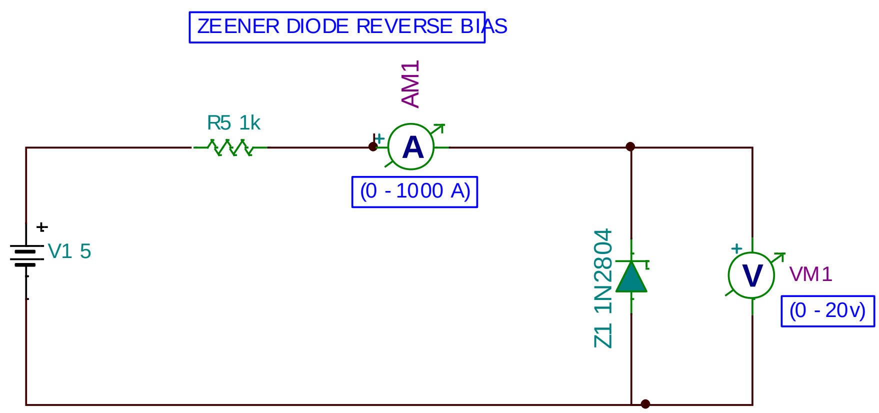
1. Zener diode (IN 2804)
2. Resistor (1kΩ)

3. THEORY:

Zener diode acts as normal PN junction diode in forward bias and during reverse bias, as reverse voltage reaches breakdown voltage diode starts conducting. To avoid high current, we connect series resistor with it. Once the diode starts conducting it maintains constant voltage across it. Specially made to work in the break down region. It is used as voltage regulator.

4. CIRCUIT





5. PROCEDURE:

Forward Bias:

1. Connect the circuit as per the given circuit diagram shown in figure:1
2. Vary the power supply voltage in such a way that the voltmeter reading is 0.1V. Note the corresponding current reading in Ammeter.
3. Repeat step-2 by increasing the voltage in steps of 0.1V, till 1.0V.

4. Plot a graph taking voltage (V) on X axis and current (I) on Y axis
5. Draw a vertical line at 0.7 V, note down the corresponding current value.

Static Resistance $r_{dc} = \frac{0.7}{I}$

6. Draw the vertical line at 0.75V, note down the corresponding current value.

Dynamic Resistance $\gamma_{ac} = \frac{\Delta V}{\Delta I}$ = $(0.75 – 0.7)/(I_2 – I_1)$

Where, I_1 and I_2 are the corresponding values of current at 0.7 and 0.75 V.

<u>Reverse Bias</u>:

1. Connect the circuit as per the circuit diagram.
2. The DC power supply is increased gradually in steps of 1 volt and the corresponding Voltmeter and Ammeter readings are noted
3. The V-I characteristics are plotted with zener voltage on X axis and current along the Y axis.
4. Note down the break down voltage and calculate the reverse resistance of the Zener diode.
6. Calculate the percentage voltage regulation.

6. OBSERVATION TABLE

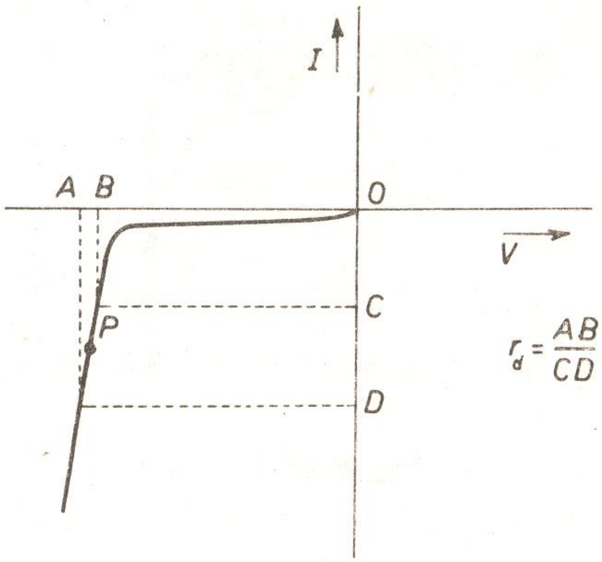
Forward bias

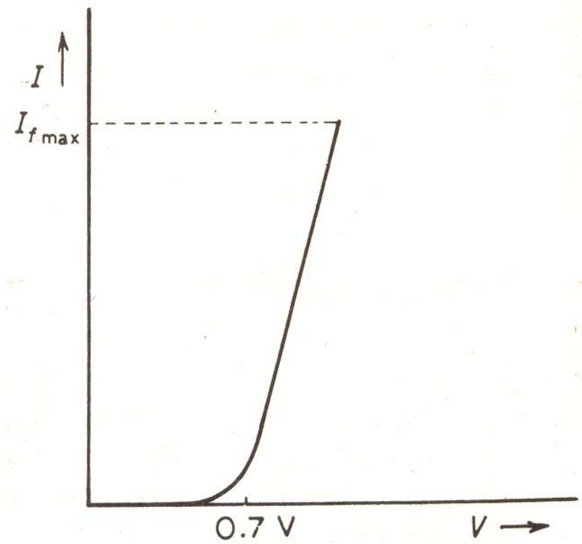
S. No.	Voltmeter reading In volt	Ammter reading In mA

Reverse bias

S. No	Voltmeter reading In volt	Ammeter reading In A

7. GRAPH





8. CALCULATIONS

Percentage line regulation=((V_{15}- V_{20})/ V20)X100% = -------
----

9. INTERFERENCE:

Zener diode is having a very sharp break down. That is for constant voltage different currents can flow through it Zener diode can be operated in reverse bias.

10. PRECAUTION

1. It is preferable to use digital Multimeter in place of analog voltmeter
2. Maximum current should not exceed the value which is given on the data sheet.

11. TROUBLE SHOOTING

If no deflection on ammeter and voltmeter, check the loose contacts in the circuit.

12. RESULT:

Percentage voltage regulation = ___________

Zener Voltage = ______________

Forward bias resistance =_________

Reverse bias resistance = _________

13. EXTENSION

Zener diode can be used as a voltage regulator.

14. APPLICATION

1. Zener diode is used as voltage regulator.
2. Used in some clipper circuit.
3. Used as reference voltage in some circuits.

15. QUESTIONS

1. What is Zener diode
2. What is breakdown voltage of Zener diode
3. What is avalanche breakdown
4. What is doping concentration of Zener diode
5. How is Zener diode different from PN junction diode

3. Input and Output characteristics of Transistor in CB configuration

1. AIM:

1) To study and plot the input and output characteristics of transistor in CB configuration.
2) To measure the current amplification factor.
3) To measure the dynamic input & output resistances.

2. i. APPARATUS:

Dual Regulated power supply (0 – 30)V
Moving coil ammeter (0 – 10) mA – 2
Moving coil voltmeter (0 – 10) V, (0 – 1) V
Bread board
Single strand connecting wires

ii. COMPONENTS:

BC107 – Transistor
Resistor – 100 Ω - (1)

3. THEORY: -

A transistor is a three terminal active device. The three terminals are emitter, base and collector. In common base configuration, We make the base common to both input and output. For normal operation, the emitter-base junction is forward biased and the collector-base junction is reverse biased.

The input characteristic is a plot between I_E and V_{EB} keeping voltage V_{CB} constant. This characteristic is very similar to that of a forward biased diode. The output characteristic curves are plotted between I_C and V_{CB}, Keeping I_E constant. These curves are almost horizontal.

When the output side is open (i.e. $I_E = 0$), The collector current is not zero, but has a small value. This collector current is called collector reverse saturation current, I_{CBO}.

Current amplification factor (α):
The ratio of change in collector current to the change in emitter current at constant collector base voltage V_{CB} is known as current amplification factor

$$\alpha = \frac{\Delta I_C}{\Delta I_B} | V_{CB} = const$$

Current amplification factor is less than unity. Practical value of α in commercial transistor range from 0.9 to 0.99

I/p Resistance is the ratio of change in emitter base voltage to the resulting change in ammeter current at constant collector base voltage

$$r_i = \frac{\Delta V_{EB}}{\Delta I_E} | V_{CB} = const$$

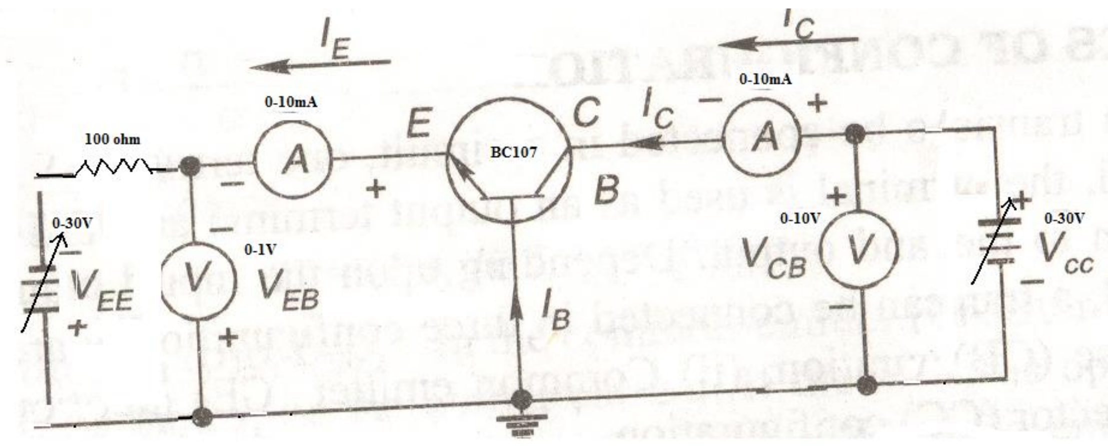
In fact, I/p resistance is the opposition offered to the signal current. As a very small V_{EB} is sufficient to produce a large flow of emitter current I_E, I/p resistance is quiet small in the order of few ohms.

O/p resistance is the ratio of change in collector base voltage to the resulting change in collector current at constant emitter current.

i.e., $r_O = \frac{\Delta V_{CB}}{\Delta I_C} | I_E = const$

The O/p resistance of CB circuit is very high in the order of several tens of kΩ's

4. CIRCUIT DIAGRAM:



5. PROCEDURE

I/p Characteristics:

1. Connect the circuit as per the given circuit diagram on bread board
2. Set V_{CB} = 0V, Vary V_{EB} in steps of 0.1V & note down the corresponding I_E for each value of V_{EB}. Repeat the above procedure for 5V and 10V.
3. Plot the graph I_E Vs V_{EB} for a constant V_{CB} taking V_{EB} on x axis & I_E on y axis
4. Find dynamic input Resistance $\frac{\Delta V_{EB}}{\Delta I_E}|_{V_{CB} = const}$

   i.e., the reciprocal of the slope of the curve.

O/p Characteristics

1.Connect the circuit as per the given circuit diagram on the bread board.

2. Open the input circuit, Vary the collector voltage V_{CB} in steps of 1V and note the collector current I_C for each value of collector voltage V_{CB}.

3.Set I_E= 2mA, vary V_{CB} in steps of 1V and note down the corresponding I_C. Repeat the above procedure for 4mA, 6mA, 8mA,…

4.Plot the graph I_C & V_{CB} for a constant I_E taking V_{CB} on x-axis & I_C on y axis.

5.Find the dynamic output Resistance $\frac{\Delta V_{CB}}{\Delta I_C}|_{V_E = const}$

6.Calculate the current amplification factor $\alpha = \frac{\Delta I_C}{\Delta I_B}|_{V_{CB} = const}$

6. <u>TABULAR FORM</u>

I/p Characteristics

V_{CB} = 0V	
V_{EB}(V)	I_E(mA)

V_{CB} = 5V	
V_{EB}(V)	I_E(mA)

V_{CB} = 10V	
V_{EB}(V)	I_E(mA)

O/p Characteristics

I_E = 0	
V_{CB}(V)	I_C(mA)

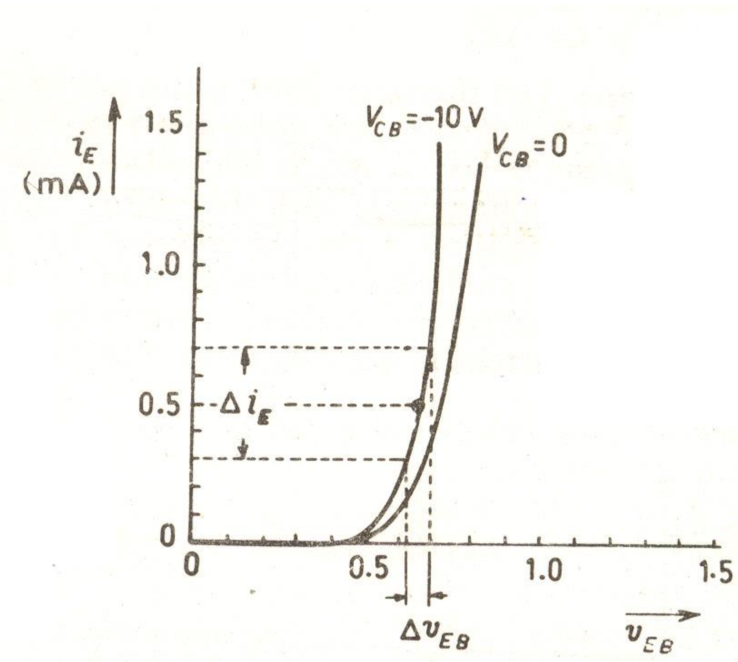
I_E = 4mA	
V_{CB}(V)	I_C(mA)

I_E = 2mA	
V_{CB}(V)	I_C(mA)

I_E = 6mA	
V_{CB}(V)	I_C(mA)

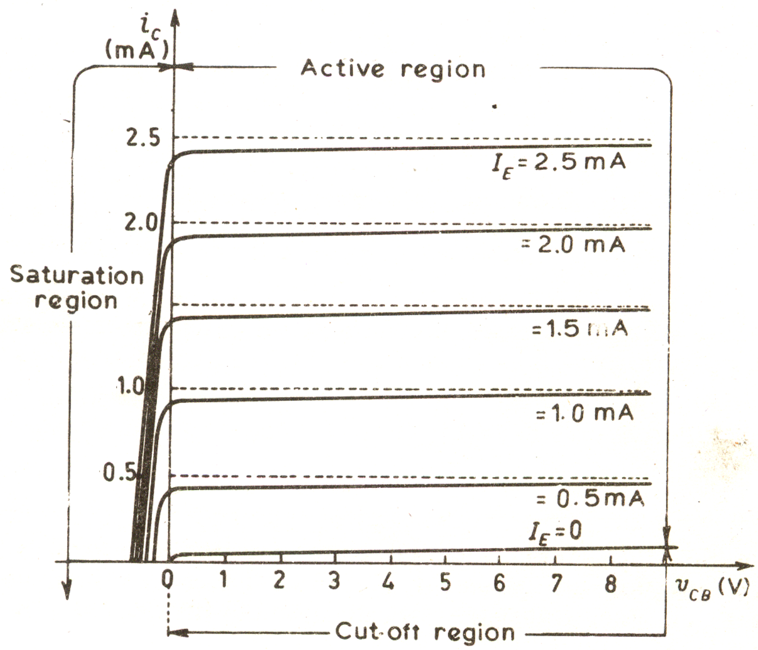
I_E = 8mA	
V_{CB}(V)	I_C(mA)

7. GRAPH: -



Common-base input characteristics

O/p Characteristics: -



Common-base output characteristics

8. CALCULATIONS: -

I/p Resistance = $\frac{\Delta V_{EB}}{\Delta I_E} |_{V_{CB} = const}$ = ____________

O/p Resistance = $\frac{\Delta V_{CB}}{\Delta I_C} |_{I_E = const}$ = ______________

the current amplification factor $\alpha = \frac{\Delta I_C}{\Delta I_B} |_{V_{CB} = const}$ =

____

9) RESULTS: -

1. Input and output characteristics are plotted on the graph.
2. The transistor parameters are given below

Dynamic I/p Resistance = ________

Dynamic O/p Resistance = ________, Current amplification factor α = ________

10. INFERENCE: -

I/p characteristics

1) The emitter current I_E increases rapidly with small increase in emitter base voltage. It means that the input resistance is very small.

2) The emitter current is almost constant with V_{CB}. This leads to conclusion that I_E (Hence I_C) is almost independent of collector voltage.

O/p characteristics:

1) Collector current I_C varies with V_{CB} only at very low voltages (<1V). A transistor is never operated in this region.

2).When the value of V_{CB} is raised above 1 – 2V, the collector current becomes constant as indicated by straight horizontal lines. It means that now I_C is independent of V_{CB} & depends on I_E only. Hence the output Resistance is very high. Transistor is always operated in this region.

11. APPLICATIONS:

1) Used as amplifier. (CB amplifiers are not used as frequently as the CE amplifiers)
2) Used in radio frequency applications
3) Used to provide voltage gain without current gain.

12. QUESTIONS:

1) Write the expression for collector current.
2) What is active region?
3) What is saturation region?
4) What is cutoff region?
5) Who invented transistor.
6) What is Early effect.
7) What is the magnitude of I_{CBO} for general purpose low power transistors?
8) What is $I_{CBO?}$
9) Is I_{CBO} temperature dependent or not.
10) In a CB connection I_E = 1mA, I_C=0.95 mA. Calculate $I_{B.}$

4. Input and Output characteristics of Transistor in **CE configuration**

1) AIM:
1) To study and plot the input and output characteristics of BJT in CE configuration.
2) Find the current amplification factor β.
3) Find the dynamic input & output Resistance.

2) i. APPARATUS:
Dual Regulated power supply (0 – 30) V
Moving coil ammeter (0 – 10 mA), (0 -1mA)
Moving coil voltmeter (0 – 1 V), (0 – 10 V)
Bread board - 1
Connecting wires (single strand)

ii.) COMPONENTS: –
Transistor BC107
Resistor – (10 kΩ)

3) THEORY:
In this CE arrangement, input is applied between base & emitter terminals and output is taken from collector and emitter terminals. Here emitter of the transistor is common to both input and output circuits. Hence the name Common Emitter (CE) configuration.

For CE configuration, we define the important parameters as follows:

1. The base current amplification factor (β) is the ratio of change in collector current ΔI_C to the change in base current ΔI_B is known as Base current amplification factor.

$$\beta = \frac{\Delta I_C}{\Delta I_B}\Big|_{V_{CB} = const}$$

In almost any transistor, less than 5% of emitter current flows as the base current. The value of β is generally greater than 20.Usually its value ranges from 20 to 500. This type of arrangement or configuration is frequently used as it gives appreciable current gain as well as voltage gain.

2. Input resistance is the ratio of change in base-emitter voltage to the change in base-current at constant V_{CE}

i.e.,

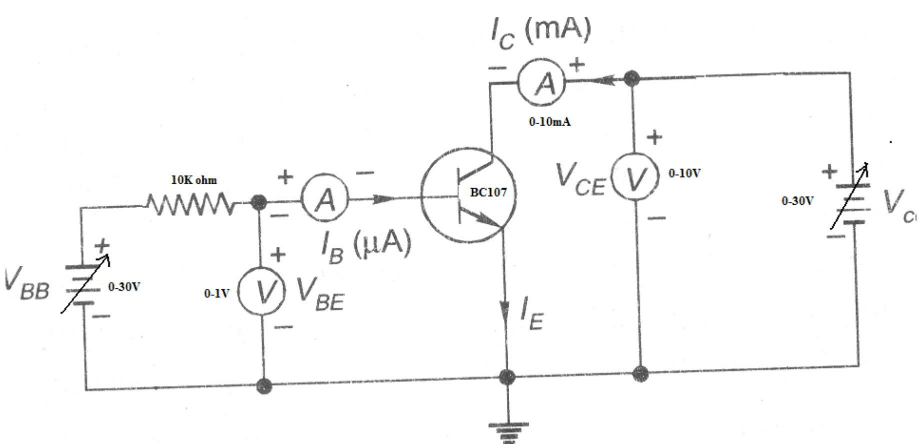
$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} | .V_{CE} = const$$

The value of input resistance for the CE circuit is of the order of a few hundredΩ's.

3. Output resistance is the ratio of change in collector-emitter voltage to change in collector current at constant I_B.

$$r_O = \frac{\Delta V_{Ce}}{\Delta I_C} | I_E = const$$ .It is in the order of 50 kΩ

4. CIRCUIT DIAGRAM:



5. PROCEDURE

Input characteristics

1. Connect the circuit as per the given circuit diagram on bread board

2. Set V_{CE} = 5V, vary V_{BE} in steps of 0.1V & note down the corresponding I_B. Repeat the above procedure for 10V, 15V & 20V
3. Plot the graph V_{BE} Vs I_B for a constant V_{CE} taking V_{BE} is taken on x axis & I_B on y axis
4. Calculate input resistance $\frac{\Delta V_{BE}}{\Delta I_B}|_{V_{CE} = const}$

Output Characteristics

1. Connect the circuit as per the given circuit diagram on the bread board
2. Open the input circuit, vary the collector voltage V_{CE} in steps of 1V and note down the corresponding collector current Ic.
3. Set I_B= 20μA, vary V_{CE} in steps of 1V and note down the corresponding I_C. Repeat the above procedure for 40μA, 80μA, 100μA.
4. Plot the graph taking V_{CE} on X-axis & I_C on y-axis at corresponding constant I_B
5. Calculate the output resistance $\frac{\Delta V_{CE}}{\Delta I_C}|_{I_B = const}$
6. Calculate the current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B}|_{V_{CB} = const}$

6. TABULAR FORM

I/p Characteristics

V_{CE} = 5V	
V_{BE}(V)	I_B(mA)

V_{CE} = 10V	
V_{BE}(V)	I_B(mA)

V_{CE} = 15V	
V_{BE}(V)	I_B(mA)

O/p Characteristics

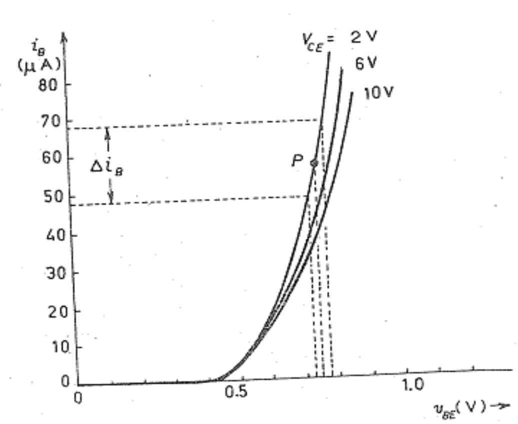
I_B = 20µA	
V_{CE}	I_C(mA)

I_B = 40µA	
V_{CE}	I_C(mA)

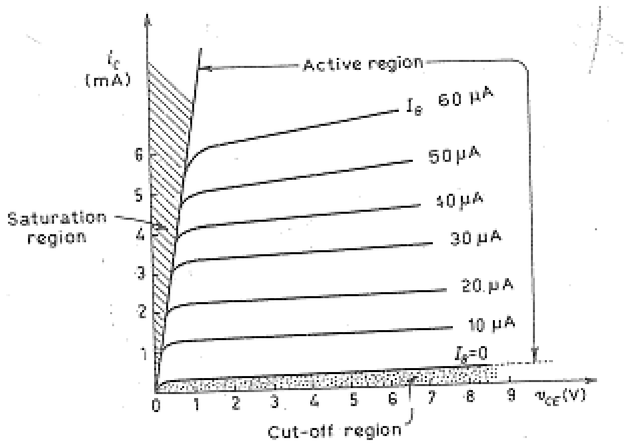
I_B = 60µA	
V_{CE}	I_C(mA)

7. **GRAPH**: -

Input Characteristics: -



Output Characteristics: -



8) CALCULATIONS: -

I/p Resistance = $\frac{\Delta V_{BE}}{\Delta I_B} |_{V_{CE} = const}$

O/p Resistance = $\frac{\Delta V_{CE}}{\Delta I_C} |_{I_B = const}$

Current amplification factor $\beta = \frac{\Delta I_C}{\Delta I_B} |_{V_{CB} = const}$

9) RESULTS: -

1. Input and output characteristics are plotted on the graph.
2. The transistor parameters are given below

Dynamic I/p Resistance = _______

Dynamic O/p Resistance = _______

Current amplification factor β=_____

10) INFERENCE: -

I/p characteristics: -

1.As compared to CB arrangement I_B increases less rapidly with V_{BE}. Input resistance of CE circuit is higher than that of CB circuit.

2. Input characteristics resemble that of a forward biased pn junction diode curve. This is expected since the base emitter section of a transistor is a pn junction.

O/p characteristics

1. For any value of V_{CE} above knee voltage, the collector current I_C is approximately equal to βI_B.
2. The collector current is not zero when I_B is zero. It has a value of I_{CEO}, the reverse leakage current.

11. APPLICATIONS:

1) Used as amplifier
2) Used in communication circuits
3) Used as a switch
4) Used in audio frequency applications

12. QUESTIONS:

1) What is Transistor?
2) Draw the npn & pnp transistor symbols.
3) Why base region is made thin?
4) Why is transistor not equivalent to two p-n junction diodes connected back to back?
5) Why is collector current slightly less than emitter current?
6) What is the significance of arrow in the transistor symbol?
7) What is β?
8) What is the range of input resistance?
9) What is the range of output resistance?
10) Why small change in α leads to large change in β.

5. Half Wave Rectifier With and Without Filter

1. AIM:

1. To examine the input and output waveform of half wave rectifier
2. To find ripple factor and average voltage

2. i. EQUIPMENTS REQUIRED:

1. Bread Board
2. CRO
3. Connecting wires
4. Digital multimeter
5. Transformer Primary voltage (0-230v)
6. BNC probes

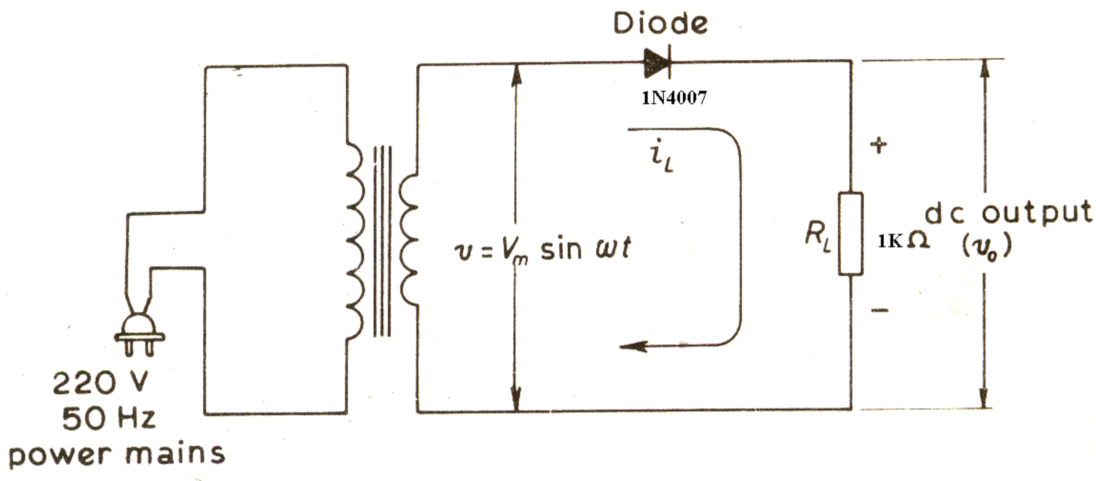
ii. COMPONENTS REQUIRED:

1. Capacitor (100µF)
2. Diode (1N4007)
3. Resistor (1kΩ)

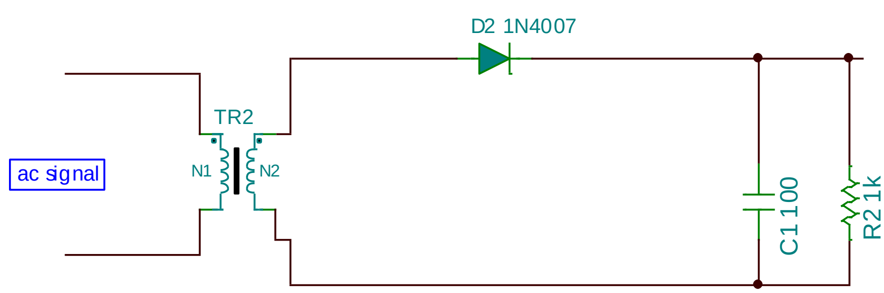
3. THEORY:

In Half wave rectifier there is one diode, transformer and a load resistance. During the positive half cycle of the input, diode is ON and it conducts current and flows through load resistance, voltage is developed across it. During the negative half cycle the diode is reversed biased, no current conduction so no current through load resistance and no voltage across load resistance

4. CIRCUIT DIAGRAM



Half-wave rectifier circuit

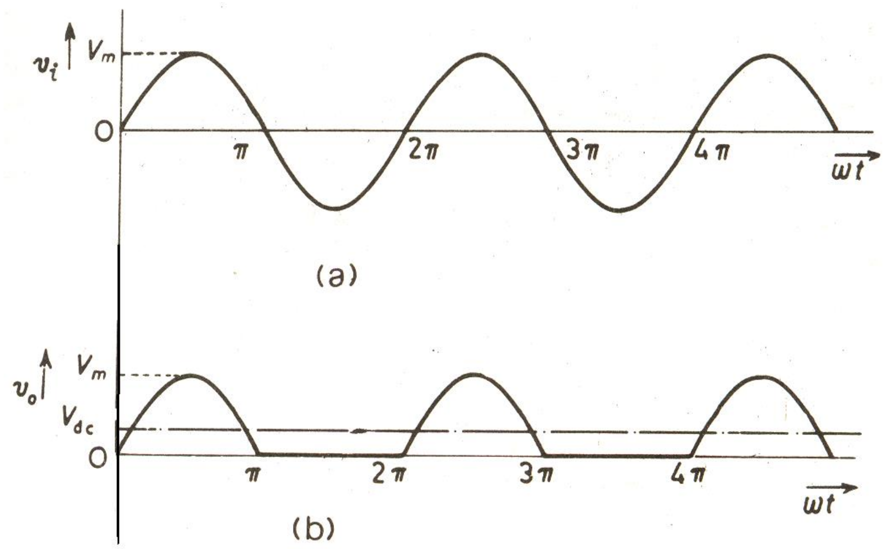


5. PROCEDURE:

With and Without filter:

1. Connect the circuit as per the circuit diagram
2. Measure the voltages at the Load resistors
   (a) Keep the DMM in DC mode to measure dc voltage
   (b) Keep the DMM in AC mode to measure RMS voltage
3. Compare the theoretical and practical values.
4. Tabulate the observations
5. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.

6.Graph:



Half-wave rectifier: (a) Input voltage waveform (b) Output voltage waveform

7. OBSERATION TABLE

Sl No.	Parameters	Theoretical value	Practical value	Difference
1	Ripple factor			
2	Average voltage			

8. CALCULATIONS :

Halfwave Rectifier without filter

Average Voltage:

Theoretically $= \frac{Vm}{\pi}$

Practically $= V_{dc}$

Ripple factor:

Theoretically = 1.21

Practically = $\frac{Vrms}{Vdc}$

Halfwave Rectifier with filter

Average Voltage:

Theoretically = $\frac{2Vm}{\pi}$

Practically = V_{dc}

Ripple factor:

Theoretically = $\frac{1}{2\sqrt{3}fCR_l}$

Practically = $\frac{Vrms}{Vdc}$

9. INFERENCE

As diode can be used as a switch, it is used in rectifier circuit to convert AC signal to DC signal, but the output of a rectifier is a pulsating dc.

10. PRECAUTIONS

1. Waveforms should be observed on CRO keeping in DC mode.
2. Use digital meter instead of analog meter.

11. TROUBLE SHOOTINGS

No meter reading then check if there are any loose connection.

12. RESULT:

Ripple factor = $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$ = ________________________

Percentage regulation $= \frac{V_{noload} - V_{fullload}}{V_{fullload}} x100\% =$ -

____

13. EXTENSSION

Efficiency of the circuit is less so we go for full wave rectifier.

14. APPLICATIONS

1. Used to convert AC signal to pulsating DC.
2. Clippers.

15. QUESTION

1. Explain the operation of half wave rectifier.
2. Derive rms & avg value of output of half wave rectifier.
3. Derive ripple factor of half wave rectifier.
4. Derive efficiency of half wave rectifier
5. What is peak factor, form factor of half wave rectifier
6. What is TUF of half wave rectifier
7. What should be PIV of diode in half wave rectifier

6. Full Wave Rectifier With and Without Filter

1. AIM:

1. To examine the input and output waveform of full wave rectifier
2. To find ripple factor and average voltage

2. EQUIPMENTS REQUIRED:

i. Apparatus:

1. Bread Board
2. CRO
3. Connecting wires
4. Digital Multimeter
5. Transformer Primary voltage (0-230v)
6. BNC probes

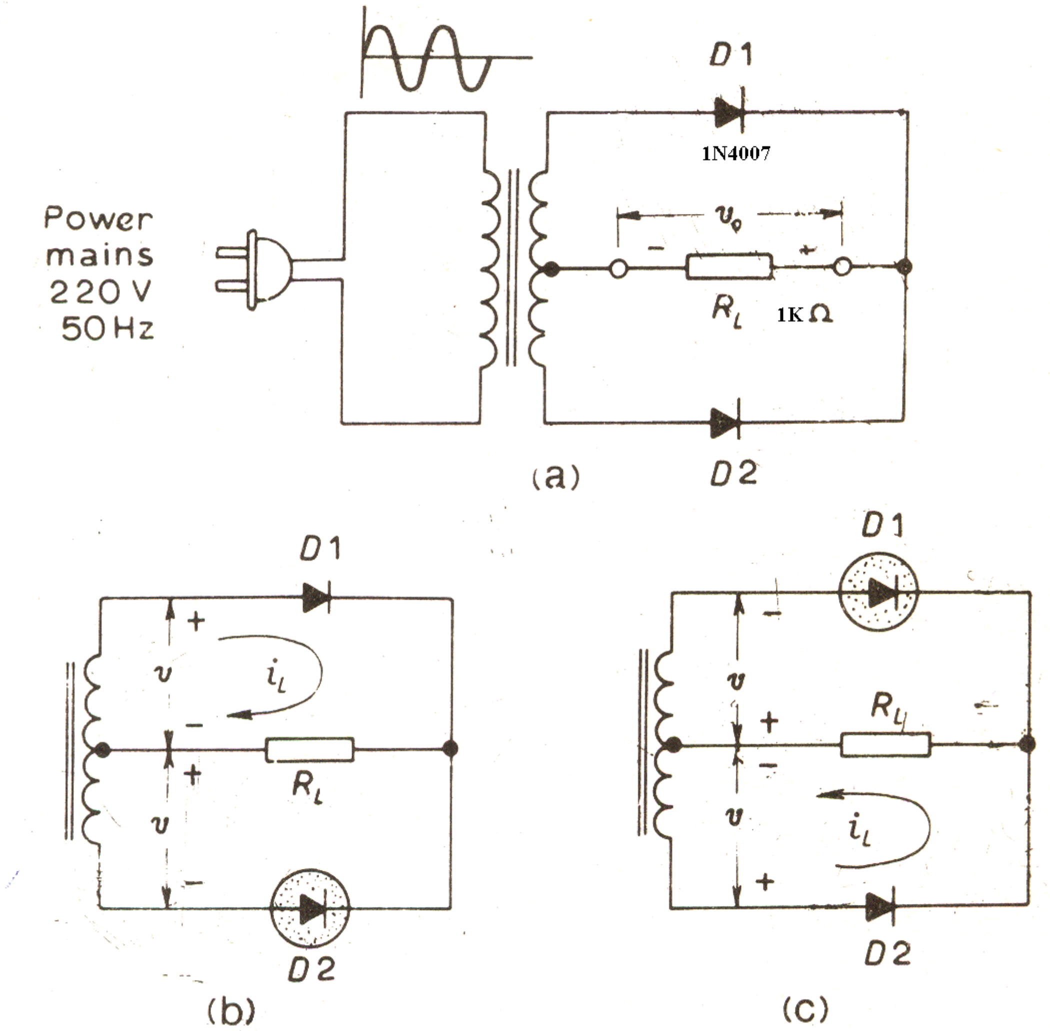
ii. COMPONENTS REQUIRED:

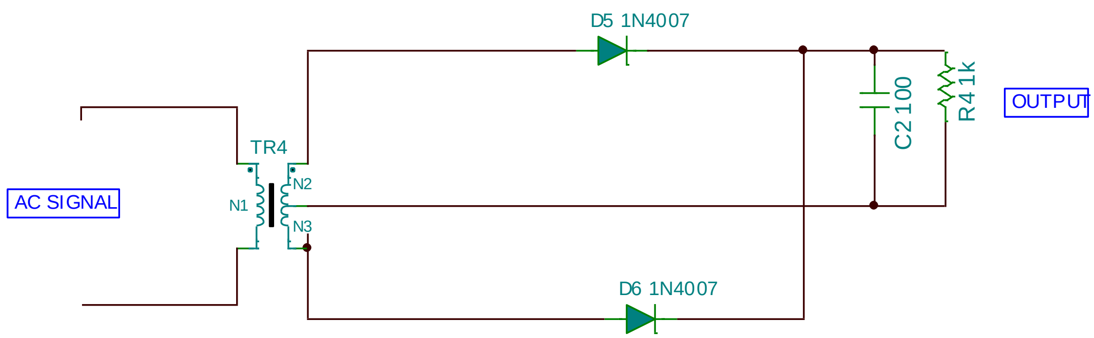
1. Capacitor (100µF)
2. Diode (1N4007)
3. Resistor (1kΩ)

3. THEORY:

During positive half cycle Diode D1 is forward biased and diode D2 is reversed biased so current conducts through D1 due to which voltage is developed across the load resistance and during negative half cycle Diode D2 is forward biased and diode D1 is reversed biased so current conducts through D2 due to which voltage is developed across the load resistance.

4. CIRCUIT DIAGRAM:





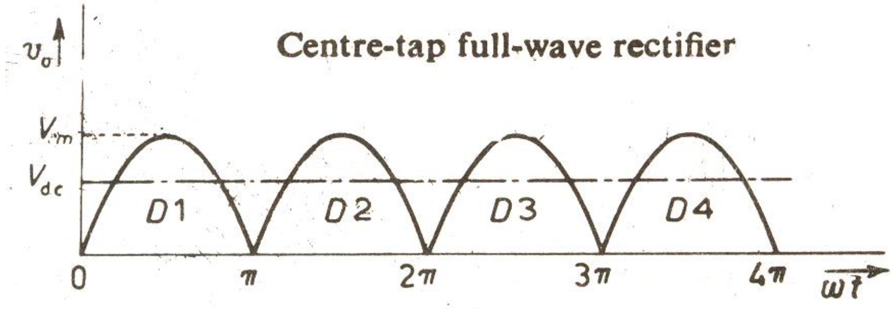
5. PROCEDURE:

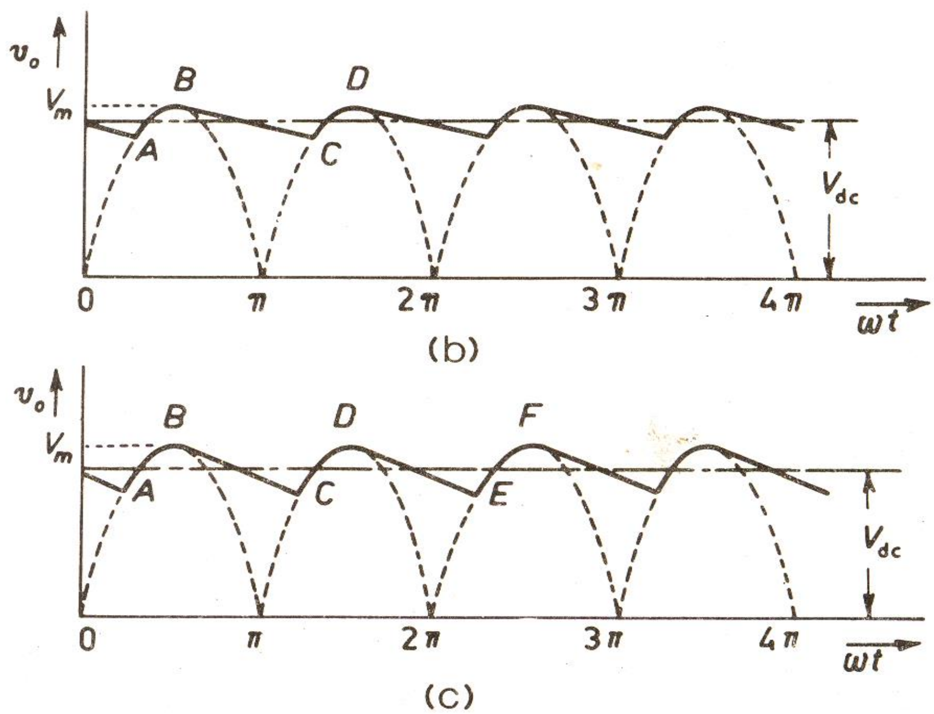
With and Without filter:

1. Connect the circuit as per the circuit diagram

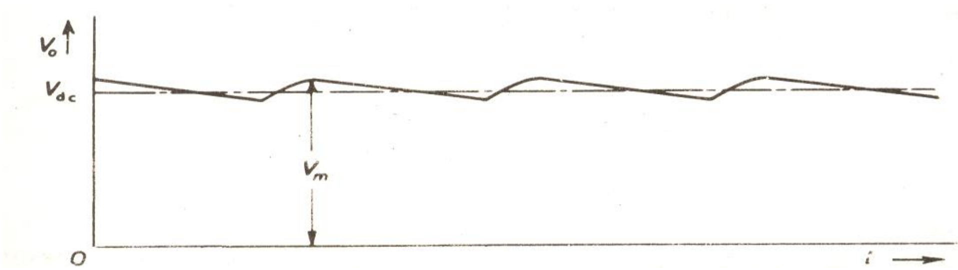
2. Measure the voltages at the Load resistors
   (a) Keep the DMM in DC mode to measure dc voltage
   (b) Keep the DMM in AC mode to measure RMS voltage
3. Compare the theoretical and practical values.
4. Tabulate the observations
5. Observe the voltage wave form across the secondary of the transformer and also across the output in CRO.

6. Graph:





Full-wave rectifier with shunt capacitance filter



7. OBSERVATION TABLE

Sl No.	Parameters	Theoretical value	Practical value	Difference
1	Ripple factor			
2	Average voltage			

8.CALCULATIONS :

Fullwave Rectifier without filter

Average Voltage:

Theoretically = $\frac{2Vm}{\pi}$

Practically = V_{dc}

Ripple factor:

Theoretically = 0.487

Practically = $\frac{Vrms}{Vdc}$

Fullwave Rectifier with filter

Average Voltage:

Theoretically = $\frac{Vm}{1+\frac{1}{4fCR_l}}$

Practically = V_{dc}

Ripple factor:

Theoretically = $\frac{1}{4\sqrt{3}fCR_l}$

Practically = $\frac{Vrms}{Vdc}$

9. INFERENCE

As diode can be used as a switch so it is used in rectifier circuit to convert AC signal to DC signal, but not perfect DC it is pulsating DC.

10. PRECAUTIONS

1. Waveforms should be observed on CRO keeping in DC mode.
2. Use digital meter instead of analog meter.

11. TROUBLE SHOOTINGS

No meter reading then check if there are any loose connection.

12. RESULT:

Ripple factor = $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$ = ______________________

Percentage regulation $= \frac{V_{noload} - V_{fullload}}{V_{fullload}} x100\% =$ -

____

13. EXTENSSION

Efficiency of the circuit is less so we go for full wave rectifier.

14. APPLICATIONS

1. Used to convert AC signal to pulsating DC.
2. Clippers.

15. QUESTION

1. Explain the operation of half wave rectifier.
2. Derive rms & avg value of output of full wave rectifier.
3. Derive ripple factor of full wave rectifier.
4. Derive efficiency of full wave rectifier
5. What is peak factor, form factor of full wave rectifier?
6. What is TUF of full wave rectifier?
7. What should be PIV of diode in full wave rectifier?

7. FET Characteristics

1. AIM

1. To study and plot the drain and transfer characteristics of JFET.
2. Find the drain resistance r_d, mutual conductance g_m and amplification factor μ of the FET.

2. APPARATUS REQUIRED

APPARATUS

1. Regulated dual power supply (0 – 30 V) – 1 No.
2. Volt meter (0 – 10)V – 2 No.
3. Milli ammeter (0-25ma) - 1 No.

COMPONENTS

1. JFET BFW10 - 1 No
2. Bread Board -1
3. Connecting Wires

3. THEORY

Field effect transistor is a unipolar device, because its function depends only upon one type of charge carrier. Unlike BJT ,an FETs has high input impedance. This is a great advantage.

A field effect transistor can be either a JFET or MOSFET. Again, a JFET can either have N-Channel or P- Channel. An N-channel JFET ,has an N-type semiconductor bar, the two ends of which make the drain and source terminals.On the two sides of this bar, pn – junctions are made. These P regions make gate. Usually, these two p-regions are connected together to form a single gate.

A way of controlling drain current is by reverse biasing the gate with respect to source. The drain is given positive potential with respect to source. Transfer or Transconductance characteristics is a graph of V_{GS} versus I_D for a constant value of V_{DS}.

The important parameters of a JFET are defined below.

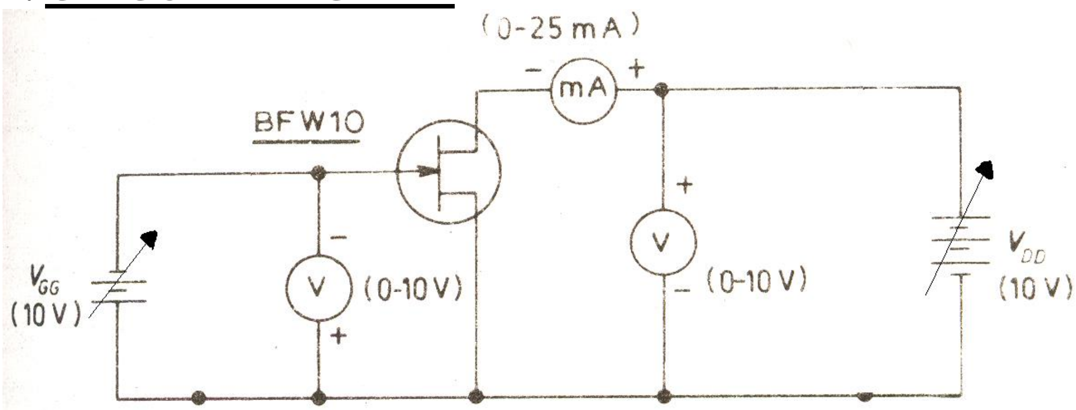
1. Dynamic drain resistance $r_d = \frac{\Delta V_{DS}}{\Delta I_D} |_{V_{GS} = const}$

2. Mutual conductance $g_m = \frac{\Delta I_D}{\Delta V_{GS}} |_{V_{DS} = const}$

3. Amplification factor $\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}} |_{I_D = const}$

These parameters are related by the equation $\mu = r_d \times g_m$

4. CIRCUIT DIAGRAM



5.PROCEDURE

1. Make the circuit connections as show in the figure.
2. Keep VGS = 0V, vary V_{DD} to increase V_{DS} in steps of 1.0, 3 volts and so on.
3. Note down the corresponding value of I_D for eachvalue of the V_{DS}.
4. Tabulate the readings and plot a graph of V_{DS} v/s I_D for V_{GS} = 0, V_{GS} = -1V, V_{GS} = -2V. V_{GS} = -3V, V_{GS} = -4V
5. Plot the(Drain characteristics)graph of V_{DS} versus I_D for different constants values
   of $V_{GS.}$ Taking V_{DS} on X-axis and I_D on Y-axis.
6. Calculate drain resistance.

6. OBSERVATIONS: **Input characteristics**

Sl.No	V_{DS}	V_{GS} = 0	V_{GS} = -1V	V_{GS} = -2V	V_{GS} = -3V	V_{GS} = -4V
		$I_{D(ma)}$	$I_{D(ma)}$	$I_{D(ma)}$	$I_{D(ma)}$	$I_{D(ma)}$
1	0					
2	1.0					
3	3.0					
4	5.0					
5	8.0					
6	11.0					
7	14.0					

Transconductance characteristics

1 Rig up the circuit on the breadboard as shown in the figure.
2 keep V_{DS} = 10 V constant.
3. Increase V_{GS} from 0V to 4/10 V in suitable steps and note the corresponding value of I_D till I_D = 0.
4. Tabulate the readings and plot the graph I_D v/s V_{GS}. Taking V_{GS} on X-axis and I_D on Y-axis.
5. Calculate transconductance and amplification factor.

Sl.No	V_{GS}(V)	I_D (mA)
1	0	
2	0.5	
3	1.0	
4	1.5	
5	2.0	
6	3.0	
7	4.0	
8	5.0	
9	6.0	

7. CALCULATIONS

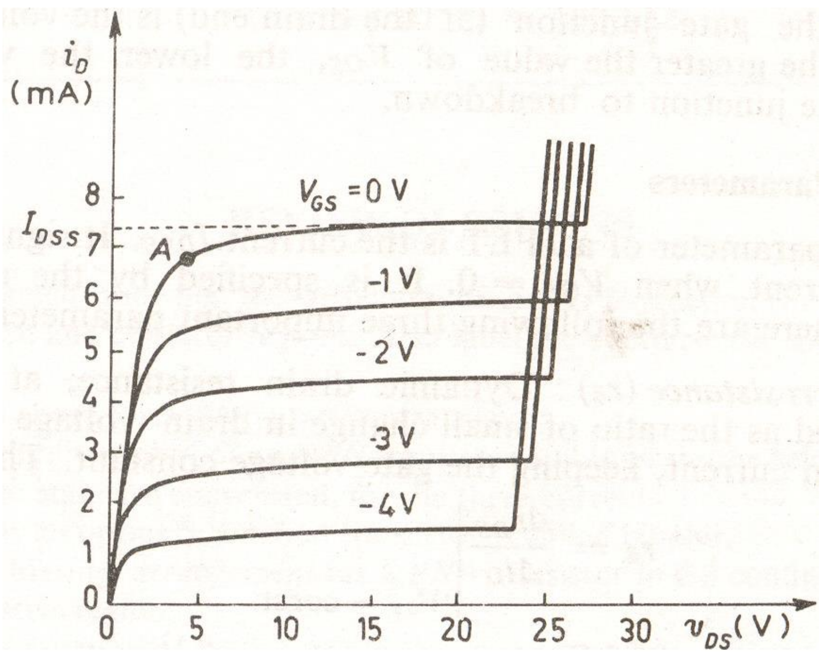
1. Dynamic drain resistance $r_d = \frac{\Delta V_{DS}}{\Delta I_D} |_{V_{GS} = const}$ = ________________

2. Mutual conductance $g_m = \frac{\Delta I_D}{\Delta V_{GS}} |_{V_{DS} = const}$ = _________________

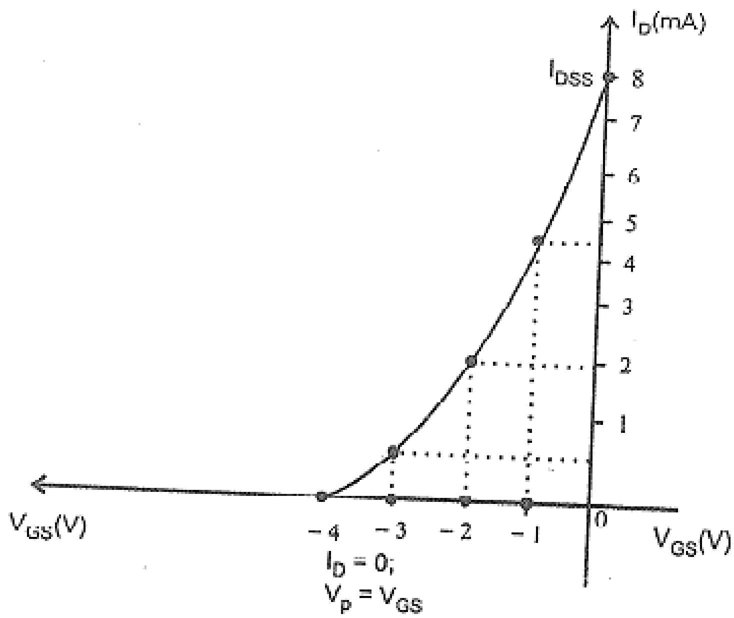
3. Amplification factor $\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}} |_{I_D = const}$ = _______________

8. GRAPH

i. Drain Characteristics



ii. Transfer characteristics



9. <u>INFERENCE</u>

The variation of I_D with V_{DS} for V_{GS} = 0, the condition when the gate is effectively short circuited to the source. As V_{DS} is increased from 0 to V_P, called the pinch off voltage, I_D increased from 0 to the maximum drain current that can be attained without destroying the JFET, the value of I_{DSS}. The JFET is normally operated in the interval V_P to V_{DS} max where no change in I_D occurs.

10. <u>PRECAUTIONS</u>

1. Identify the JFET terminals.
2. Do not install the JFET or remove from a circuit with power ON.
3. Use meters of proper range.
4. Be certain that the polarity of bias voltage on the gate is correct before applying the power.

11. <u>TROUBLE SHOOTING:</u>

1. Check the battery connections.
2. Check the terminals of the JFET.
3. Check the polarities of the meters.
4. Check where the Shield is connected.

12. RESULT / CONCLUSION

1. Drain and Transfer characteristics are plotted.
2. The transistor parameters are given below
   Dynamic drain resistance r_d = _______
   Mutual conductance g_m = _______
   Amplification factor μ =________

13.**EXTENSION**

1. FET as an amplifier.
2. FET as an oscillator.

14. APPLICATIONS

1. In digital millimeters.
2. Amplifiers
3. Switches.
4. Oscillators.

15. QUESTIONS

1. Compare BJT and JFETS.
2. Explain the working of N-Channel JFET.
3. What is pinch off voltage?
4. Define the parameter of JFET
5. Why input resistance of JFET is larger than that of BJT.
6. Whatdo you understand by the term 'channel' in a JFET?
7. What is ohmic region in JFET drain characteristics?
8. Why drain current remains constant for V_{DS} greater than V_P?
9. Give the relation between μ , r_d and g_m.
10. Draw the circuit symbol of N-channel JFET and P-channel JFET.

8. SELF-BIAS CIRCUIT

1. AIM:

To design a self bias circuit and observe stability by changing β of the transistor.

2. EQUIPMENT AND COMPONENTS:

I. Equipment:

1. Power supply (0-30v) – 2Nos
2. Digital Multimeter

II. Components:

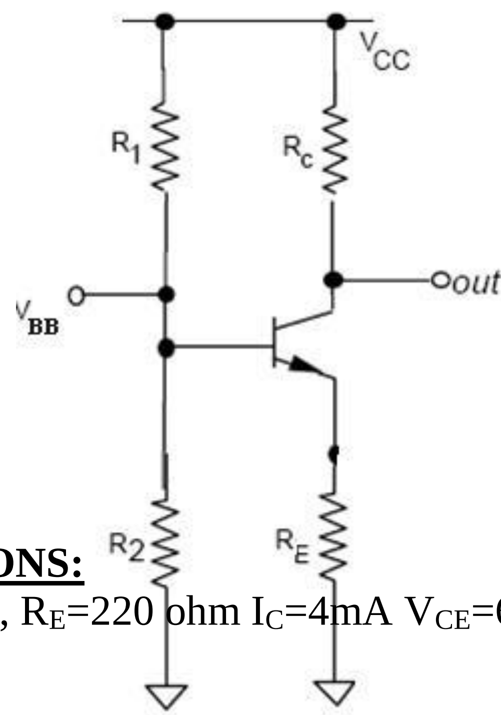
1. Transistors with different β values (SL100)
2. Resistors (according to design values)
3. Bread board
4. Connecting wires

3. THEORY:-

A better method of biasing is obtained by inserting the bias resistor directly between the base and collector, as shown in figure. By tying the collector to the base in this manner, feedback voltage can be fed from the collector to the base to develop forward bias. This arrangement is called self-bias. Now, if an increase of temperature causes an increase in collector current, the collector voltage (V_C) will fall because of the increase of voltage produced across the load resistor (R_L). This drop in V_C will be fed back to the base and will result in a decrease in the base current. The decrease in base current will oppose the original increase in collector current and tend to stabilize it. The exact opposite effect is produced when the collector current decreases

A self bias circuit stabilizes the bias point more appropriately than a fixed bias circuit.

4. CIRCUIT DIAGRAM:



5. CALCULATIONS:

Given V_{CC}=10V, R_E=220 ohm I_C=4mA V_{CE}=6V V_{BE}=0.6V h_{fe}=229

$R_C=(V_{CC}-V_{CE})/I_C$

$I_B=I_C/\beta$

$R_B=\beta*R_E/10$

$V_{BB}=I_B*R_B+V_{BE}+(I_B+I_C)R_E$

$R_1=(V_{CC}/V_{BB})*R_B$

$R_2 = R_B/(1 - V_{BB}/V_{CC})$

6. PROCEDURE:

1. Assemble the circuit on a bread board with designed values of resistors and transistor.
2. Apply Vcc and measure VCE, VBE and VEE and record the readings in table I.
3. Without changing the values of biasing resistors, change the transistor with other β values and repeat the above steps and record the readings in the table.

7. OBSERVATIONS:

β value	VCE	VBE	VEE	$I_C=(V_{CC}-V_{CE})/R_C$	$I_E=V_{EE}/R_E$

8. RESULT:

In this experiment CE configuration is used and a self bias circuit is designed and verified.

9. INFERENCES:

Unlike other biasing circuits, only one dc supply is necessary.
Operating point is almost independent of β variation. Operating point stabilized against shift in temperature. It improves circuit's stability.

10. PRECAUTIONS:

1. The supply voltage should not exceed the rating of the transistor
2. Connect the circuit with proper polarities.
3. Avoid loose connections.

11. APPLICATIONS:

The circuit's stability makes it widely used for linear circuits.

12. TROUBLE SHOOTING:

1. Check for any loose connection
2. Test the transistor before using in the circuit

13. QUESTIONS:

1. What are the advantages of self bias?
2. What are the various other configurations available for bias?

9. Frequency response of CE Amplifier

1. AIM

1. To study and plot the frequency response curve of CE amplifier
2. Measure the bandwidth and voltage gain of the amplifier in mid frequency range .
3. Measure the operating point, input and output impedances .

2 i. APPARATUS REQUIRED

APPARATUS

1. Regulated dual power supply (0 – 30 V) – 1 No.
2. Function generator – 1 No.
3. CRO (20MHZ) Dual trace - 1 No. each

ii. COMPONENTS

1. Transistor BC 107 - 1 No
2. Resistor 10k Ω ,33K Ω, 4.7K Ω, 560Ω, 2.2 K Ω – 1 each.
3. Capacitors 10µF -2
4. Capacitor 100µF -1
5. Bread Board & Connecting Wires -

iii. SPECIFICATIONS:

BC 107 is an N-P-N
H_{fe} = 500 at I_C= 2mA, V_{CE} = 5V
I_{CBO}=15 micro amps
I_{CM} = 200 mA
V_{CEO} =45V
Ti=175 degree C.

3 THEORY

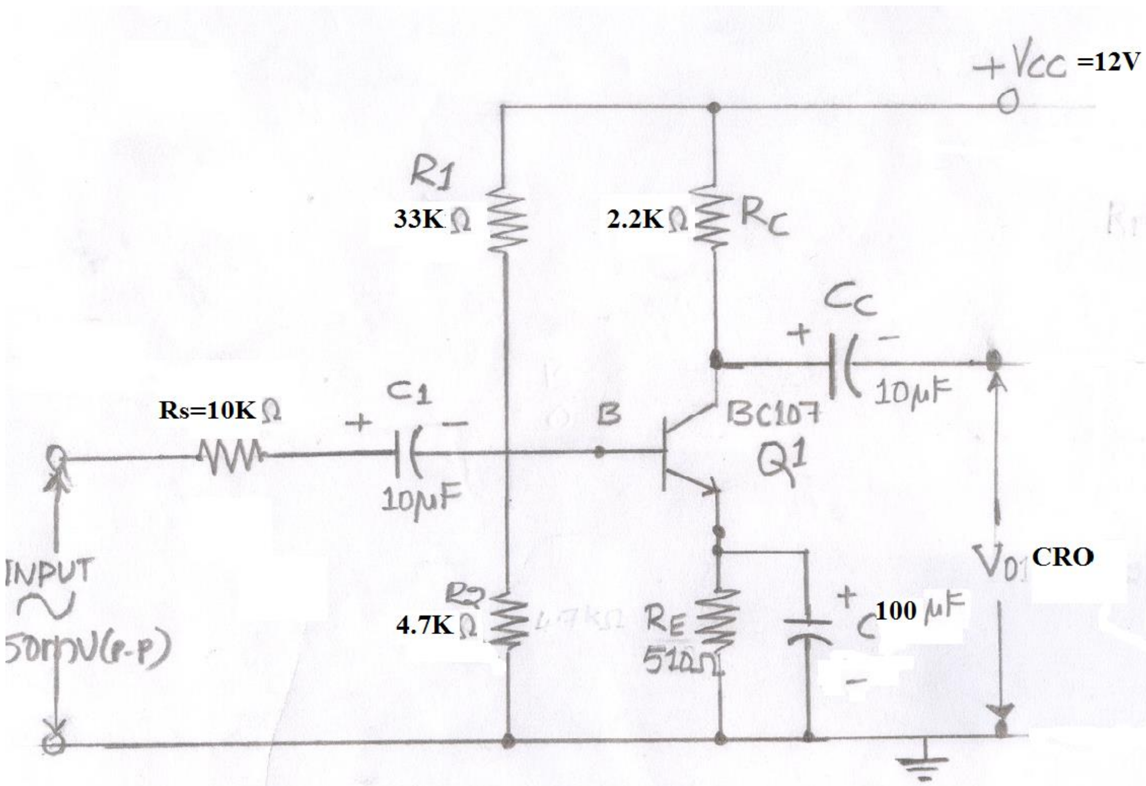
In the amplifier circuit shown in the figure, The resistor R_1, R_2 and R_E fix the operating point. The resistor R_E stabilizes it against temperature variations. The capacitor C_E bypasses the resistor R_E for the ac signal. As it offers very low impedance path for ac, the emitter terminal is almost at ground potential. When the ac signal is applied to the base, The base-emitter voltage changes, because of which the the base current changes. Since the collector current depends on the base current, the collector current also changes. When this collector current flows through the load resistor, ac voltage is produced at the output. As the output voltage is much greater than the input voltage, the circuit works as an amplifier.

The voltage gain of the amplifier is given by the formula

$$Av = \frac{\beta R_{ac}}{r_{in}} \angle 180^0$$

Where r_{in} is the dynamic input impedance, β is the current amplification factor and R_{ac} is the ac load resistance in the circuit.

4 CIRCUIT DIAGRAM



5 PROCEDURE

i. Operating point

1. Disconnect the signal generator, apply Vcc = 12V.
2. Measure the voltage between collector and emitter terminals of the transistor (V_{CE}).
3. Measure the voltage between collector of the transistor and ground (Vc).
4. Calculate the collector current using the following expression

$$Ic = \frac{Vcc - Vc}{R_C}$$

Make sure that the transistor is operating in the active region by noting that V_{CE} is about half of Vcc.

ii. Frequency response & Impedances.

1. Make the circuit connections as show in the figure.
2. Set input ac signal at 1KHz using the signal generator and observe the amplified waveform on CRO. Increase the input signal till the output wave shape starts distorted. Measure this input signal. this is the maximum signal that the amplifier can amplify without distortion.
3. Set V_{in}= 50mv (say), using the signal generator.
4. Set the frequency of signal generator at 1KHz, measure the input current Ii through the resistor Rs and find the input impedance r_{in}.
5. Measure the output voltage V_0 & current Ic and find the output impedance r_o.
6. Keeping the input voltage constant, vary the frequency from 50 HZ to 1 MHZ in regular steps and note down the corresponding output voltage.
7. Plot the graph of gain v/s frequency.
8. Find the bandwidth and voltage gain at mid frequency range.

6. OBSERVATIONS

i.Operating point

V_{CE} = ______________, Vc = ___________ Ic = ________________.

ii.Frequency response

1. *Maximum signal that can be handled by the* the amplifier without introducing
distortion = __________mV at the input frequency of 1KHz.

2. At Vm = 50mv, Frequency = 1KHz

V_{in} = _____________ Ii = ___________, r_{in} = ________________,

V_0 = _____________ Ic = ___________, r_o = ________________,

TABULAR FORM:

S.No	Frequency	V_0(Volt)	Gain = V_0/Vin	Gain (db) = 20 log V_0/Vin
1	50 HZ			
2	100 HZ			
3	200 HZ			

7. CALCULATIONS

$Ic = \frac{Vcc - Vc}{R_C}$ = ____________

$r_{in} = \frac{V_{in}}{I_i}$ = ___________

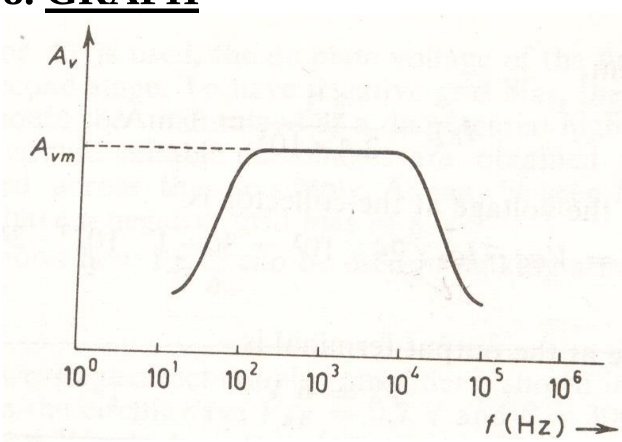
$r_o = \frac{V_0}{I_c}$ = ____________

Band width = f_H - f_L = ______________

| A | max (dB) =____________

- 3dB | A | max = ___________

8. GRAPH



9. INFERENCE

Emitter bypass capacitors are used to short circuit the emitter resistor and thus increase the gain at high frequency. These coupling and bypass capacitors cause the fall off in the low frequency response of the amplifier because their impedance becomes large at low frequencies. In the mid frequency, the large capacitors are effective short circuits and the stray capacitors are open circuits, so that no capacitance appears in the mid frequency range.Hence the mid band gain is maximum. At the high frequencies the bypass and coupling capacitors are replaced by short circuits and stray capacitors cause the fall in the gain.

10. PRECAUTIONS

1. Note down the type number of the transistor. Note the important specifications of the transistor from the data book.
2. Do not exceed the maximum values specified in data book
3. Do not install a transistor or remove one from a circuit with power ON.
4. Identify the terminals of the transistors.
5. Check the transistors.
6. Set the function generator just below the point of distortion, so that the maximum undistorted sine wave appears.
7. Adjust the oscilloscope for proper viewing.

11 TROUBLE SHOOTING:

1. Check the transistor.
2. Check the battery connections.
1. Measure VBE and VCE (= $V_{CC}/2$) with the DMM..
2. Check weather undistorted input signal can be viewed on the CRO.
3. Check the CRO probe.

12 RESULT / CONCLUSION

1. Frequency response is plotted
2. Operating point $Q(V_{CE}, I_C)$ = ______________

3. Input impedance r_{in} = _______________
4. Output impedance r_o = ____________
5. Bandwidth = ___________.
6. Mid frequency gain = _________
7. *Maximum signal handling capacity* = ______________mV at the input frequency of 1KHz.

13 EXTENSION

1. Multistage amplifier.

14. APPLICATIONS

1. Amplifiers.
2. Modulation.
3 Waveform generation.
4. Switching etc.

15. QUESTIONS

1. What is meant by Q point?
2. What is the need for biasing a transistor?
3. What factors are to be considered for selecting the operating point for an amplifier?
4. What is thermal runaway? How it can be avoided.
5. What three factors contribute to thermal instability?
6. Define stability factor.
7. What is thermal resistance? What is the unit of thermal resistance?
8. What is a heat sink? How does it contribute to increase in power dissipation
9. Name different biasing circuits?
10. What are the advantages of self biasing over the other biasing circuits?

10. Frequency response of CC Amplifier

1. AIM

1. To plot the frequency response curve.

2. APPARATUS REQUIRED

i. APPARATUS

1. Function generator - 1 No.
2. CRO (20MHZ) Dual trace - 1 No. each
3. Regulated Power supply - 1 No.

ii. COMPONENTS

1. Transistor BC 107 - 1 No
2. Resistor 5KΩ , 10KΩ, 100K Ω - 1 each.
3. Bread Board & Connecting Wires
4. Capacitor 10μF – 2 Nos

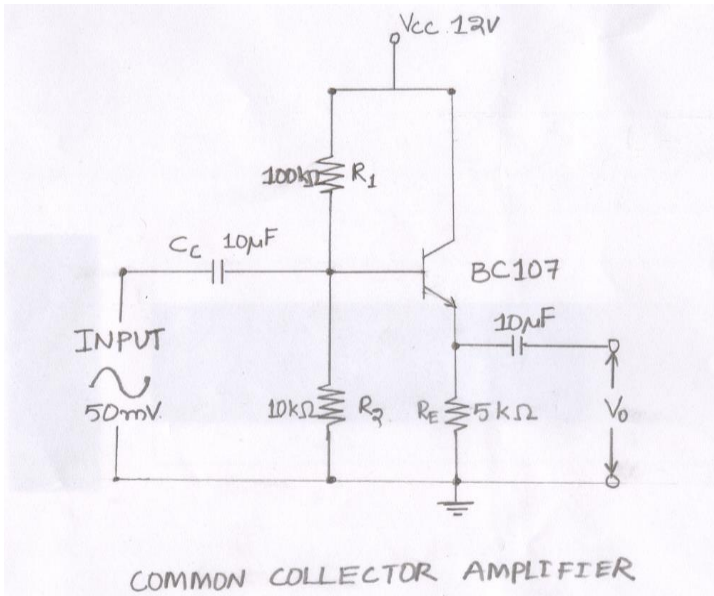
iii. SPECIFICATIONS:

BC 107 is an N-P-N
H_{fe} = 500 at IC= 2mA, VCE = 5V
I_{CBO}=15 micro amps
I_{CM} = 200 mA
V_{CEO} =45V
Ti=175 degree C.

3. THEORY:

In this circuit, input is applied between the base and collector terminals and the output is taken across the emitter and collector terminals and the capacitors in the circuit block the D.C and pass the A.C signal current in the circuit.

4. CIRCUIT DIAGRAM



5. PROCEDURE

1. Make the circuit connections as show in the figure.
2 Set V_{in}= 50mv (say), using the signal generator.
3. Keeping the input voltage constant, vary the frequency from 50 HZ to 1 MHZ in regular steps and note down the corresponding output voltage.
4. Plot the graph of gain v/s frequency.
5. Find the bandwidth.

6. OBSERVATIONS

Vm = 50mv

S.No	Frequency	V_0(Volt)	Gain = V_0/Vin	Gain (db) = 20 log V_0/Vin
1	50 HZ			
2	100 HZ			
3	200 HZ			

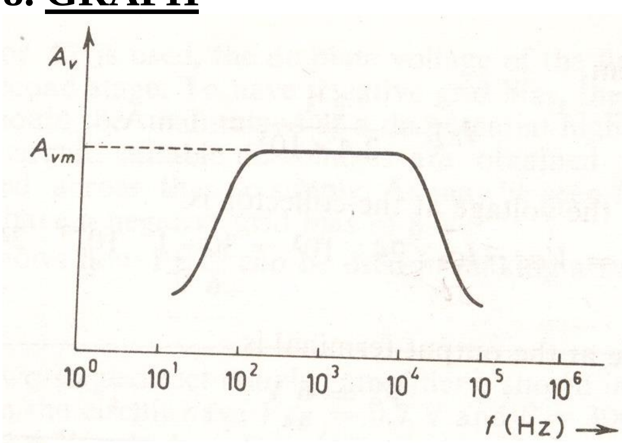
7. CALCULATIONS

Band width = f_H - f_L

| A | max (dB) =

- 3dB | A | max =

8. GRAPH



9. INFERENCE

Emitter bypass capacitors are used to short circuit the emitter resistor and thus increase the gain at high frequency. These coupling and bypass capacitors cause the fall off in the low frequency response of the amplifier because their impedance becomes large at low frequencies. In the mid frequency, the-large capacitors are effective short circuits and the stray capacitors are open circuits, so that no capacitance appears in the mid frequency range hence the midband gain is maximum. At the high frequencies the bypass and coupling capacitors are replaced by short circuits and stray capacitors and the transistors determine the response

10. PRECAUTIONS

1. Note down the type number of the transistor. Note the important specifications of the transistor from the data book.
2. Do not exceed the maximum values specified in data book
3. Do not install a transistor or remove one from a circuit with power ON.
4. Identify the terminals of the transistors.
5. Check .the transistors.
6. Set the function generator just below the point of distortion, so that the maximum undistorted sine wave appears.
7. Adjust the oscilloscope for proper viewing.

11. TROUBLE SHOOTING:

1. Check the transistor.
2. Check the battery connections.
3. Measure VBE and VCE ($=V_{CC}/2$) with the DMM..
4. Check weather undistorted input signal can be viewed on the CRO.
5. Check the CRO probe.

12. RESULT / CONCLUSION

1. Frequency response is plotted
2. Bandwidth was calculated.

13. EXTENSION

1. Multistage amplifier.

14. APPLICATIONS

1. Amplifiers.
2. Modulation.
3 Waveform generation.
4. Switching etc.

15. QUESTIONS

1. What is meant by Q point?
2. What is the need for biasing a transistor
3. What factors are to be considered for selecting the operating point for an amplifier?
4. What is thermal runaway? How it can be avoided.
5. What three factors contribute to thermal instability?
6. Define stability factor.
7. What is thermal resistance? What is the unit of thermal resistance?
8. What is a heat sink? How does it contribute to increase in power dissipation

11. Frequency Response of Common source FET Amplifier

1. AIM:
To determine the frequency response of a FET Amplifier.

2. EQUIPMENT AND COMPONENTS:

I. Apparatus:
1. Regulated power supply 0-30 v/1 Amp - 1
2. Function generator - 1
3. CRO – 1
4. Multimeter – 1
5. Digital Multimeter

ii. Components:
1. FET BFW 10/11
2. Bread board, wires and probes
3. Resistors – 22k, 1k, 10k,
4. Capacitors – 10 µf – 2

Specifications:

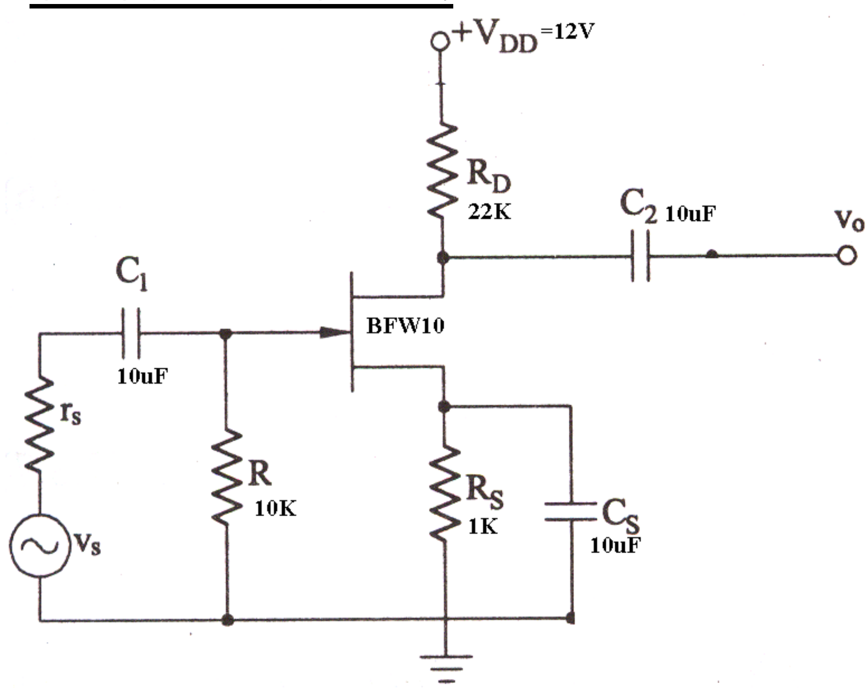
	BFW11	**BFW10**
I_{DSS}	4-10 mA	8-20 mA
V_{GS}	2-4 v	4-8 v
g_m	3.9 mA/V	3.2 mA/v

3. THEORY:-
In a FET, the conduction of current through the device is controlled by the electric field between the gate and the conducting channel of the device. The output current is

controlled by the input voltage. Thus, FET is basically a voltage controlled device.

In common source JFET amplifier there is phase displacement of 180 degrees between the output and input voltage the mid frequency voltage gain of the amplifier is given by $A = g_m \times R_d$ The voltage gain and phase angular are constant in mid frequency range.

4. CIRCUIT DIAGRAM:



5. <u>PROCEDURE:</u>

1. Connect the signal generator at the input terminals
2. Connect output terminals to the Oscilloscope. Switch ON the Trainer and observe the power LED indication
3. Select 1000 Hz sine wave from signal generator and set the amplitude to minimum of 100mV.
4. Change the frequency of the input signal from 10Hz to 1MHz. Keep the input signal amplitude constant. For every frequency observe and record the out voltage.
5. Calculate the gain of the amplifier using the formula

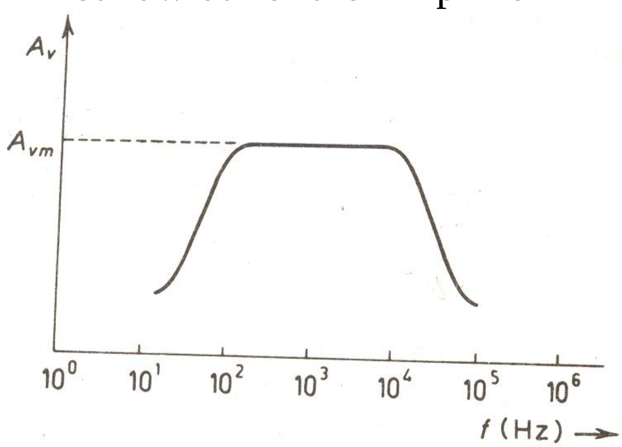
$$\text{Gain} = \frac{V_0}{V_{in}}$$

6. OBSERVATIONS:

Sl.No.	Frequency	Output voltage Vo	Voltage gain Av = Vo/Vi	Voltage gain Av dB = 20 log Vo/Vi

7. GRAPH:

Plot the graph voltage gain (dB) versus frequency, and find the bandwidth of the Amplifier



Frequency response curve of an *RC*-coupled amplifier

8. CALCULATIONS:

Bandwidth = f_H-f_L

|A|max (dB) =

-3 dB |A|max (dB) =

9. RESULT:

1. Frequency response curve is plotted.
2. Bandwidth is calculated.

10. INFERENCES:

1. The maximum voltage gain occurs at mid band.
2. The gain at the half power point is 3 dB less than the mid band gain.
3. The gain remains constant throughout the mid band.
4. The gain decreases both at low frequency and high frequency.

11. PRECAUTIONS:

1. Identify the terminals of FET properly.
2. Set the function generator just below the point of distortion. So that maximum undistorted sine wave appears.
3. Adjust the oscilloscope for proper viewing.

12. APPLICATIONS:

1. Voltage amplifier

13. EXTENSION:

Multi stage amplifier.

14. TROUBLE SHOOTING:

1. Check whether undistorted input signal can be viewed on the CRO.
2. Check the CRO probe.

15. QUESTIONS:

1. What is the difference between FET and BJT?
2. Explain the construction and working of JFET?
3. Briefly describe some applications of FET.
4. What is the difference JFET and MOSFET?
5. What do you mean by frequency response?

12. SCR Characteristics

1. AIM:

To draw the forward and reverse characteristics of silicon controlled rectifier.

2. EQUIPMENT AND COMPONENTS:

I. Equipment:

1. Power supply (0-30v)
2. Voltmeter (0-30v).
3. Ammeter (0-10 mA)
4. Ammeter (0-100 mA)

II. Components:

1. SCR
2. Resistor – 2K, 50K
3. Bread board
4. Connecting wires

III. Specifications:

1. Break over voltage range (50v-500v)
2. Forward current rating of 40A

   V_{PO} – Peak reverse voltage, gate open
   P_{GM} – Peak gate power dissipation
   Tstg – Storage temperature
   T_J – Operating junction temperature.

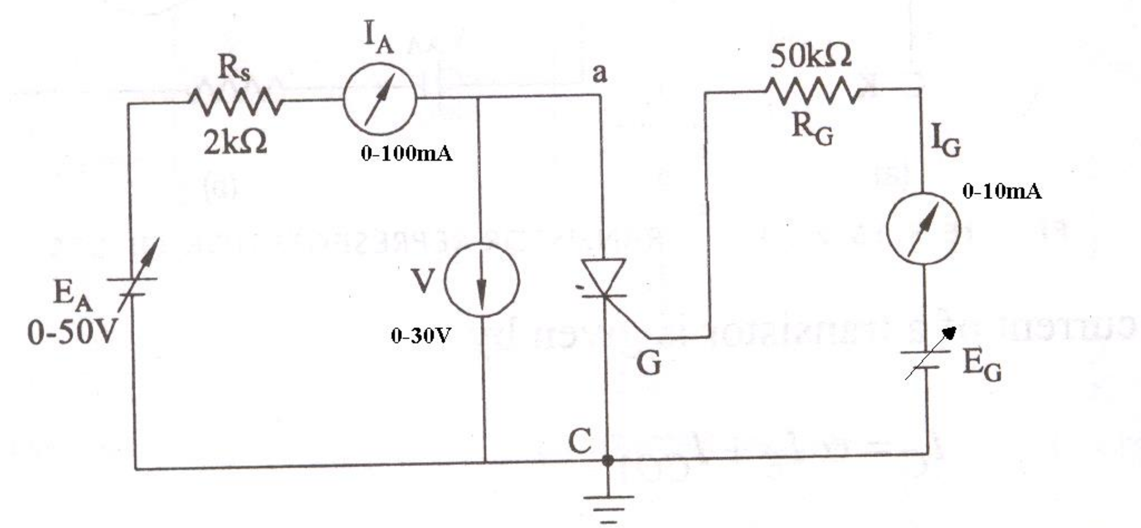
3. THEORY:-

SCR is a four layer, three junction, P-N-P-N semi conductor switching device. It has three terminals: 1. Anode 2. Cathode 3. Gate. The gate terminal carries a low level gate current in the direction of gate to cathode. From the V-I characteristics of an SCR, Va is the anode cathode voltage and Ia is the anode current. The SCR characteristics are divided into three regions of operation. They are 1. Reverse blocking region 2. Forward blocking region 3. Forward conduction mode. The SCR in reverse blocking may treated as a open switch because it offers very high impedance.

Latching current: It is defined as the minimum current of anode, which it must attain during turn-on process to maintain conduction when gate signal is removed.

Holding current: It is defined as the minimum value of anode current below which it must fall turning off the SCR.

4. CIRCUIT DIAGRAM:



SCR CHARACTERISTICS - EXPERIMENTAL SETUP

5. PROCEDURE:

1. Connect the circuit as shown in the figure.
2. Keeping Ig = Ig1 amp, increase the voltage Ea.
3. Increase the Ea voltage and note down the voltage (V) and Current (I_A) across the SCR
4. Tabulate the readings obtained in steps 2 and 3 and plot the graph between anode voltage and current.

5. To get the reverse bias characteristics change the polarities of Ea and the procedure is same.

6. OBSERVATIONS:

Sl No.	I_{g1}		I_{g2}	
	V	I_A	V	I_A

7. GRAPH:

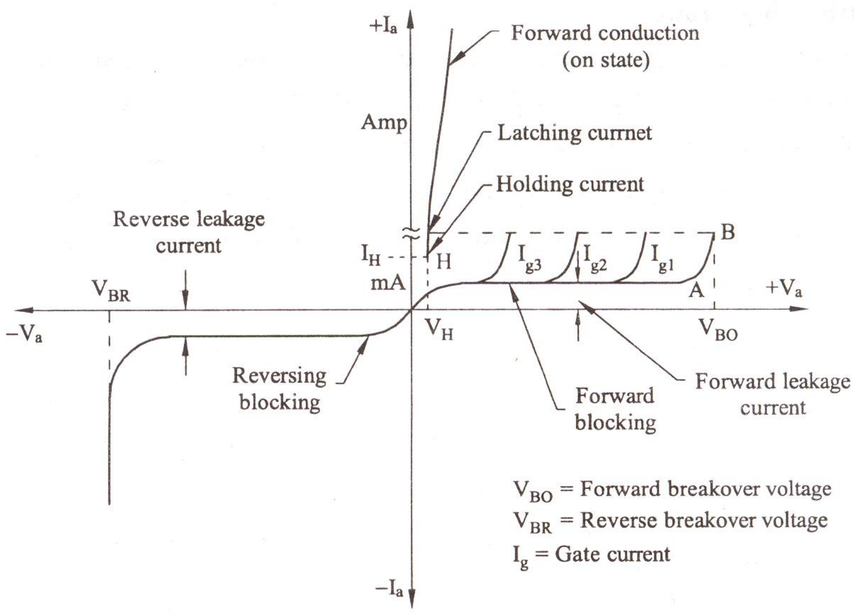


FIGURE 5.15.4 : V-I CHARACTERISTICS OF SCR

8. RESULT:

V-I characteristics of SCR are ploted between Va and Ia for different gate current readings.

9. INFERENCES:

SCR differs from the two element diode rectifier in that it will not pass any appreciable current, although forward biased, until the anode voltage equals or exceeds a value called the forward break over voltage V_{FBO}. When V_{FBO} is reached, the SCR is switched on that is, it becomes highly conductive. The value of V_{FBO} can be controlled by the level of gate current. The gate then provides a new dimension in rectifier operation in which low level of gate current control high levels of anode or load current.

10. PRECAUTIONS:

1. Note the readings without parallax error.
2. Connect the circuit with proper polarities.
3. Avoid loose connections.

11. APPLICATIONS:

1. SCR can be used as switch
2. In half wave rectifier circuit
3. In power control circuits.
4. Speed control motor.

12. EXTENSION:

Design a circuit to use SCR as a power control device

13. TROUBLE SHOOTING:

1. Check for any loose connection
2. Test the SCR before using in the circuit

15. QUESTIONS:

1. How does SCR differ from ordinary rectifier?
2. Why is SCR always turned on by gate current?
3. Why are SCRs usually used in A.C. circuits?
4. Why SCR can't be used as bidirectional switch?
5. What are the applications of SCR?

13. UJT Characteristics

1. AIM:

To plot the V-I characteristics of JUT and to obtain peak and valley voltages.

2. EQUIPMENT AND COMPONENTS:

I. Equipment:

1. Power supply (0-30v)
2. Voltmeter (0-20v).
3. Voltmeter (0-10v).
4. Ammeter (0-20 mA)

II. Components:

1. UJT (2N2646)
2. Resistor – 1KΩ
3. Bread board
4. Connecting wires

III. Specifications:

When there is no voltage applied to the UJT, the value of resistance R_{BB} is typically 5 to 10kΩ depending upon the value of emitter current, the value of resistance RB1 can vary typically from 4kΩ to 40Ω.

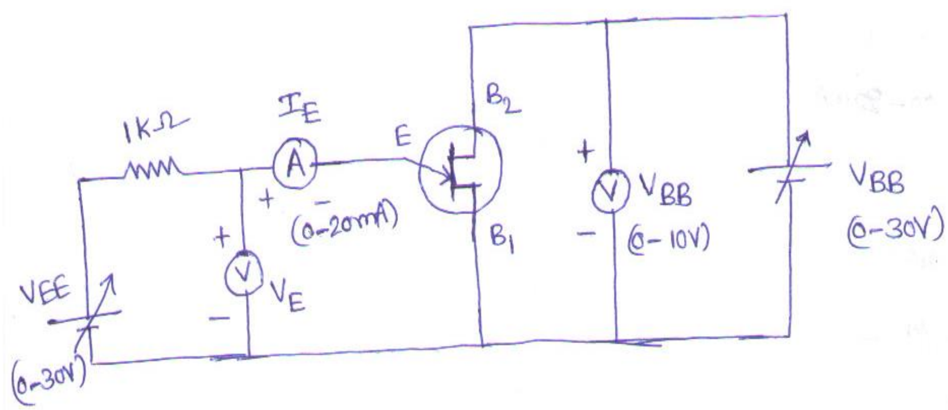
3. THEORY:-

A unijunction transistor (abbreviated as UJT) is a three terminal silicon semiconductor device. As the name indicates, the UJT has only one PN junction like an ordinary diode.

However, it is different from the ordinary diode in the sense that it has three terminals.

In UJT if the applied emitter voltage is below the total reverse bias voltage across the diode, it remains reverse biased, and there is no emitter current. However, as the applied emitter voltage reaches a particular value, the diode conducts and the emitter current flows. The value of emitter voltage. Under this condition, the UJT is said to be ON. At this instant, the holes from the P-type emitter region.

4. CIRCUIT DIAGRAM:



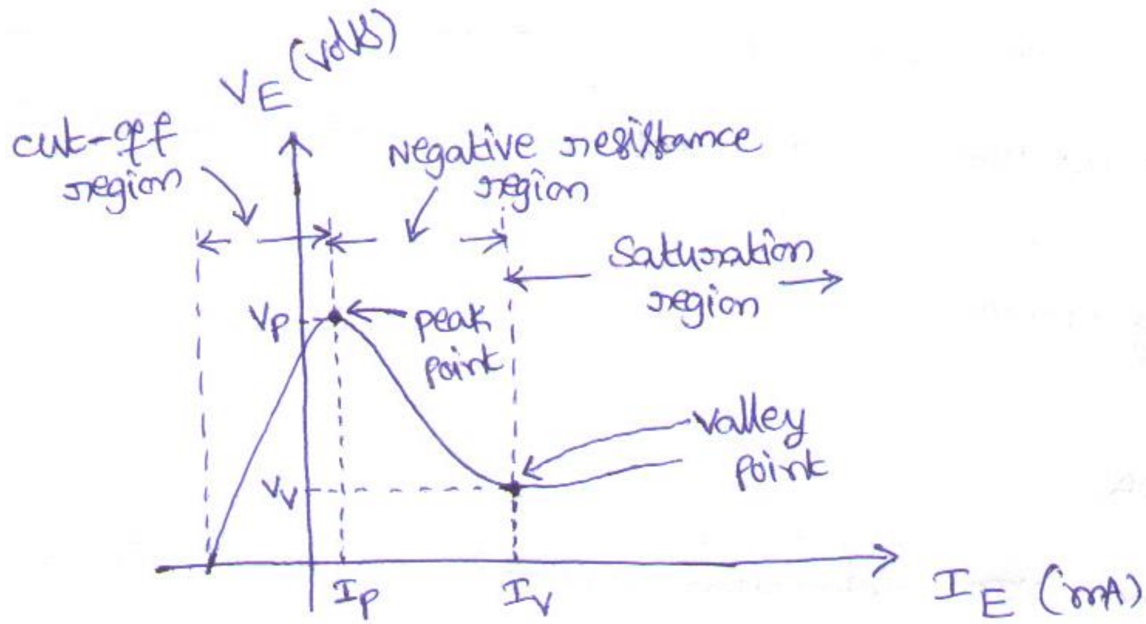
5. PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep V_{BB}= 5V, vary the V_{EE} to increase V_E in steps of 1V, note down the corresponding value of I_E for each value of $V_{E.}$
3. Tabulate the readings and plot the graph V_E Vs I_E
4. Repeat the above procedure for V_{BB}= 10V also.

6. OBSERVATIONS:

Sl No.	VBB=5V		VBB=10V	
	VE(volts)	IE(mA)	VE(volts)	IE(mA)

7. GRAPH:



8. RESULT:

V-I characteristics of UJT are plotted between V_E Vs I_E and for different V_{BB} values and the peak and valley voltage values are calculated from graph.

9. INFERENCES:

1. UJT is a unique three terminal device which possess negative resistance region in its characteristic curve.

2. A UJT can be switched ON from its OFF position by applying a +ve voltage at its emitter terminal.

3. If the applied emitter voltage (V_E) is greater than peak voltage(V_P) then only UJT comes to ON position.

10. PRECAUTIONS:

1. Identify the UJT terminals.
2. Connect the circuit with proper polarities.
3. Avoid loose connections.
4. Don't install or remove the UJT from a circuit with power ON.

11. APPLICATIONS:

1. Trigger device for SCR's and TRIAC's.
2. It can be used as a relaxation oscillator (Saw-tooth wave generator).
3. Timing circuits.

12. EXTENSION:

Design an UJT relaxation oscillator circuit for a specific frequency.

13. TROUBLE SHOOTING:

1. Check for any loose connection
2. Test the UJT before using in the circuit

15. QUESTIONS:

1. How does UJT differ from BJT and FET?
2. What does Intrinsic stand-off voltage stand for?
3. Define Intrinsic stand-off ratio?
4. What are the applications of UJT?

<u>PART-C</u>

Equipment required for Laboratories:

1. Regulated Power supplies (RPS) - 0-30v
2. CROs - 0-20M Hz.
3. Function Generators - 0-1 M Hz.
4. Multimeters
5. Decade Resitance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Micro 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,M OSFETs, diodes Ge & Si type, Transistors - npn & pnp type