SVR ENGINEERING COLLEGE

Approved by AICTE & Permanently Affiliated to JNTUA

Ayyalurmetta, Nandyal – 518503. Website: www.svrec.ac.in

Department of Electronics and Communication Engineering

(15A04305) ELECTRONIC DEVICES AND CIRCUITS LABORATORY LABORATORY

R15

II B. Tech (ECE & EEE) I Semester 2016-17

STUDENT NAME	
ROLL NUMBER	
SECTION	

SVR ENGINEERING COLLEGE

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DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

ACADEMIC YEAR: 2016-17

This is to certify that the bonafide record work done by

*Mr./Ms.*____ *bearing*

H.T.NO. ____________________ *of II B. Tech*

I Semester in the **ELECTRONIC DEVICES AND CIRCUITS LABORATORY**

Faculty In-Charge **Head of the Department**

II-I ECE & EEE - R15 - Syllabus – List of experiments :

PART – A : Electronic workshop practice:

1. Identification, Specification and testing of R, L, C components(Colour codes), Potentio meters, coils,Gangcondensers,Relays and bread board.
2. Identification, Specification and testing of Active devices - Diodes, BJT's, JFET's, LED's, LCD's, SCR and UJT.
3. Soldering practice – Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog & Digital multimeters, Function generator, Regulated power supply and CRO.

PART – B : List of experiments.

(For laboratory Examinatrion – Minimum of ten experiments)

1. PN junction diode characteristics :
   A : Germanium diode (Forward bias & Reverse bias)
   B : Silicon diode (Forward bias only)
2. Zener diode characteristics :
   A : V – I characteristics
   B : Zener diode act as a voltage regulator
3. Rectifiers (Without & with *C* filter)
   A : Half wave rectifier
   B : Full wave rectifier
4. BJT characteristics (CE configuration)
   A : Input characteristics
   B : Output characteristics
5. FET characteristics (CS configuration)
   A : Drain (output) characteristics
   B : Transfer characteristics
6. SCR characteristics
7. UJT characteristics
8. Transistor biasing
9. CRO operation and its measurements.
10. BJT – CE amplifier
11. Emitter follower - CC amplifier
12. FET – CS amplifier

ECE DEPT VISION & MISSION PEOs and PSOs

Vision

To produce highly skilled, creative and competitive Electronics and Communication Engineers to meet the emergingneeds of the society.

Mission

- Impart core knowledge and necessary skills in Electronics and Communication Engineering throughinnovative teaching and learning.
- Inculcate critical thinking, ethics, lifelong learning and creativity needed for industry and society
- Cultivate the students with all-round competencies, for career, higher education and self-employability

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO1: Graduates apply their knowledge of mathematics and science to identify, analyze and solve problemsin the field of Electronics and develop sophisticated communication systems.

PEO2: Graduates embody a commitment to professional ethics, diversity and social awareness in theirprofessional career.

PEO3: Graduates exhibit a desire for life-long learning through technical training and professional activities.

II. PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1: Apply the fundamental concepts of electronics and communication engineering to design a variety of components and systems for applications including signal processing, image processing, communication, networking, embedded systems, VLSI and control system

PSO2: Select and apply cutting-edge engineering hardware and software tools to solve complex Electronics and Communication Engineering problems.

III. PROGRAMME OUTCOMES (PO'S)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and anengineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, andin multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects andin multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

IV. COURSE OBJECTIVES

- This Lab provides the students to get an electrical model for various semiconductor devices.
- Students can find and plot V_I characteristics of all semiconductor devices.
- Student learns the practical applications of the devices.
- They can learn and implement the concept of the feedback of the small signal amplifier
- They can learn and implement the concept of the frequency response of the small signal amplifier

V. COURSE OUTCOMES

After the completion of the course students will be able to

Course Outcomes	Course Outcome statements	BTL
CO1	Students able to learn electrical model for various semiconductor devices	L1
CO2	Students able to learns the practical applications of the semiconductor devices.	L2
CO3	Analyze the Characteristics of UJT, BJT, FET, and SCR	L3
CO4	Design FET based amplifier circuits/BJT based amplifiers for the given specifications.	L4
CO5	Simulate all circuits in PSPICE /Multisim.	L5

VI. COURSE MAPPING WITH PO'S AND PEO'S

Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O 7	P O 8	PO 9	PO 10	PO 11	PO 12	PSO 01	PSO 02
Electronic Devices and Circuits Lab	2.2	2.6	2.6	2.6	2.6	2.4	2.6	2.8	2.4	2.2	2.4	2.6	2.4	2.2

VII MAPPING OF COURSE OUTCOMES WITH PEO'S AND PO'S

Cours eTitle	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 01	PSO 02
CO1	2	3	3	2	3	2	3	3	1	3	3	2	3	3
CO2	3	3	2	3	2	3	2	3	3	2	2	3	3	2
CO3	2	3	3	2	2	3	3	2	2	2	2	2	3	3
CO4	1	2	2	3	3	1	3	3	3	1	2	3	1	2
CO5	3	2	3	3	3	3	2	3	3	3	3	3	2	1

LABORATORY INSTRUCTIONS

1. While entering the Laboratory, the students should follow the dress code. (Wear shoes and White apron,Female Students should tie their hair back).

2. The students should bring their observation book, record, calculator, necessary stationery items and graphsheets if any for the lab classes without which the students will not be allowed for doing the experiment.

3. All the Equipment and components should be handled with utmost care. Any breakage or damage will becharged.

4. If any damage or breakage is noticed, it should be reported to the concerned in charge immediately.

5. The theoretical calculations and the updated register values should be noted down in the observation bookand should be corrected by the lab in-charge on the same day of the laboratory session.

6. Each experiment should be written in the record note book only after getting signature from the lab in-charge in the observation notebook.

7. Record book must be submitted in the successive lab session after completion of experiment.

8. 100% attendance should be maintained for the laboratory classes.

Precautions.

1. Check the connections before giving the supply.

2. Observations should be done carefully.

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Max. Marks per each experiment : 5

Sl. No	Name of the Experiment	Page No.	Date of Performed	Date of Submitted	Marks Obtained	Signature of lab incharge
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------------ PTO ------------

------------- Continued -------------

PART – A

Electronic work shop practice

Experiment No. : 1 **Date :**

Name of the Experiment : IDENTIFICATION, SPECIFICATIONS, TESTING OF R,L,C COMPONENTS, POTENTIOMETERS, COILS, GANG CONDENSERS, RELAYSAND BREAD BOARD. (PASSIVE DEVICES)

AIM :

To study the identification, specifications, Testing of R,L,C components, potentiometers, Gang condensers, coils, Relays and bread board.

COMPONENTS:

1).Resistors:

a).Wire wound resistor Any one value -------------- 1 No.
b). Ceramic resistor Any one value -------------- 1 No.
c). Carbon composition resistor Any 10 values -------------- Each one.
d). Potentiometer Any one value -------------- 1 No.
e). Preset Any one value -------------- 1 No.
2). Inductor Any one value -------------- 1 No.
3). Capacitors:
a). Electrolytic/Paper capacitor Any one value -------------- 1 No.
b). Disc type / Ceramic capacitor Any one value -------------- 1 No.
c). Box type capacitor Any one value -------------- 1 No.
d). Polyester capacitor Any one value -------------- 1 No.
d). Gang condenser Any one value -------------- 1 No.
5). Relays:
a). Semiconductor type Any one value ------------- 1 No.
b). Coil type Any one value -------------- 1 No.

PASSIVE COMPONENTS :

The passive component is a device, which is basically static in operation. It is not capable of amplification or oscillation. It does not require power for its characteristic operation.

Examples:

1. Resistors 2. Inductors 3. Capacitors
4. Fuses 5. Switches.

1). RESISTORS :

These are the passive components. These are used to control current to a specific value and also to provide a desired voltage drop. The resistance of a resistor is a measure of opposition on to the flow of current. It is measured in *Ohms*. It's symbol is **Ω**.

1.1). TYPES OF RESISTORS:

These are the two types. They are,

1). Fixed resistor : It is the resistor having the resistance value is fixed. It is not variable.

2). Variable resistor: The values of these resistors are in variance. It means we can vary the value of the resistance which we required. The symbols of fixed and variable resistors are given below,


Figure: Symbol of fixed resistor.

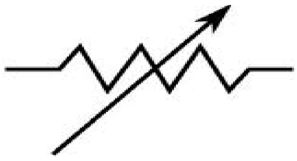


Figure: Symbol of variable resistor.

1.2) FIXED RESISTOR:

The explanation about the different types of resistors are given below,

a). Wire wound resistor b). Ceramic resistor. c). Carbon composition resistor.

1.3). WIRE WOUND RESISTOR :

These resistors are made up of a special type of resistance wire which is wrapped around an insulating core. The resistance of the wire depends on the wire *resistivity* and *length*. These are used for high current applications. The resistance values from 10Ω to several KΩ are available in the market. Their power rating range from 5W to 100W.

1.4). CERAMIC RESISTOR :

It is made by using the material *ceramic*.

1.5). CARBON COMPOSITION RESISTOR :

These are made up of finely divided carbon mixed with a powdered insulating material as a binder. The element is enclosed in a plastic case for insulation and for providing mechanical strength. The two ends are connected to metal caps.

These are available for the resistance values from 1Ω to 20MΩ, having the power rating values of 1/10, 1/8, ¼, ½, 1, 2 Watts. These resistors are small in size and low cost.

1.6). TERMINAL IDENTIFICATION OF A DIFFERENT TYPES OF RESISTORS:

Figure: Terminal identification of *Wire wound resistor.*

Figure: Terminal identification of *Ceramic resistor.*

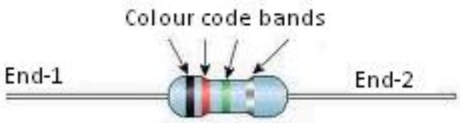


Figure: Terminal identification of *Carbon resistor*

1.7). SPECIFICATIONS OF A RESISTOR :

While selecting the resistor to particular application the following three main specifications are to be considered. These are given below,

1). Resistance value in Ohms(Ω).

2). Tolerance in ±percentage.

3). Wattage or power rating in Watts.

1). Resistance value:This is the value of the resistance expressed in Ohms. This resistance value is either printed on the body of the resistor or indicated by a color code depends on its structure. The value of the resistance is printed on the top of Wire wound & Ceramic resistors; but value of the resistance of *Carbon resistor* would found by using the color coding chart.

2). Tolerance: It is the deviation of the resistance value i.e. the variation in the value of the resistance that expected from the exact indicated value. Usually tolerance is represented in percentage. It's typical values rating from 1% to 20%.

3). Wattage/Power rating: The power rating is very important , in the sense, that is determines the maximum current that a resistor can with stand without being destroyed. The power rating of resistor is specified as so many watts at a specific temperature such as 1 or 2 Watts at 70°C.

The other specifications are:

a). % per °C voltage rating in volts in ppm/ °C

b). Temperature co-efficient of resistance

c). Voltage co-efficient of resistance in % per volt.

1.8). RESISTOR COLOR CODE:

The resistance value and tolerance of carbon resistor is usually indicated by color coding. Color strips or bands are printed on the insulating body. They consists of 4 or more than 4 color bands and they are read from left to right. The following figure shows the color code diagram of *carbon resistor,*

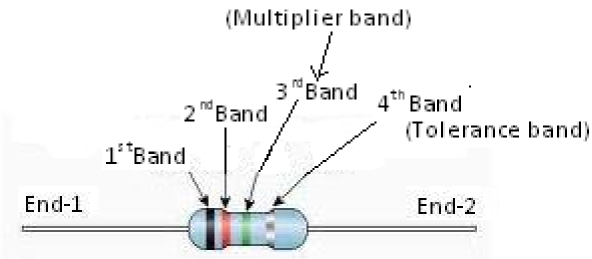


Figure: Color coding diagram of *Carbon resistor.*

In the above figure, 1stband represents first digit, 2nd band represents second digit, 3rd band represents the multiplier and fourth band represents the tolerance in percentage.Some resistors are having more than 4 bands, but the band which is first from tolerance band is multiplier and remaining bands are same. The color coding of the carbon resistor is given in the following,

Sl.No.	Color	Ist digit for the IstBand.	IInd digit for the IInd band.	Multiplier digit for the IIIrdband.	Resistance Tolerance
1	Black	0	0	10^0	--
2	Brown	1	1	10^1	--
3	Red	2	2		±2%
4	Orange	3	3	10^3	±3%
5	Yellow	4	4	10^4	±4%
6	Green	5	5	10^5	--
7	Blue	6	6	10^6	--
8	Violet	7	7	10^7	--
9	Gray	8	8		--
10	White	9	9	10^9	--
11	Gold	--	--	10^{-1}	±5%
12	Silver	--	--	10^{-2}	±10%
13	No Band	--	--	--	±20%

If the IIIrdband is consists the *Gold* color, the remaining digits (which are coded according to the color bands from the left side in the resistor) are multiplied by 10^{-1}, If it is *Silver* the remaining digits are multiplied by 10^{-2}.

If the IVth band is *Gold* the tolerance is ±5%,

If the IVth band is *Silver* the tolerance is ±10%,

If the IV[th] band is *No color* (*Absent*) the tolerance is ±20% .
Note: Some resistors are consists the more than 4 bands. At this time we can consider the bands as per following,
i). The *tolerance band* is at last (end2 terminal)
ii). The *multiplier band* is just at left side of the *tolerance band* ,
iii). The remaining *regular bands*(i.e. 1[st],2[nd],3[rd],4[th] and so on) are from left side (end1 terminal) and up to the band which is just left side of the *multiplier band* of the resistor.

Example 1

Band / Color	I[st] band.	II[nd] band.	III[rd] band.	IV[th] band.
Colors	Brown	Black	Brown	Gold
Digits	1	0	10^1	±5%

From the above table we can found the value of the carbon resistor as following,
Value ⟶ $1\ 0 \times 10^1$ ±5%.
= 100 Ω ± 5%.

Example 2

Band / Color	I[st] band.	II[nd] band.	III[rd] band.	IV[th] band.
Colors	Orange	Orange	Red	Silver
Digits	3	3		±10%

From the above table we can found the value of the carbon resistor as following,
Value ⟶ 3 3 × ±10%.
= 3300 Ω ± 10% = 3.3KΩ ±10%.

Example 3

Band / Color	I[st] band.	II[nd] band.	III[rd] band.	IV[th] band.	V[th] band.
Colors	Red	Black	Black	Green	No Color
Digits	2	0	0	10^5	±20%

From the above table we can found the value of the carbon resistor as following,
Value ⟶ $2\ 0\ 0 \times 10^5$ ±20%.
= $20 \times 10 \times 10^5$ ±20%.
= 20 MΩ ± 20%

Example 4

Band / Color	I[st] band.	II[nd] band.	III[rd] band.	IV[th] band.
Colors	Brown	Black	Gold	Gold
Digits	1	0	10^{-1}	±5%

From the above table we can found the value of the carbon resistor as following,
Value ⟶ $1\ 0 \times 10^{-1}$ ± 5%.
= 1 Ω ± 5%.

1.9). VARIABLE RESISTOR :

Variable resistors are of carbon type and wire wound type. They are available in the following forms,

Tapped control : In this, R changes with shaft rotation. The change in R is obtained by different densities of carbon in resistance element.

Decade Resistance Box (DRB) :This p[rovides wide range of variation of R. It is a part of test equipment for setting different R values. A few series of strings of resistors exist in abox. The resistance can be varied in steps.

Rheostats: It is a variable resistance. It's two terminals are connected in series with the load and voltage source. It is used to vary the current.

Potentio meter & Preset : These are called a resistance pot and has three terminals. It's ends are connected across voltage sources. It taps off part of the potential. The following figure shows the terminal identification of the potentio meter & Preset.

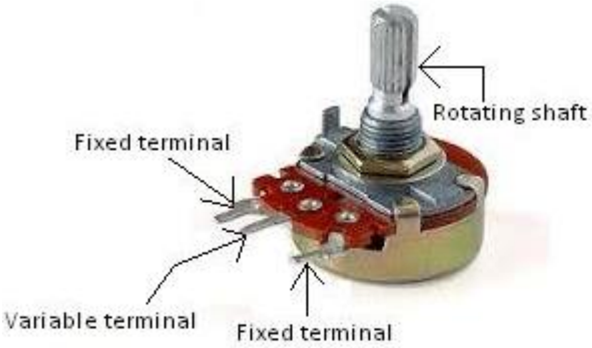


Figure: Terminal identification of *Potentio meter.*

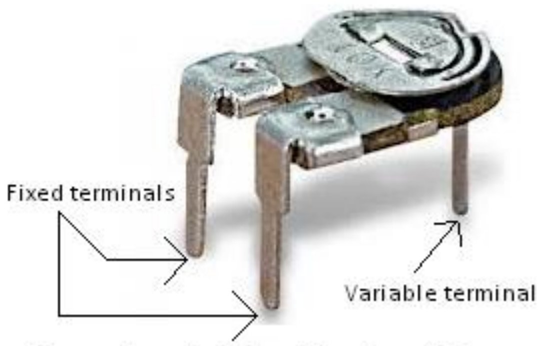


Figure: Terminal identification of *Preset.*

1.10). TESTING OF RESISTOR :

Resistors are checked by an *Ohmmeter* or Digital Multi Meter(DMM). The testing process is given below,

Sl.No.	If DMM Shows	Remark
1	0	Short
2	OL or 1	Open
3	Resistance value	Working normally

When the probe of the DMM's is connected to each lead(end) of resistor without considering the +ve&-ve polarities, the readings can observed in DMM in the above table,

2). INDUCTOR :

Inductor (Coil) is an electromagnetic device consisting of a conductor wound in cylindrical or spiral form to obtained concentrated field parallel to the axis of the coil. For these coils air acts as a magnetic circuit. These are known as air core inductor. It is not a polarity sensitive device. It means it is not having the +ve& -ve polarities.

Note: It is not a polarity sensitive device.

2.1). INDUCTANCE OR SELF INDUCTANCE :

Inductance is the property of an inductor and is defined as the ability of an inductor which opposes the change in current. It is denoted by a letter '**L**' and it's unit is ***Henry***.

The following figures shows the symbol & terminal identification of the *inductor.*

Figure: Terminal identification of an Inductor.

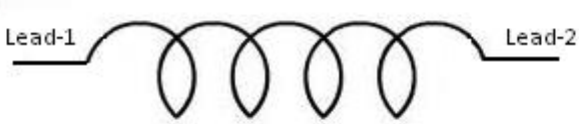


Figure: Symbol of a fixed type Inductor.

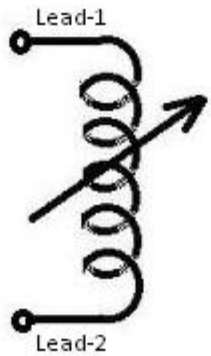


Figure : Symbol of a variable type inductor.

2.2). FACTOR AFFECTING THE INDUCTOR :

According to physical constructions the inductance of an inductor is given by,

$$L = \frac{1.2 \times 10^{-6} \times \mu_r \times N^2 \times A}{L_{ength}}$$

Where, N = Number of turns
A = Area of the coil
μ_r = Relative permeability
L = Inductance of the coil
L_{ength} = Length of the coil

The above formula shows, the inductance is directly proportional to the Number of turns, Area of the coil, Relative permeability, Inductance of the coil, L_{ength} = Length of the coil.

2.3). TESTING OF INDUCTOR :

It can tested by removing from the circuit. To test it followed the procedure given below,

1. Select the high resistance range in the DMM.
2. Connect the two probes of the DMM to the two leads of an inductor without considering the +Ve& -Ve polarities. Observe the following readings in DMM's display as per following table,

3.CAPACITOR :

Capacitance of a capacitor is the ability of a dielectric to store electric charge. It's unit is *FARAD* it is named after *Michael Faraday*. It blocks direct current and allows alternate current.

A capacitor is made of an insulator between two conductors. Here insulator means air or liquid solid. The insulator is separating the two plates of a capacitor is called *dielectric*.

Note :

1. If the value of the capacitor is less than the 1µF then it is not a polarity sensitive device. So we can connect it in any direction in the circuit.
2. If the value is 1µF or above 1µF then it is a polarity sensitive device. So we can consider the +ve&-ve polarities while connect in the circuit.

The following figure shows the symbols of a capacitor,

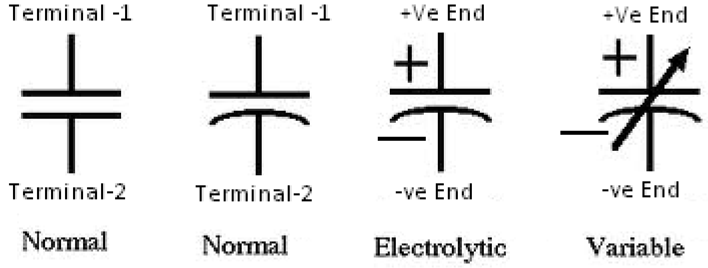


Figure: Symbols of a capacitor.

3.1 TYPES OF A CAPACITOR :

The capacitors are classified either according to the *shape of conductor* or *dielectrics*. According to shape of conductor, the capacitors types are,

1. Parallel plate capacitor 2. Spherical capacitor,
3. Cylindrical capacitor 4. Parallel wire capacitor, etc.

According to the *dielectric material*,

1. Air capacitor 2. Paper capacitor 3. Mica capacitor
4. Ceramic capacitor 5. Electrolytic capacitor 6. Plastic film capacitor.

Air capacitor : These are constructed with meshed plates. They are available in the range of 10pF – 40pF.

Paper capacitor: It is constructed with two rolls of tinfoil conductor separated by a tissue paper insulator. It's range is 0.001µF – 1µF.
Mica capacitor: It is made up of stacked sheets and offer capacitance in the range of 10nF – 5nF.
Ceramic capacitor : It is made up of tubular conductors or disks and a material of *ceramic.* It's available capacitance range is 0.002µF – 1600pF. It is also called *disk type capacitor*.
Electrolytic capacitors : These are made up of Aluminum or *tantalum* materials. Available in the range of 5µF - 1000µF. It's common application is to eliminate 50Hz. AC ripple in a DC power supply.
Plastic film capacitor: It is made by using *rolled foil* and offering in the range of 0.001µF - 1µF.

3.2 SPECIFICATIONS OF CAPACITORS :

The main specifications of a capacitor are as follows,
Value of capacitance: This ia the value of the capacitor expressed in *Farads.* This value is printed on the capacitor body itself.
Voltage rating : The voltage rating is very important in the sense, that it determines the maximum voltage that a capacitor can with stand without being destroyed. This value can printed on its body.
The other specifications are,

1. Tolerance
2. Temperature Co-efficient
3. Leakage current
4. Frequency range
5. Dielectric constant
6. Dielectric strength.
7. Power factor
8. Stability.

3.3 TERMINAL IDENTIFICATION OF A DIFFERENT TYPES OF CAPACITORS :

The terminal terminalidentification of different types of capacitors are given below,

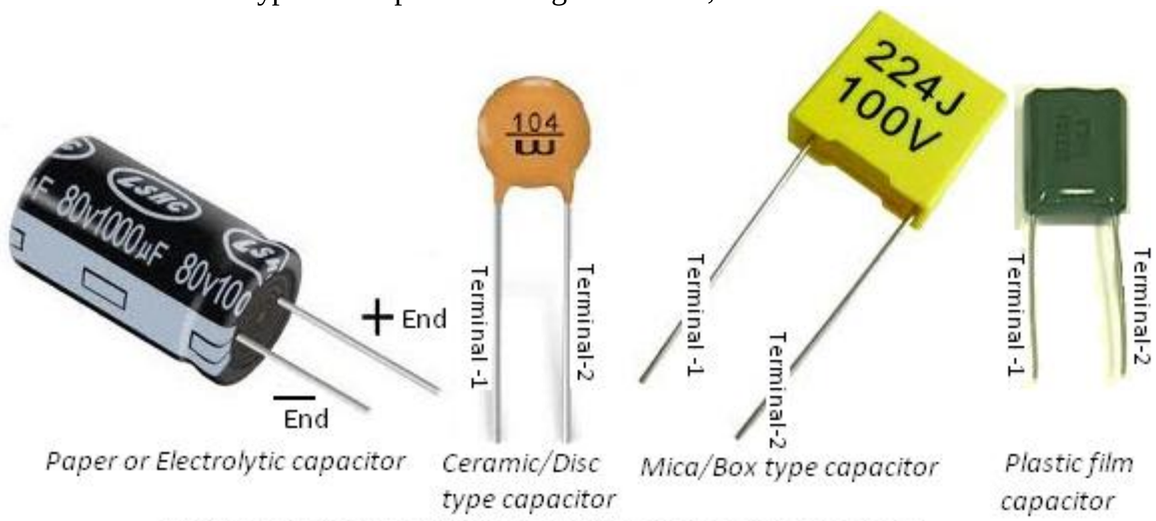


Figure: Terminal identification of different type of a capacitors.

3.4 TESTING OF CAPACITORS :

The capacitor can be open or short, In both cases they are not useful as they cannot store charge. A good capacitor has high resistance. It is of the order of MΩ. It can tested by *Digital Multy Meter(DMM).* Testing is done by disconnecting it from the circuit. To test it the following procedure must be follows,

1. Select the maximum resistance in DMM
2. Connect the two probes of the DMM's to the two leads(ends/terminals) of capacitor without considering the +ve& -ve polarities. Observe the following readings in DMM to find the which one is normally working or not.

Sl.No.	Indicating in DMM	Remarks
1	Small resistance	Open
2	Zero resistance	Burned
3	Low resistance and quickly moves towards high resistance	Working normally

3.5 GANG CONDENSER :

The combination of more than one capacitor are connected together is called *Gang condenser*. It is example of variable capacitor. Uses mainly in frequency tuners to select the required frequencies. Mainly uses in Radios & TV's to select the required relay stations and channels respectively.

Symbol & terminal identification of this device is as follows,

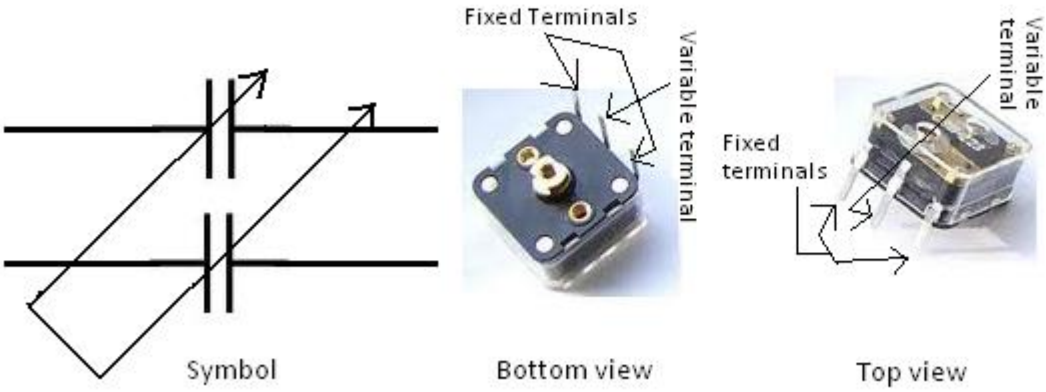


Figure: Symbol & Terminal identification of a *Gang condenser.*

3.6 SPECIFICATIONS OF A GANG CONDENSER :

The specifications are same as explained under the heading of *specifications of a capacitor* .

4. COILS :

A length of wire arranged into a senses of circles, one above the other is called the *Coil* . A coil is a twisted length of wire through which an electric current travels. Generally coil is nothing but inductor.

The symbol & identification of a coil is given below,

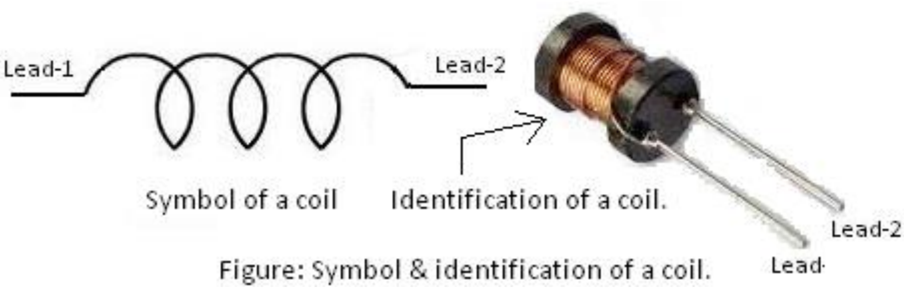


Figure: Symbol & identification of a coil.

4.1 SPECIFICATIO0NS OF A COIL :

Specifications of a coil is given below,

$$L = \frac{1.2 \times 10^{-6} \times \mu_r \times N^2 \times A}{L_{ength}}$$

Where, N = Number of turns
A = Area of the coil
μ_r = Relative permeability
L = Inductance of the coil
L_{ength} = Length of the coil

The above formula shows, the inductance is directly proportional to the Number of turns, Area of the coil, Relative permeability, Inductance of the coil, L_{ength} = Length of the coil.

5 RELAYS :

A *Relay* is an electrically operated switch controlled by a current. Electro magnetic relays are activated by a current that passes through a coil to create a magnetic field. This magnetic field exerts the same attractive on near by ferromagnetic materials as would the field of a permanent magnet. If this force is use to attract and move a pivoted piece of metal called an armature, and if the motion of this armature is used to open and close electric contacts. This assembled is called an *Electromagnetic relay*.

5.1 TYPES OF RELAYS :

Relays are classified according to,

Phenomena(Operating principle):

1. Thermal relays. 2. Electromagnetic relays.
3. Solid state relays. 4. Hybrid relays (Combination of 2 & 3)

Electrical parameters:

1. Current relays 2. Voltage relays 3. Power relays 4. Frequency relays.

Polarity convention:

1. Polarized relays. Ex. Telegraph relays. 2. Non polarized relays Ex. Telephone relays.

5.2 SPECIFICATIONS OF RELAYS :

The following are the specifications of a relay,

1. Contacts. 2. Contact rating. 3. Contact material. 4. Max. operating temperature.5. 5. Voltage & current requirements. 6. Operate & release time.

The following figures shows the symbol & identification of a relay,

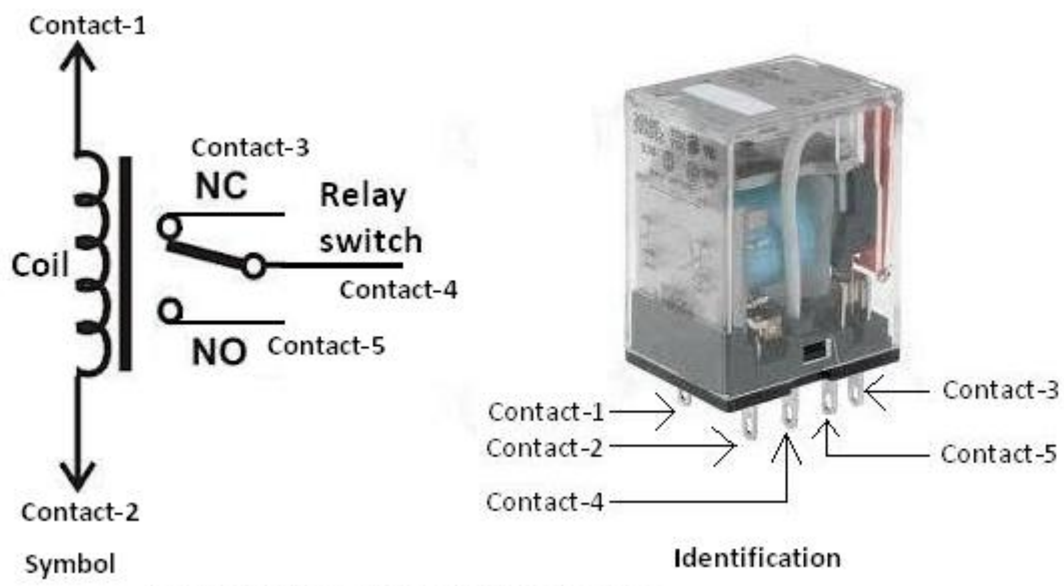


Figure: Symbol & Identification of a relay.

6. BREAD BOARD :

It is used for testing the circuit. While connecting the circuit to a another board OR PCB(Printed Circuit Board), it is a necessary to check that circuit in a bread board. The figure of the bread board is given below,

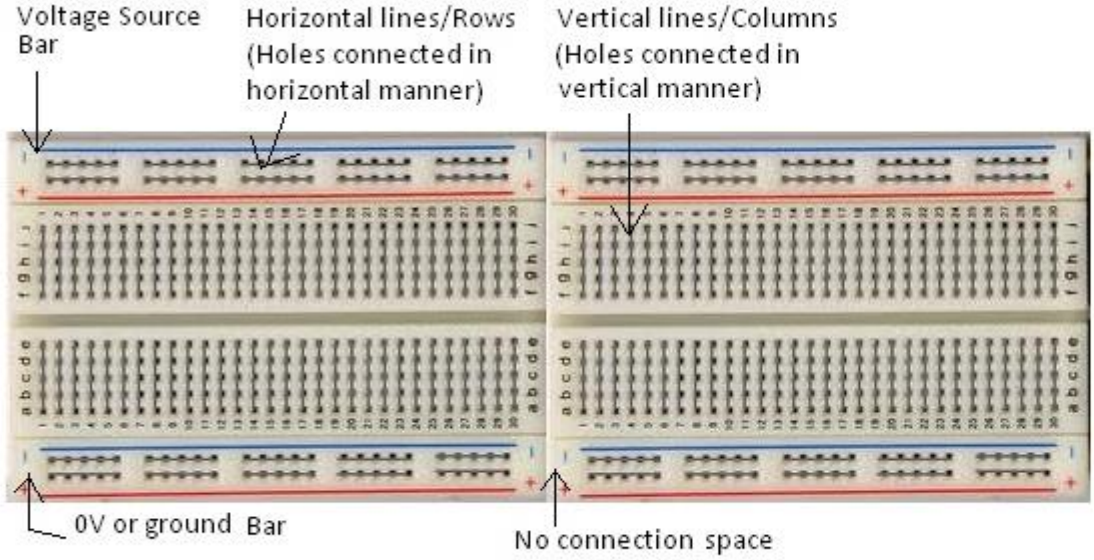


Figure: How the holes in a bread board are connected electrically

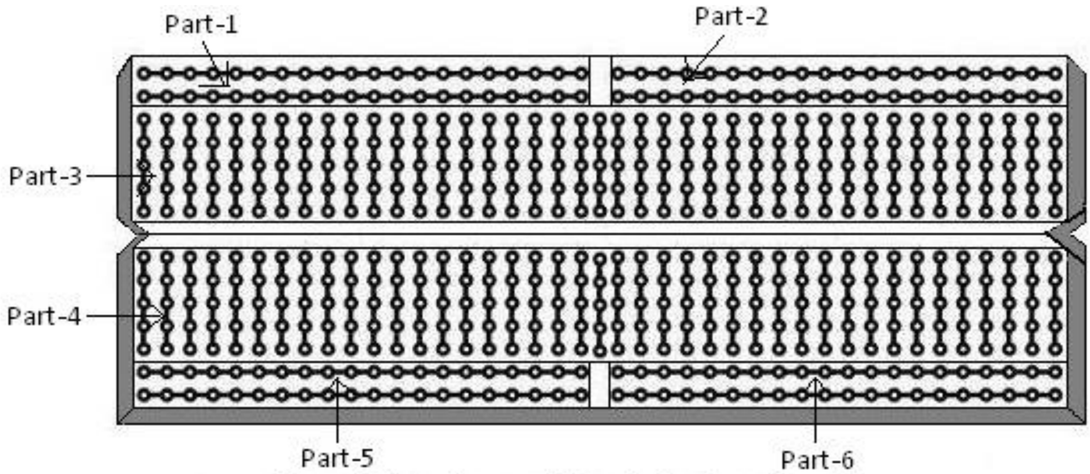


Figure: Internal connections in the bread board

In the above two figures, the horizontal lines are treated as *rows* and vertical lines are *columns*. Part-1, part-2, part-5 & part-6 are consists of horizontal lines/rows, and part-3, part-4 are vertical lines/columns.

In we observed in the figure No.2, in part-1, part-2, part-5, part-6 the holes are connected in horizontal. Therefore if we connected voltage source to these parts the current is passed through them as horizontal manner. If we observed, there is no connection in between part-1 & part-2. It means the current is not flow from part-1 to part-2. If we require to pass the current in between these parts, it is a need to connect a connecting wire in between them.

In part-1 and part-2 two horizontal lines are available. There is no connection in between them in each part. The same principle is applicable for part-5 & part-6.

In part-3 & part4 the holes are connected in vertical manner. Therefore if we connected voltage source to these parts the current is passed through them as vertical manner. If we observed, there is no connection in between part-3 & part-4. It means the current is not flow from part-3 to part-4. If we require to pass the current in between these parts, it is a need to connect a connecting wire in between them. In part-3 and part-4 no. of vertical lines are available. There is no connection in between them in each part.

Note: If we want to flow a current from any hole of any one of the part To a hole of any one of the part in the bread board, we require to connect the wire in between these two holes.

Rules to follow to give the connections in the bread board :

1). The voltage sources are to be connect in part-1&part2(*Voltage Source bars*).

2). The ground connections are in part-5&part6(*ground bar*).\

3). The remaining connections in the circuit are connected in the part-3 & part-4.

8. RESULT :

We have studied the identification, specifications, testing of R,L,C components, potentiometers, gang condensers, switches, coils, relays, transformers and bread board.

Experiment No. : 2 **Date :**

Name of the Experiment : IDENTIFICATION,SPECIFICATIONS AND TESTING OF ACTIVE DEVICES - DIODES, BJT's, LOW POWER JFET's, LED's, LCD's, SCR, UJT.

AIM :

Identification, Specifications and Testing of Active devices, diodes, BJT's, low power JFET's, LED's, LCD's, SCR, UJT .

APPARATUS :

1. Digital Multi Meter (DMM) ----------- 1 No.

COMPONENTS :

1. Diode PN
   a) Silicon 1N4007 ----------- 1 No.
   b) Germanium OA79 ----------- 1 No.
2. Zener Diode
   a) 9.1V,1W ----------- 1 No.
   b) 6.9V,1/2 W ----------- 1 No.
3. Bipolar Junction Transistors
   a) BC 547 (npn) ----------- 1 No.
   b) BC 557 (pnp) ----------- 1 No.
   c) BC 107 (npn) ----------- 1 No.
   d) CL 100/SL 100 (npn) ----------- 1 No.
   e) Power transistor 2N 3055 (npn) ----------- 1 No.
4. Junction Field Effect Transistor (JFET)
   a) BFW 10 ----------- 1 No.
   b) BFW 11 ----------- 1 No.
5. Uni Junction Transistor (UJT) 2N2646 ----------- 1 No.
6. Light Emitting Diode(LED)
   Red & Green color ----------- Each 1 No.
7. Seven segment display
   Common cathode & Common anode ----------- Each 1 No.
8. Liquid Crystal Display (LCD) ----------- 1 No.
9. Silicon Control Rectifier (SCR) Any one value ----------- 1 No.

1). DIODES:

Under this heading we can learn about the following components,

1. PN Junction Diode
2. Zener Diode.

1.1). PN JUNCTION DIODE:

The semiconductor diode is created by simply joining an n-type and a p-type material together. The PN-Junction Diode can consists the two leads(terminals) i.e.*anode* and *cathode*.

The following figure shows the symbol & identification of a *PN junction diode.*

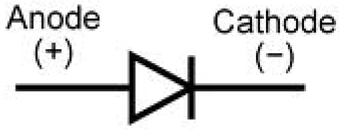


Figure: Symbol of a PN junction diode

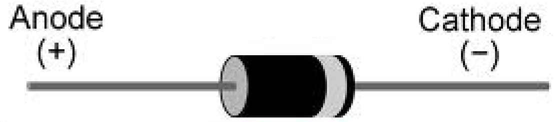


Figure: Terminal identification of a PN Junction diode.

In the above figure (b) the terminal which is nearest to the *white* coating material is called the *cathode* and remaining one is *anode*. The anode and cathode can represent by the letters A and K respectively.

1.1.1). SPECIFICATIONS OF PN JUNCTION DIODE :

To select a proper diode for a particular application the dada provided by the manufacturer must be considered. Some of the important specifications are listed below,

1. Maximum forward current (I_A) :

It is the maximum current in forward bias that a PN-Junction can conduct without damage to the junction.

2. Peak Inverse Voltage (PIV):

It is the maximum voltage that can be applied to PN-Junction without damage to the junction.

3. Reverse Break down Voltage (RBV):

The maximum reverse voltage at which diode may break down is called RBV.

4. Power rating:

That maximum power that a device can safely dissipate on a continuous basis in free air at 25ºC.

1.1.2). TESTING OF PN JUNCTION DIODE :

Testing of PN Junction diode is generally perform by the Multi Meter. Select the Diode testing mode in DMM. Connect the probes of DMM to the terminals of PN junction diode and observe the following readings in DMM as per given in the following table,

SI. No.	When diode connected in	Indicate by DMM	Remarks
1	Forward bias with DMM	1).In between 400Ω to 700Ω (for Silicon diode) **OR** In between 200Ω to 400Ω (For Germanium diode)	Working Normally
		2). 1 OR 0 (Either it is silicon or Germanium)	Open (Defective)
		3). <400Ω (For silicon diode) **OR** <200Ω (For Germanium diode)	Short (Defective)
2	Reverse bias with DMM	1). 1 OR OL (Either it is Silicon or Germanium)	Working Normally
		2). 0 or Some value rather than 1 **and** OL (Either it is Silicon or Germanium)	Defective

In the above table, if the diode is becomes *Working Normally* in biases, then it said to be the diode is working normally. Otherwise it is faulty one.

1.1.3). APPLICATIONS OF PN JUNCTION DIODE :

This device generally uses,

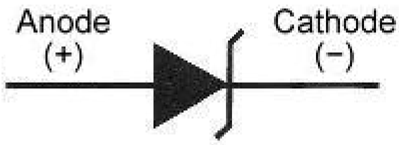
1. As a Switch
2. In Rectifier Circuits
3. In Regulator Circuit
4. Clipping & Clamping Circuits.

Examples:

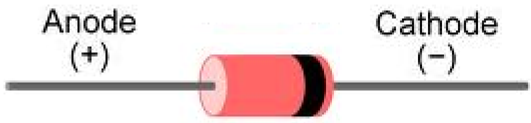
1. BY127 2.BZC 6:3 3.AA113 4.1N4007 5.OA79

1.2). ZENER DIODE:

The *Zener Diode* can consists the two leads (terminals) i.e. *Anode* & *Cathode* ..
The symbol and terminal identification of *Zener diode* is given as follows,



Figure(a): Symbol of a Zener diode



Figure(b): Terminal identification of a Zener diode.

In the above figure(b), the terminal which is nearest to the black coating material is called the *cathode* and remaining one is *Anode*. The anode and cathode can represent by the letters A & K respectively.

1.2.1). SPECIFICATIONS OF ZENER DIODE :

To select a proper Zener Diode for a particular application the dada provided by the manufacturer must be considered. Some of the important specifications are listed below,

Maximum forward current(I_A) :

It is the maximum current in forward bias that a PN-Junction can conduct without damage to the junction.

Peak Inverse Voltage(PIV) :

It is the maximum voltage that can be applied to PN-Junction without damage to the junction.

Reverse Break down Voltage(RBV) :

The maximum reverse voltage at which diode may break down is called RBV.

Power rating :

That maximum power that a device can safely dissipate on a continuous basis in free air at 25ºC.

1.2.2). TESTING OF A ZENER DIODE :

Testing of Zener Diode is generally perform by the Multi Meter. Select the Diode testing mode in DMM. Connect the probes of DMM to the terminals of Zener Diode and observe the following readings in DMM as per given in the following table,

SI.No.	When Zener diode connected in	Indicate by DMM	Remarks
1.	Forward bias with DMM	1**).** Low Resistance	Working Normally
		2). High Resistance (1 OROL)	Open (defective)
		3). Beep Sound OR < 200Ω	Short (defective)
2.	Reverse bias with DMM	1). 1 OR OL	Working normally
		2). 0 OR Some value rather than 1 and OL	Defective

In the above table, if the diode is becomes ***Working Normally*** in both biases, then it said to be the diode is working normally. Otherwise it is faulty one.

1.2.3). APPLICATIONS OF ZENER DIODE :

1). Uses in Voltage regulators

2). TRANSISTORS:

Here, we can discuss about the following transistors,

1. Bipolar junction Transistors (BJT)
2. Junction Field Effect Transistors (JFET)
3. Metal Oxide Semiconductor Field Effect Transistors (MOSFET)
4. Uni Junction Transistor (UJT)

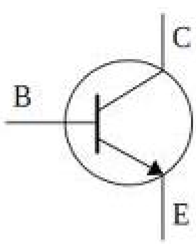
2.1). BIPOLAR JUNCTION TRANSISTORS (BJT) :

The transistor is a three-layer semiconductor device consisting of either two n- and one p-type layers of material OR two p- and one n-type layers of materials. The former is called the *npn* transistor and later is called the *pnp* transistor.

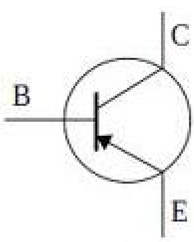
It can consists three terminals, they are, Emitter(E), Base(B) and emitter(E). In this transistor the holes and electrons participate in the injenction process into oppositely polarized material. So it is called the *Bipolar Junction transistor*. If only one carrier is employed (Electron or Hole),It is considered as a *Unipolar Device.*

Power Transistor*:* These transistors can delivers the high power. So it can useful where the high power can delivers. The symbol and specifications of this transistor is same as the BJT.

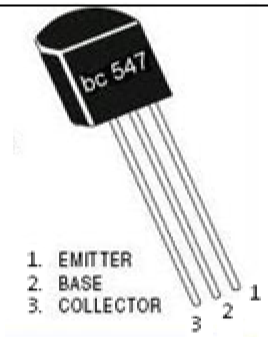
The following figures shows the symbol & terminal Identification for different types of the ***BJT's***.



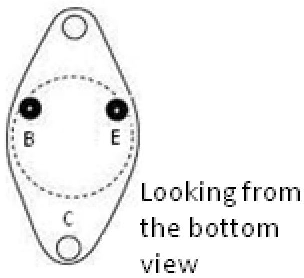
Figure(a): Symbol of a NPN Bipolar Junction Transistor (BJT).



Figure(b): Symbol of a PNP bipolar Junction transistor (BJT).



Figure(C): Terminal identification(front view) of a BJT BC 547



Figure(D): Terminal identification (back view) of the NPN Power transistor 2N3055

Figure(E): Front view of the NPN Power transistor 2N3055

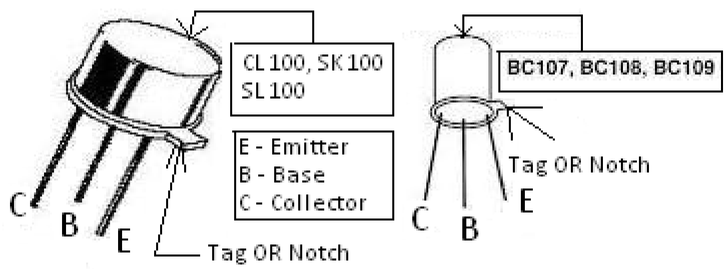


Figure: Terminal identification of different types of NPN BJT's.

2.1.1). SPECIFICATIONS OF BJT'S :

The following Specification parameters corresponding to maximum ratings of the BJT at which without destroying the ***BJT.***

SI. No.	Symbols	Meaning
1.	V_{CE}	Collector to emitter voltage
2.	V_{CB}	Collector to Base voltage
3.	V_{EB}	Emitter to Base voltage
4.	$V_{CE(BR)}$	Collector to Emitter Break down voltage
5.	$V_{CB(BR)}$	Collector to Base Break down voltage
6.	$V_{EB(BR)}$	Emitter to Base Break down Voltage
7.	$I_{C(OFF)}$	Collector cut-off Current
8.	$I_{E(OFF)}$	Emitter Cut-off Current
9.	$V_{CE(SAT)}$	Collector to Emitter Saturation voltage
10.	$V_{BE(SAT)}$	Base to emitter Saturation voltage

2.1.2). TESTING OF BJT :

The transistor can check by Ohm Meter, Multi Meters and Curve Tracers. But generally the transistor can check by Multi meters. So Here the method given to check the transistor by Digital Multi Mete(DMM). Select the diode mode in DMM, and connect the terminals (Base, Emitter and Collector) of transistor to DMM as per the following table,

SI. No.	To the Base	To the Emitter	To the Collector	For npn transistor if DMM shows in Ω		For pnp transistor if DMM shows in (Ohms)	
				Si	***Ge***	***Si***	***Ge***
1	+Veof DMM	-Ve of DMM	Open	400to 800	200 to 400	1 or OL	1 or OL
2	+Ve of DMM	Open	-Veof DMM	400 to 800	200 to 400	1 or OL	1 or OL
3	-VeofDMM	+Veof DMM	Open	1 or OL	1 or OL	400 to 800	400to 800
4	-Veof DMM	Open	+Veof DMM	1 or OL	1 or OL	400 to 800	400to 800
5	Open	+Veof DMM	-Veof DMM	1 or OL	1 or OL	1 or OL	1 or OL
6	Open	-Ve of DMM	+Ve of DMM	1 or OL	1 or OL	1 or OL	1 or OL

If the DMM is shown the all the reading for all conditions as per shown in the above table, then we can said the BJT is working normally. If it is fails to show any one of reading as per shown in the table then it is defective one.

2.1.3). APPLICATIONS OF BJT's:

The BJT 's are used in ,

1. Switches
2. Amplifiers.
3. Oscillator.
4. Inverter
5. Regulator
6. Water Level Indicator
7. Wave Shaping Circuits
8. Flip-Flops
9. Sweep Circuit
10. Alarm Circuit, etc.

The ***Power Transistor*** can uses in

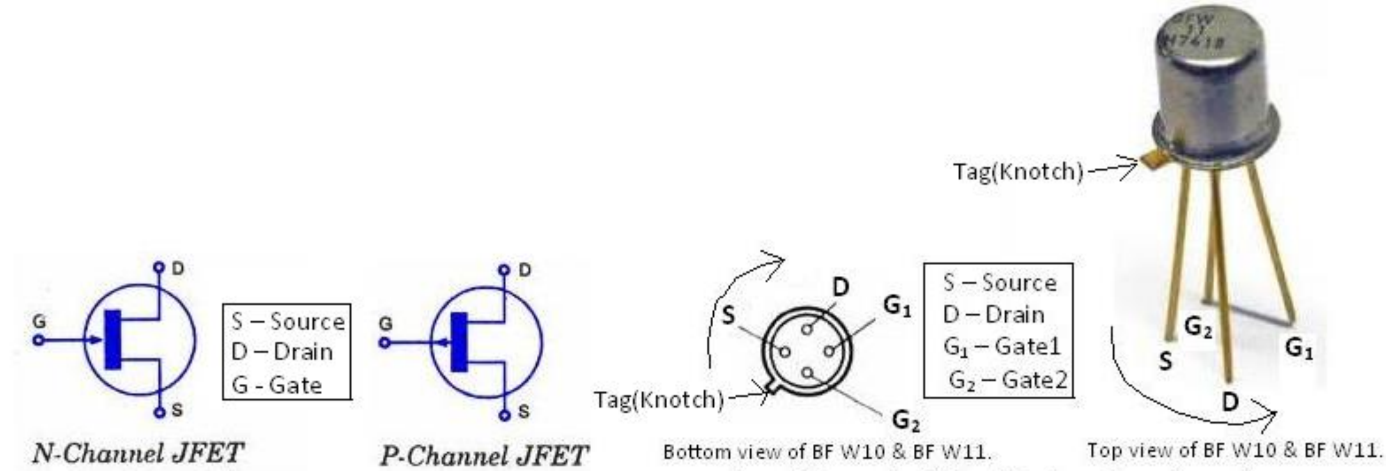
1. Regulated power supplies
2. Inverters

2.2). JUNCTION FIELD EFFECT TRANSISTOR (JFET):

The field effect transistor is a three terminal device used for a variety of applications. Those terminals are Source(S), Drain (D) and Gate (G). It is the voltage controlled device. The FET's are two types, they are,

1). n – Channel FET *2). p – Channel FET*

The FET is a *Uni polar* device depending solely on either *electron* (n – channel) or *hole* (p- channel) conduction. The following figure shows the symbol and terminal identification of ***JFET,***



Figure(a) : Symbols of N - channel & P - channel JFET. Figure(b): Terminal identification of N - Channel JFET.

SPECIFICATIONS OF JFET :

A few of the most important specifications are listed in the following. If the values against specifications are exceeded then the ***JFET*** can destroyed.

1. Drain – Source Voltage, $V_{DS\,(max)}$
2. Drain – Gate Voltage, $V_{DG(max)}$
3. Reverse Gate – Source Voltage, $V_{RGS\,(max)}$
4. Gate Current, $I_{G\,(max)}$
5. Total dissipation at $T_A = 25^oC$, $P_{D\,(max)}$

The specified maximum levels for V_{DS} and V_{DG} must not be exceeded at any point in the design operation of the device. The applied source V_{DD} can exceed these levels, but the actual level of voltage between these terminals must never exceed the level specified. The term reverse in V_{RGS} defines the maximum voltage with the source positive with respect to the gate (As normally biased for an n – channel device), before break down will occur. The total device dissipation at 25ºC (Room Temp) is the maximum power the device can dissipate under normal operating conditions.

TESTING OF JFET :

The JFET can test by disconnect from the circuit. It can test by using DMM or Ohmmeter or Curve Tracer. Here the method given is for by using DMM. Select the 200KΩ range in this DMM, connect the source, drain, gate of JFET to the probes of DMM as per given in the table, and observe the readings in DMM.

SI.No.	If source connected to	If drain connected to	If gate connected to	DMM readings
1	Open	-Ve of DMM	+Ve of DMM	High(1 or OL)
2	+Veof DMM	-Ve of DMM	Open	Low (<= 200Ω)
3	Open	+Ve of DMM	-Ve of DMM	High(1 or OL)
4	-Ve of DMM	+Ve of DMM	Open	Low (<= 200Ω)
5	-Ve of DMM	Open	+Ve of DMM	High(1 or OL)
6	+Ve of DMM	Open	-Ve of DMM	High(1 or OL)

If the DMM shows all the readings for all conditions as per shown in the above table, then it said to be a good one (working normally). Otherwise (if it is fails to show the reading for any one of the condition as per shown in the above table), it is defective one.

Note:For testing of P - channel FET , can apply the all above conditions in opposite method.

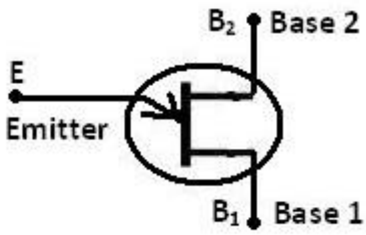
APPLICATIONS OF JFET's:

The JFET's are used in,

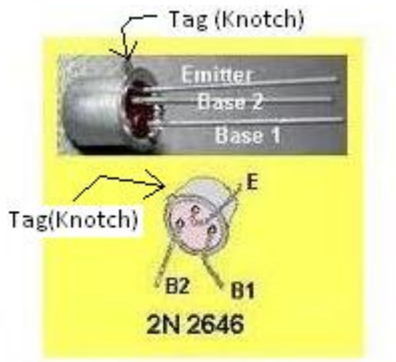
1. Digital and Analog switches.
2. Buffer Voltage amplifiers.
3. Very High resistance amplifiers.
4. Voltage controlled resistance devices.
5. Current sources.

UNI JUNCTION TRANSISTOR (UJT):

The UJT is a three-terminal device having the single junction .it is a –Ve resistance semiconductor device.The following figures shows the symbol and terminal Identification of *UJT,*



Figure(a): Symbol of a Uni Junction Transistor(UJT)



Figure(b): Terminal identification of a UJT

Note that in the above figure(a), the base terminals are opposite each other, where as the emitter terminal is between the two. In addition, the base terminal to be tied to the higher potential is closer to the extension on the lip of the casing.

SPECIFICATIONS OF UJT :

The specifications of the UJT is explained here under,

1) Inter base resistance (R_{BB})

This is the sum of r_{B1} and r_{B2} when I_E is zero. The typical value is 7KΩ.

2) Intrinsic stand off ratio

It is the **s**imply the ratio of $r_{B1}$to R_{BB} . The peak point voltage is determined from η
The supply voltage, and the diode voltage drop;

$V_P=V_D+ \eta V_{B1B2}$, Typical value is,0.65

3) Emitter Saturation Voltage $V_{EB(sat)}$

The emitter voltage when the UJT is operating in the saturation region of its characteristics; the minimum V_{EB1} level. Because of it is affected by the emitter current and the supply voltage, $V_{EB1(sat)}$ is specified for given I_E and V_{B1B2} levels.

Typical value is $V_{E(sat)}$= 2 V (when V_{BB} = 3 V, I_E =50 mA).

4) Peak Point Emitter Current (I_P)

I_P is important as a lower limit to the emitter current. If the emitter voltage source resistance is so high that I_E is not greater than I_P, the UJT will simply not trigger ON. The maximum emitter voltage source resistance is,

$R_{E(max)} = \frac{V_{B1B2} - V_P}{I_P}$, The typical value is --------- 0.044A (when V_{BB} =25 V)

5) Valley Point Current (I_V) :

I_V is important in some circuits as an upper limit to the emitter current. If the emitter voltage source resistance is so low that I_E is equal to or greater than I_V the UJT will remain on once it is triggered; It will not switch *off* so, the minimum emitter voltage source resistance is,

$R_{E(min)} = \frac{V_{B!B2} - V_{EB1(sat)}}{I_V}$, Typical value is 6 mA (when V_{BB} =20 V)

APPLICATIONS OF UJT :

UJT is widely used.

1. in non-sinusoidal oscillator circuits.
2. in trigger circuits.
3. in relaxation oscillator.
4. as fast switch
5. in sawtooth generators
6. For phase control
7. in timing circuits.
8. in bistable circuits
9. in current regulated circuits.
10. for firing silicon Rectifiers, etc.

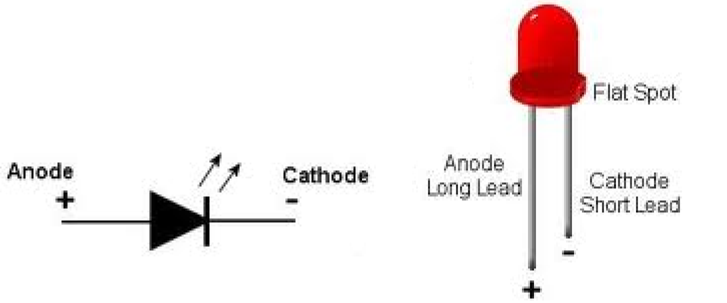
OPTO ELECTRONIC DEVICES:

Opto electronic devices emit light, modify light, have their resistance affected by light, or produce current and voltages proportional to light intensity. The names of some of these devices has been given below, LED's, LCD's, Seven segment Displays, Photo conductive cell, Photo Diode and Solar Cell, Photo Transistors and Opto couplers.

LED:

The full name of LED is **light emitting diode.** It is the 2 terminal device LED'scan be manufactured to produce light of virtually any color.

The symbol and terminal identification of LED is given below,



(a). Symbol (b). Terminal identification

Figure: Symbol & terminal identification of a LED.

In the above figure (b), the lengthiest lead is called the ***Anode*** and the smallest lead is called the ***Cathode***.

SPECIFICATIONS OF LED :

The specifications of ***LED'***s are listed below,

1. Luminous intensity (I_V at 20 m A).
2. Forward Voltage (V_F).
3. Reverse break down voltage (V_{VFBR}).
4. Peak forward current ($I_{F\,(max)}$)
5. Average forward current ($I_{F(av)}$)
6. Power dissipation (P_D).
7. Response Speed (t_s)
8. Peak wavelength

APPLICATIONS OF LED :

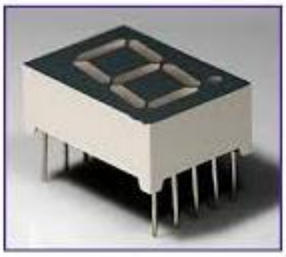
The ***LED's*** are typically used in indicating lamps and in numerical displays.

SEVEN SEGMENT DISPLAYS:

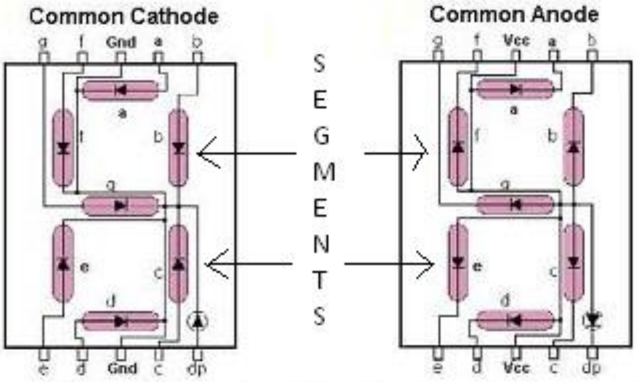
Generally LED's are two types, they are,

1). Common cathode
2). Common Anode.

The arrangement of a seven-segment LED numerical display is shown in the following figure,



Figure(b): Image of the 7 Segment display.



Figure(a): Terminal identification of 7 Segment display.

Any desired numeral from0 to 9 can be indicated by passing current through the appropriate segments. The relatively large amounts of current consumed by LED Seven-Segment Displays are their major disadvantage. Apart from this, LEDs have the advantage of long life and ruggedness.

APPLICATIONS OF 7 SEGMENT DISPLAY :

The ***Seven Segment displays*** uses in,

1. Counting System
2. Regulated Power Supplies

LIQUID – CRYSTAL DISPLAYS (LCD'S):

A liquid – crystal is a material (Namely organic for LCD's) that flows like a liquid but whose molecular structure has some properties normally associated with solids.

The LCD does not generate its own light, but depends on an internal or external source. Under dark conditions it would be necessary for the unit to have its own internal light source either behind or to the side of the LCD. During the day, or in lighted areas, a reflector can be put behind the LCD to reflect the light back through the display for *max. intensity.*

The advantage is,

- It can consumes the less power (In microwatts) than the LED's (In milli watts).

The disadvantages are,

- Limited to a temp. range of 0^oC to 60^oC.
- Lifetime is an area of concern, because LCD's can chemically degrade.

The applications are,

APPLICATIONS OF LCD's :

1). Calculators for display 2). Digital watches. 3). Digital multi meters.

The different types of LCD's images are shown below,

Figure(a): LCD TV

Figure(b): LCD display of 1 rupee telephone coin box.

THYRISTORS :

These devices can used in applications where high voltages and high powers we need. These are used in power electronics. The following devices are comes under this category. They are,

1. Silicon Controlled Rectifier (SCR). 2). DIAC 3). TRIAC.

SILICON CONTROLLED RECTIFIER (SCR) :

Because of its construction, the SCR is sometimes referred to as a four layer diode, OR a pnpn device. The layers are design rated p_1 , n_1 , p_2& n_2. They consists three junctions - J_1 , J_2& J_3 and three terminals – *Anode(A), Cathode(K) & Gate(G)*. It is a rectifier constructed of *silicon* material with a third terminal for control purposes. Silicon was chosen because of its high temperature and power capabilities.

It's state is controlled by the magnitude of the gate current. The forward bias voltage across the device will determine the level of gate current required to fire (turn *ON*) the device. The high the level of Of

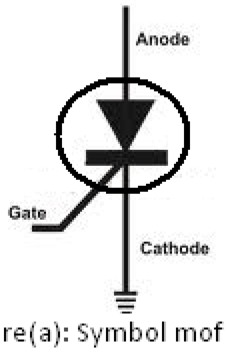
Biasing voltage, the less is the required gate current.

Examples: 2N5060, 2N6396, BT 151, C3 5N.

APPLICATIONS OF SCR: The SCR is uses in,

1). Relay controls. 2). Time delay circuits. 3). Regulated power supplies.
4). Static switches. 5). Motor controls. 6). Choppers.
7). Inverters. 8). Cycloid converters. 9). Battery chargers.
10). Protective circuits. 11). Heater controls. 12). Phase controls.

The following figures the symbol and terminal identification of the *SCR*.



Figure(a): Symbol mof a SCR

Figure(b): Terminal identification of a SCR

RESULT :

We have studied about the identification, specifications and testing of *Active devices.*

Experiment No. : 3 **Date :**

Name of the Experiment :SOLDERING PRACTISE – SIMPLE CIRCUITS
(Using active & passive components)

AIM :

To study and learn about the soldering practice.

APPARATUS:

1). Soldering iron	Any power rating	----	1 No.
2). Lead		----	A few gms.
3) Flux material (Soldering paste)		----	A few gms.

COMPONENTS:

1). Carbon resistors ----------	560Ω & 2.2kΩ	----	Each 1 No.
2). Pn Junction diode ----------	1N4007	----	1 No.
3). Connecting wires		----	A few Nos.

THEORY :

The soldering practice is where all the electrical connections between components leads and their corresponding printed circuit board and pad area are made this process involves he application of solder and a flux material to the board.

Definition of soldering :

In simple words, soldering is an alloying process between two metals (Lead, Tin)

OR

Soldering is the process in which two wires are connected to provide a conductive path for electricity.

METHODS OF SOLDERING PRACTICE :

Areas where connections are to be made, They are two methods in soldering practice namely,
1.Manual soldering or hand soldering 2. Mass soldering or automatic soldering.
They are,

1.Manual soldering or hand soldering : This is also known as iron soldering. In this soldering iron is used.

2. Mass soldering or automatic soldering : It is incorporates those techniques by which large no.of joints are made using a path. The various techniques applies of this methods. The various names of different techniques are given below,

1.Dip soldering 2.Drag soldering 3.Wave soldering.

SOLDERING TECHNIQUES :

There are 4 types of soldering techniques are given below,

1.Hand soldering : It is also known as iron soldering. This is the most common method used for small batches and the pre-working of faulty PCB's. By definition each solder joint is created separately which that the quality of soldering can vary across a board.

2.DIP soldering : This is the technique where the PCB is brought into contact with the surface of a Melton solder path.

3.Drag soldering : In this a conveyor system is used to move the PCB, so that it passes successively over a flux station. A flux drier and then over the surface of a long and narrow solder path.

4.Wave soldering: In this instead of lowering the boards on to a solder path, solder is pumped out of a narrow slot to create a standing wave in the solder path The boards after passing over the useful fluxing and drying sections are conveyed across crest of the solder wave. This is preferred usually in large scale production.

SOLDERING MATERIALS :

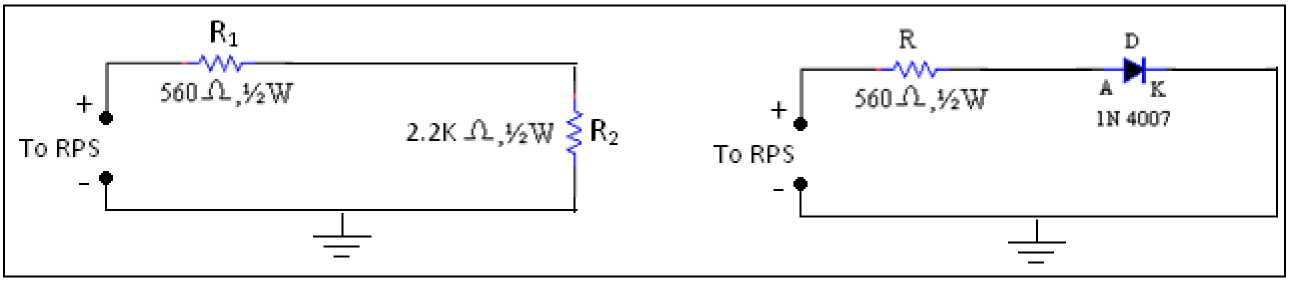
Two materials are required, such as solder (lead) and flux.

Solder is an alloy which has lower solidification temperature than any other ratio, that means lowest freezing point. Generally tin and lead or antimony or silver tin alloy is used as solder. According to their properties the melting point also varies.

Flux is a cleaning agent, which helps to clean the surface to be soldered. It must be a good conductor of heat so as to allow all area of a joint to reach soldering temperature uniformly. It removes and prevents the reformation of any metal oxide, sulphides which for the formation of a good solder joint. The flux material is a material which allows the solder to wet the material and prevents deoxidization of the metal. Flux , is known Zinc chloride. It may be mixed with ammonium or sodium chloride or tin chloride to lower the fusion point.

SIMPLE CIRCUITS FOR SOLDERING PRACTICE :

The simple circuits for soldering practice are given below,



RESULT :

We have studied and learned about the soldering practice.

Experiment No. : 4 **Date :**

Name of the Experiment : STUDY & OPERATION OF AMMETERS, VOLTMETERS, TRANSFORMERS, ANALOG & DIGITAL MULTIMETERS, FUNCTION GENERATOR AND REGULATED POWER SUPPLY (RPS)

AIM :

To study about the Ammeters, Voltmeters, Transformers, Analog & Digital Multimeters, Function Generator And Regulated Power Supply (RPS) & CRO

APPARATUS:

1). Ammeters	Any type & Any range	-----	1 No.
2). Voltmeters :	Any type & Any range	-----	1 No.
3). Transformers :	Centre tapped & Any value	-----	1 No.
4). Analog multi meter	Any range of value	-----	1 No.
5). Digital multi meterAny	Any range of value	-----	1 No.
6). Function generator	Any range of value	-----	1 No.
7). Regulated power supply (RPS)	Any range of value	-----	1 No.

COMPONENTS :

1) Carbon Resistors	Any Value	-----------------	2 No.
2) Capacitors	Any Value	-----------------	2 No.
3) Diode	IN4007	-----------------	1 No.
4) Transistors	BC547 NPN	-----------------	1 No.
	BC557 PNP	-----------------	1 No.

THEORY : Now we can discuss about the all above said meters & instruments as given below,

METERS :

Generally meters are used to measure the voltage or current quantities. According to the reading shows in which form the meters are two types, They are,

1. Analog meters
2. Digital meters.

1.Analog meters : These meters are used to measure the current or voltage in analogous form, which means the needle in that meter can tells the reading.

2. Digital meters : These meters are used to measure the current or voltage in digital form, which means the reading can display in digits i.e 23, 45.

According to the type of the quantity (AC or DC) measuring the meters are two types, They are,

1. AC meters
2. DC meters.

1.AC meters : These are used to measure the only AC quantity it means voltage or current readings.

2.DC meters : These are used to measure the only DC quantity it means voltage or current readings.

AMMETERS :

These meters uses to measure the current values either AC current or DC current. These are available in the market as analog or digital meters. We can identify the AC analog ammeters that the meter inside having the symbol of sine wave (~) for representation of AC quantity and symbol '***A*** 'for representation of current. As well as for DC analog meters, the meter inside having the symbol a straight line **(' –')** for representation of AC quantity and symbol

'***A*** 'for representation of current. But for AC digital & DC ammeters the manufacturer itself represented by ***AC A*** or ***DC A***. These are available in different ranges, Ex: (0-50)mA, (0-500)mA, (0-5)A.

VOLTMETERS :

These meters uses to measure the voltage quantity (values) either AC voltage or DC voltage. These are available in the market as analog or digital meters. We can identify the AC analog voltmeters that the meter inside having the symbol of sine wave (**~**) for representation of AC quantity and a symbol '***V*** 'for representation of voltage. As well as for DC analog meters, the meter inside having the symbol a straight line **(' –'**) for representation for DC quantity and symbol '***V*** 'for representation for voltage. But for AC digital & DC digital voltmeters the manufacturer itself represented by ***AC V*** or ***DC V***. These are available in different ranges, Ex: (0-2)V, (0-50)V,
(0-10)V.

The following figures shows the different types of bench panel meters.

Analog bench panel meters :

Figure: Identification of Analog AC ammeter

Figure: Identification of Analof DC Ammeter

Figure: Identification of Analog AC voltmeter

Figure: Identification of Analog DC voltmeter

Digital bench panel meters :

Figure: Identification of Digital AC ammeter

Figure: Identification of Digital DC ammeter

Figure: Identification of Digital AC voltmeter

Figure: Identification of Digital DC voltmeter

TRANSFORMER :

It works on the concept of flux linkage and mutual inductance. The transformer has primary and secondary windings. It transfers power from primary to secondary. It can be step-up or step down transformer.

Step –up transformer :It consists more no. of windings in the secondary side compare to primary side. It can uses to step-up to the applied primary voltage.

Step-down transformer : It consists less no. of windings in the secondary side compare to primary side. It can uses to step-down to the applied primary voltage

Centre tapped transformer :It can consists of a terminal in the middle of the transformer which can uses to divide the voltages at secondary side. The symbol & identification of a transformer is given below,

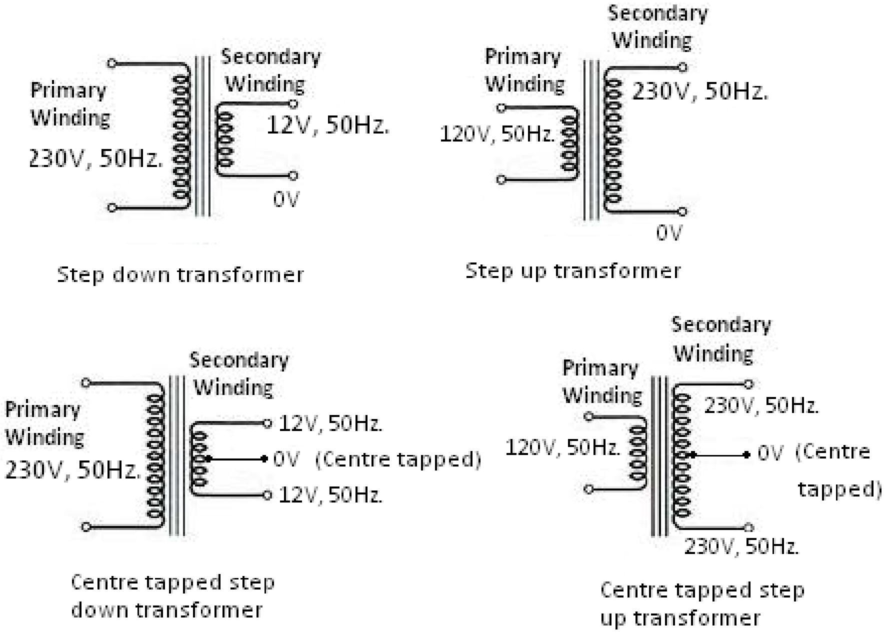


Figure: Symbols of different types of transformers.

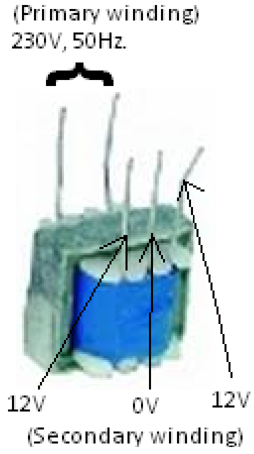


Figure: Identification of a centre tapped step down transformer

SPECIFICATIONS OF A TRANSFORMER :

The important specifications of a transformer are given below,

Primary voltage :Specifies the which value of voltage is to be apply to the primary winding of the transformer

Secondary winding : Specifies the which value of voltage the transformer gives at secondary winding.

Current rating :Specifies the maximum amount of the current it can deliver. It means up to how much of the load we can connect to it

.

MULTI METERS:

Generally the Multi Meters can uses to measure the Resistance, AC/DC Voltage and AC/DC Current. Now a days some meters are also supported to measure the Capacitance, Frequency and Continuity.There are two types of Multimeters. They are,

1. Analog Multi Meter
2. Digital Multi Meter.

ANALOG MULTI METERS:

These meters can shows the readings in analogous form. It means it can consist the separate scale for each three measurement quantities (Such as Resistance, voltage, and Current) and a needle. If the needle deflects and stops at particular position on the scale, then we can said that the position shown by the needle is the value of particular measurement quantity The front panel diagram of Analog Multi Meter is shown in next page,

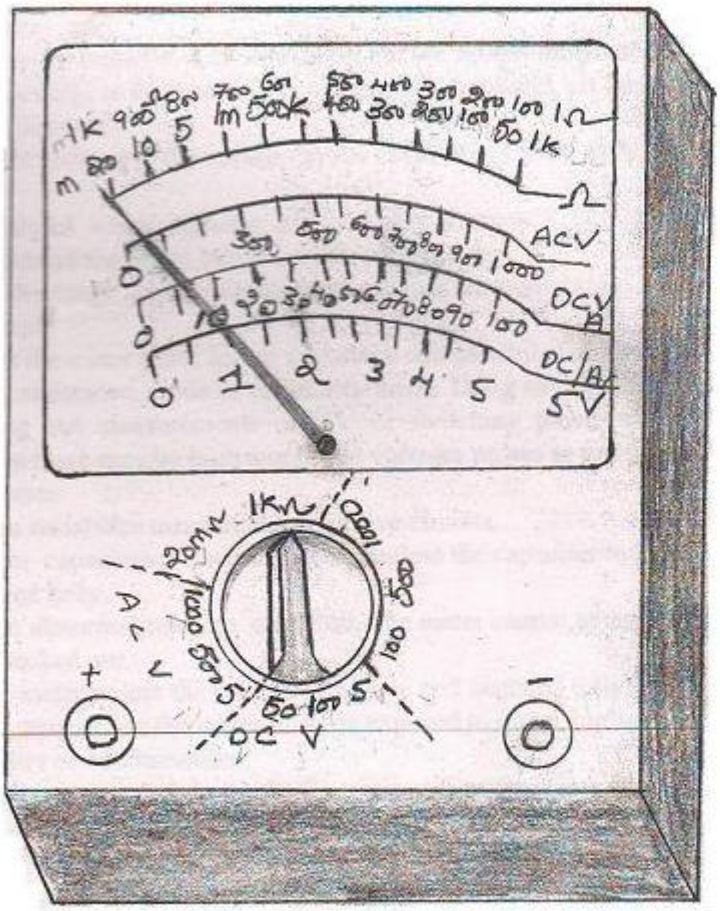


Figure: Front pannel diagram of Anolog multimeter.

DIGITAL MULTI METERS(DMM):

These meters shown the measurement readings in digital form, it means in digits

Safety Information: Follow all safety and operating instructions to ensure that the meter is used safely and is kept in good operating condition.

During Use:

1. Never exceed the protection limit values indicated in specifications for each range of measurement.
2. When the meter is linked to a measurement circuit, do not touch un used terminals.
3. When the value scale to be measured is unknown beforehand, set the range selector at the highest position.
4. Do not measure voltage if the voltage on the terminals exceeds 1000v above earth ground.
5. Always be careful when working with voltages above 60V DC or 30V AC rms, keep fingers behind the probe barriers while measuring.
6. Before rating the range selector to change functions, disconnect test leads from the circuit under test.
7. Never connect the meter leads across a voltage source while the function switch is in the current, resistance, diode or continuity mode. Dong so can damage the meter.
8. When carrying out measurements on TV or switching power circuits, always remember that there may be high amplitude voltages pulses at test points, which can damage the meter.

9. Never perform resistance measurements on live circuits.
10. Never perform capacitance measurements unless the capacitor to be measured has been discharged fully.
11. If any faults or abnormalities are observed, the meter cannot be used any more and it has to be checked out.
12. Never use the meter unless the rear case in place and fastened fully.

13. Please do not store or use the meter in areas exposed to direct sunlight, high temperature, humidity or condensation.
14. Always set the power switch to the OFF position when the meter is not in use.

Description: The following figure shows the front panel diagram of *Digital Multi meter (DMM).*

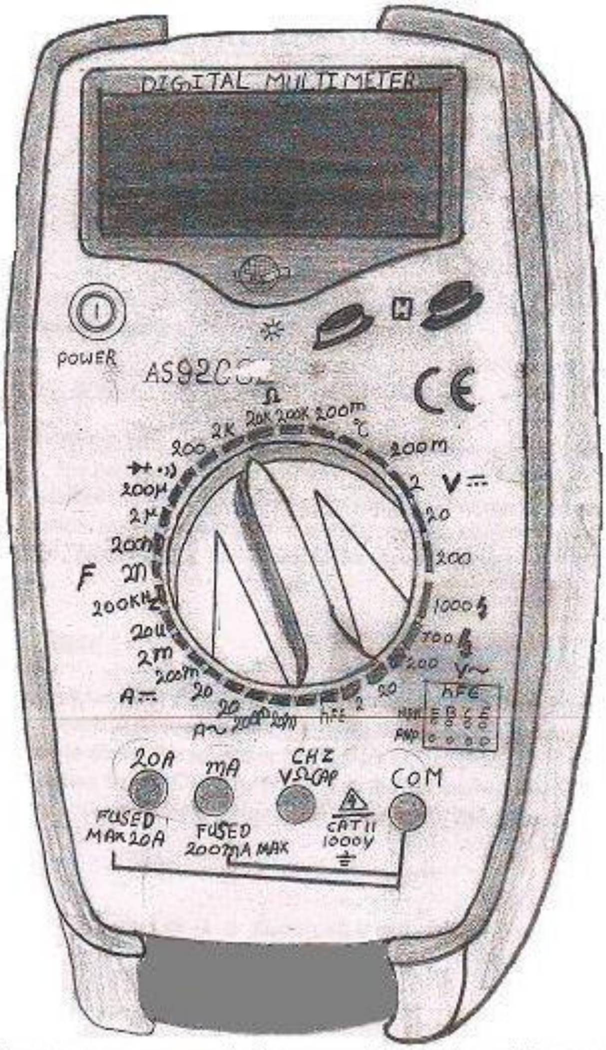


Figure: Front pannel diagram of Digital multimeter.

Function and Range Selector:

1). This meter has the function of preventing the test leads from wrong connecting. The input socket for red test lead is arranged with proper functions and ranges, when the transform switch can't be rotated, stop rotating. It means the selected range isn't suitable with position of the red lead socket. Pull out the red lead and then select the range required, this provides protection for meter to avoid damage by operating improperly.

2). A rotary switch is used to select functions as well as ranges.

OPERATING INSTRUCTIONS OF DMM:

Data Hold: If you need data hold when measuring, you can put on 'H', it will hold the reading; if you put the button again, data hold stops.

Back light: If the dark circumstance light makes the reading difficulty when measuring, you can put ON to open the back light.

Preparation for measurement:

1. Put ON the POWER button switch. If the battery voltage is less than 7V, display will shown [- +], the battery should be replaced at this time.
2. The ⚠ besides the input jack shows that the input voltage or current should be less than specification on the sticker of meter to protect the inner circuit from damaging.
3. Select a range properly for the item to be measured and set the rotary switch accordingly.

Measuring Voltage:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack.
2. Set the rotary switch at desired V------ (DC Position) or V~ (AC Position) range position.
3. Connect test leads across the source or load under measurement.
4. You can get reading on LCD. The polarity of the red lead connection will be indicated along with the voltage value when making DC voltage measurement.

Note:

1. When only the digit 1 or -1 is displayed, it indicates over-range situation and the higher range has to be selected.
2. When the value scale to be measured is unknown beforehand, set the range selector at the highest position.
3. It means you can't input the voltage more than 1000V DC or 7000V rms AC, it's possible to show higher voltage, but it may destroy the inner circuit.

Measurement of Current :

1. Connect the black test lead to **COM** jack and the red to mA jack. For a maximum 200mA current, for a maximum 20A current, move the red lead to the 20A jack.
2. Set the rotary switch at desired A----- (DC current position) or A~ (AC current position) range position.
3. Connect test leads in series with the load under measurement.
4. You can get reading on LCD. The polarity of the red lead connection will be indicated along with the current value when making DC current measurement.

Note:

1. When only the digit 1 or -1 is displayed, it indicates over-range situation and the higher range has to be selected.
2. When the value scale to be measured is unknown beforehand, set the range selector at the highest position.
3. The picture ⚠ means the socket mA's maximum current is 200mA and 20A's maximum current is 20A, over current will destroy the fuse.

Measurement of Resistance:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack
2. Set the rotary switch at desired **Ω** range position.
3. Connect test leads across the resistance under measurement.
4. You can get reading on LCD.

Note:

1. When only the digits 1 or -1 is displayed, it indicates over-range situation and the higher range has to be selected.
2. For measuring resistance above 1M Ω, the meter may take a few seconds to get stable reading.
3. When the input is not connected, i.e. at open circuit, the digit 1 will be displayed for the over-range condition.

4. When checking in-circuit resistance, be sure the circuit under test has all power removed and that all capacitors have been discharged fully.
5. At 200M Ω range, display reading is around 10 counts when test leads are shorted. These counts have to be subtracted from measuring results. For examples, for measuring 100M Ω Resistance, the display reading will be 101.0 and the correct measuring result should be 101.0-1.0=100.0M Ω.
6. When the value scale to be measured is unknown beforehand, set the range selector at the highest position.

Measurement of Capacitance:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack.
2. Set the rotary switch at the desired **F** range position.
3. Before inserting the capacitor under measurement into capacitance testing socket, be sure that the capacitor has been discharged fully.
4. You can get reading on LCD.

Transistor Test:

1. Set the rotary switch at $\mathbf{h_{fe}}$ position.
2. Determine whether the transistor under testing is NPN or PNP and locate the emitter, base and collector leads. Insert the leads into proper holes of $\mathbf{h_{fe}}$ socket on the front panel.
3. Read the approximate $\mathbf{h_{fe}}$ value at the testing condition of base current $\mathbf{I_b}$ 10μA and $\mathbf{V_{CE}}$ 3V

Diode Testing:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack. (The polarity of red lead is +).
2. Set the rotary switch position at the (Diode) range position.
3. Connect the red lead to the *anode* and the black lead to the *cathode* of the diode under the testing.
4. You can get the reading on the LCD.

***Note*:**

1. The meter will show approximate forward voltage drop of the diode.
2. If the lead connections are reversed, only the digit **1** will be displayed.

Continuity Test:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack. (The polarity of red lead is +).
2. Set the rotary switch position at the (Buzzer) range position.
3. Connect the test leads across two points of the circuit under the testing.
4. If continuity exists (i.e., resistance less than about 70 Ω), built-in buzzer will sound.

Note:

1. If the input open circuit, the digit **1** will be displayed.

Measurement of Frequency:

1. Connect the black test lead to **COM** jack and the red to **V/Ω/ CAP** jack. (The polarity of red lead is +).
2. Set the rotary switch position at the 20KHZ range position.
3. Connect the test leads across the source or load under measurement.
4. You can get the reading on the LCD.

Note:

1. Reading is possibly at input voltage above 10V r m s, but the accuracy is not guaranteed.
2. In noisy environment it is preferable to use shield cable for measuring small signal.

Measurement of Temperature :

1. Set the rotary switch at the ºC range position.
2. The LCD will shows the current temperature of the environment.

2). FUNCTION GENERATORS:

This is the equipment uses to generated the different types wave forms such as Sine wave, Square wave, Triangle wave and Saw tooth waves at different requirement of frequencies and amplitudes.

The following figure shows the Front Panel diagram of the *Function Generator*.

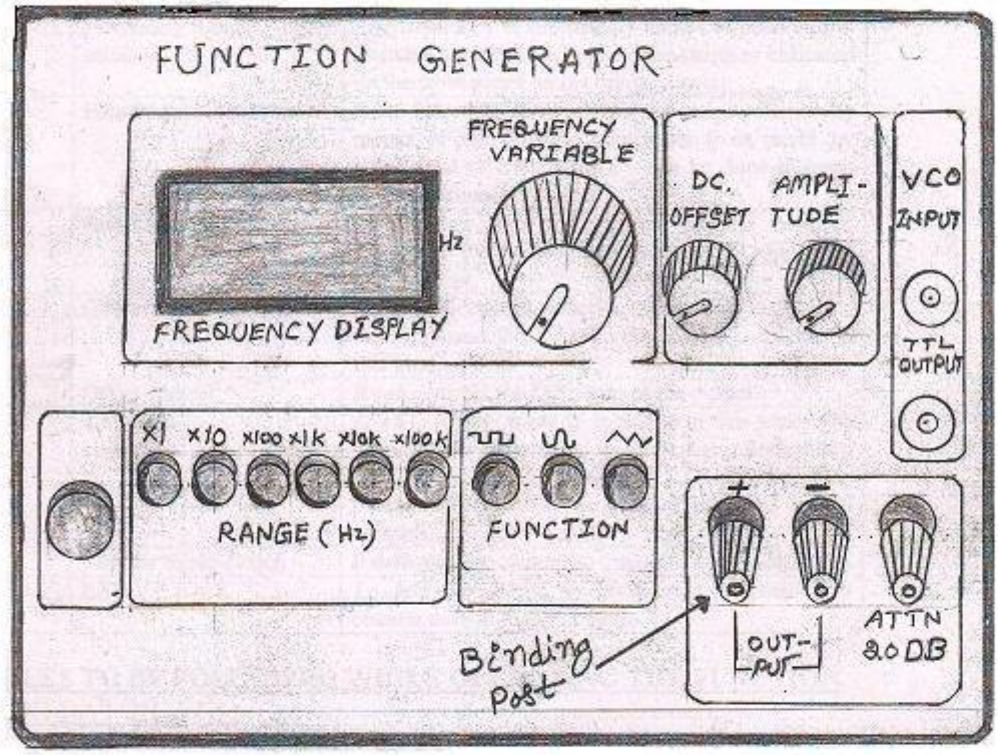


Figure: Front pannel diagram of the Function generator

OPERATIONAL CONTROLS OF THE FUNCTION GENERATOR:

The following table describes the working of the controls for Function Generator.

Sl.No.	Name of the Control	Description
1.	Power ON & OFF switch	By depressing this switch turns ON FG. To turn OFF push again and release.
2.	Function Selector	Select decide output signal by pressing the appropriate switch on the front panel which appears on the binding post on the front panel.
3.	Frequency Range selector	The frequency is selected by means of push button switches to select the appropriate range as indicated on the front panel on the digital display.
4.	Fine frequency control	After selection of the frequency range selector by means of the position switch on front panel by adjustment of the frequency can be done through this potentiometer control.
5.	Amplitude control	By varying this control can get the required amplitude for the output signal which appears at binding post.
6.	Output binding post	Signals selected by function switches as wells as the superimposed DC of set voltages are available at this binding point.
7.	Offset control	It can controls the DC offset of the output.
8.	TTL Jack	A TTL square wave is available at this jack. The frequency is determined by the range selected and this setting of the frequency. This output is independent of the amplitude and DC offset controls.

RULES TO BE FOLLOWED WHILE OPERATING THE FUNCTION GENERATOR(FG):

The following rules should be followed while operating the Function generator,

1. Always should keep the DC Offset Control at OFF position, otherwise the clipping may Occurs in output signal.
2. To get the amplitude of the signal in Volts, then take the output from the RED(Positive & BLACK terminals of the binding post, it means by decreasing or keeping the gain at 0 or 20dB.
3. To get the amplitude of the signal in milli Volts, then take the output from the GREEN(Positive) & BLACK (Negative) terminals of the binding post, it means by increasing or keeping the gain at 40 or 60 dB.

REGULATED POWER SUPPLY (RPS):

This equipment can uses to give power supply of DC voltage to the electronic circuits. Mostly these equipments used by scientists to investigate the new electronic circuits in their laboratories. It is just acts as Battery. It is abbreviated as RPS.

The following figure shows the front panel diagram of the *Regulated Power Supply.*

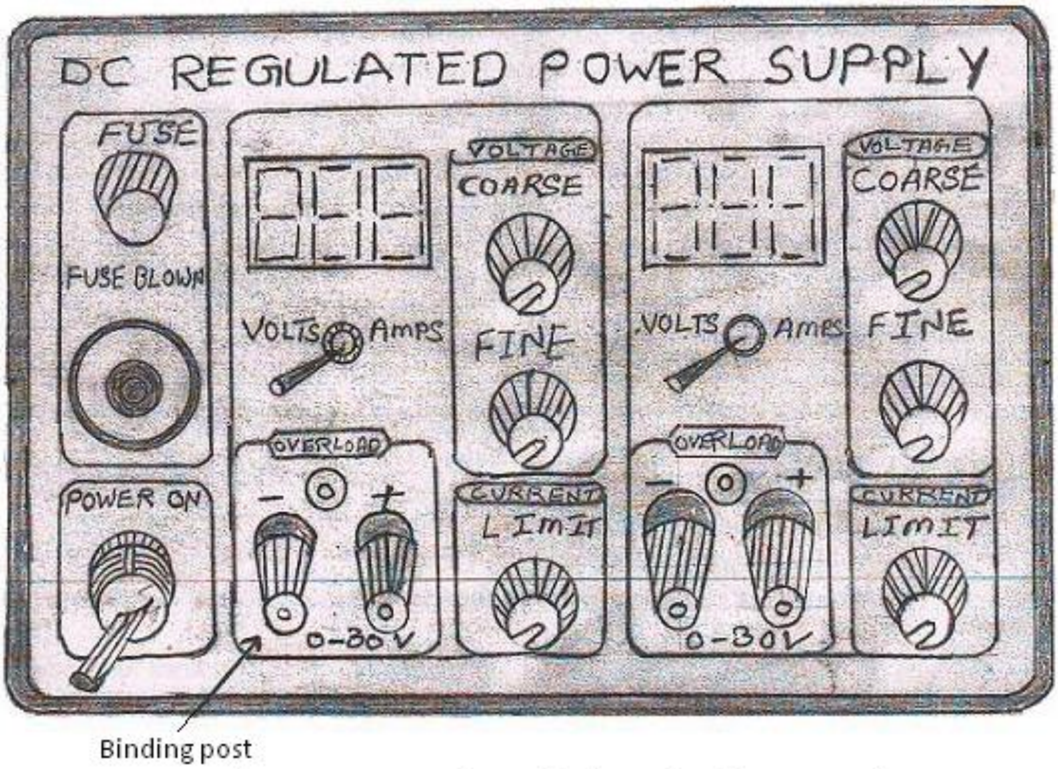


Figure: Front pannelcontrols of Regulated power supply.

OPERATIONAL CONTROLS OF THE REGULATED POWER SUPPLY:

The following table describes the working of the controls for Regulated Power Supply.

Sl.No.	Name of the Control	Description
1.	Power ON	Switch to connect instrument to mains supply.
2.	Voltage Course	Separate controls can available for both channels CH1 & CH2. By varying this control can get desired DC voltage in large variation in between 0 to 28V.
3.	Voltage Fine	Separate controls can available for both channels CH1 & CH2. By varying this control can get desired DC voltage in small variation in between 0 to 2V.

P.T.O

Contd….. Controls of the *RPS*

4.	Current Limit	Separate controls can available for both channels CH1 & CH2. Adjust the limit of maximum current that can be drawn by the load. Beyond the set current limit the power supply functions as a constant current source.
5.	Output Binding Posts 1. Red Binding Post: 2. Black Binding Post: 3. Green Binding post:	Uses to get the output voltages from the RPS. To get Positive output. Available for both channels i.e.CH1 & CH2. get To get the negative output voltage . Available for both channels i.e. CH1 & CH2. Chassis ground. Available for bother channels i.e. CH1 & CH2.
6.	Displays	Consisting two displays(Which are making by using seven segment displays) in both channels, i.e. CH1 & CH2. Uses to display the readings regarding to the Voltage & Current values.
7.	Selector Switch	Consisting two separate switches for both channels to select the voltage or current reading display in the seven segment displays.

INDICATORS AVAILABLE IN THE REGULATED POWER SUPPLY:

The following table describes the indicators available in the Regulated Power supply.

Sl.No.	Name of the Indicator	Description
1.	Over Load	Provided for both channels i.e. CH1 & CH2 glows when the load current reaches the maximum current set by the current limit control.
2.	Fuse Blown	Glows when the main supply fuse is blown.

RULES TO BE FOLLOWED WHILE OPERATING THE REGULATED POWER SUPPLY(RPS):

The flowing rules should be followed before switch ON the Regulated Power Supply,

1. Initially Keep the *voltage Course & Voltage fine controls* of RPS at minimum position. Later (After switch ON the RPS) can vary these controls slowly to get the required voltage.
2. Always keep the Current Limit control at maximum position, Otherwise the display can shows the constant voltage instead of varying.

TROUBLE SHOOTING WHILE OPERATING THE *RPS* :

The following trouble shooting can done while operating the RPS,

During connecting the RPS to the circuit and varying the Voltage Course & Voltage Fine Controls, If it displays the voltage as constant or above 30V then it can said that either the circuit is shorted OR the Current Limit control is not kept at maximum position.This problem can solve to prevent the circuit from shorted and by keeping the Current Limit control at maximum.

RESULT:

We have studied about the operation for the following equipments,

1. Ammeters
2. Voltmeters
3. Multi Meters
4. Function Generator(FG)
5. Regulated Power Supply(RPS).

PART – B

Laboratory experiments

Experiment No. : 1 **Date :**

Name of the Experiment : PN JUNCTION DIODECHARACTERISTICS (Using Germanium & Silicon diodes)

AIM : To study the V-I characteristics of the PN junction diode using germanium & silicon diode.

1). To obtain the Forward resistance.
2). To obtain the Reverse resistance.

APPARATUS :

1). Voltmeters :	a). (0 – 2)V	Digital / Analog	DC Type	----- 1 No.
	b). (0 – 50)V	Digital / Analog	DC Type	----- 1 No
2). Ammeters :	a). (0 – 50)mA	Digital / Analog	DC Type	----- 1 No.
	b). (0 – 2000)µA	Digital only	DC Type	-----1 No.
3). Regulated Power Supply (RPS) :	(0-30)V, 1A	Dual channel,		----- 1 No.
4). Bread board				----- 1 No.
5). Connecting wires :				----- A few Nos.

COMPONENTS :

1). PN Junction Diode Silicon (Si) 1N 4007 ------- 1 No.
Germanium (Ge) OA 79 ------- 1 No.
2). Carbon fixed resistor 560 Ω , ½ W -------- 1 No.
18 KΩ , ½ W -------- 1 No.

THEORY :

Definition: A p-n junction is an interface or a boundary between two semiconductor material types, namely the p-type and the n-type, inside a semiconductor. The p-side or the positive side of the semiconductor has an excess of holes and the n-side or the negative side has an excess of electrons.

A PN Junction Diode is one of the simplest semiconductor devices around, and which has the characteristic of passing current in only one direction only. ... By applying a negative voltage (reverse bias) results in the free charges being pulled away from the junction resulting in the depletion layer width being increased.

In a standard diode, forward biasing occurs when the voltage across a diode permits the natural flow of current, whereas reverse biasing denotes a voltage across the diode in the opposite direction

Depletion region or depletion layer is a region in a P-N junction diode where no mobile charge carriers are present. Depletion layer acts like a barrier that opposes the flow of electrons from n-side and holes from p-side.

The ideal diode equation is very useful as a formula for current as a function of voltage. However, at times the inverse relation may be more useful; if the ideal diode equation is inverted and solved for voltage as a function of current, we find: v(i)=ηVTln[(iIS)+1].

CIRCUIT DIAGRAMS :

A). Forward bias using silicon (Si) diode:B). Reversebias using silicon (Si) diode :

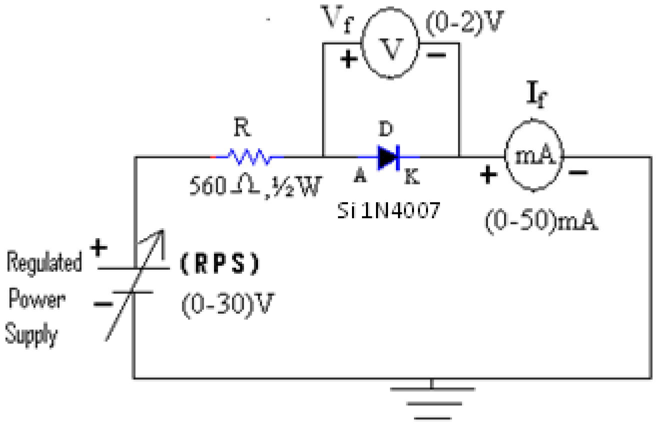


Figure: Circuit diagram of PN junction diode in forward bias using Silicon(Si) diode

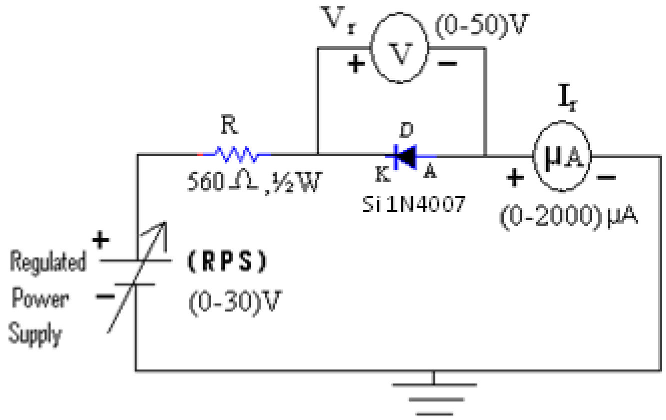


Figure: Circuit diagram of PN junction diode in reverse bias using Silicon(Si) diode

C). Forward bias using germanium(Ge) diode:

D). Reversebias using germanium(Ge) diode :

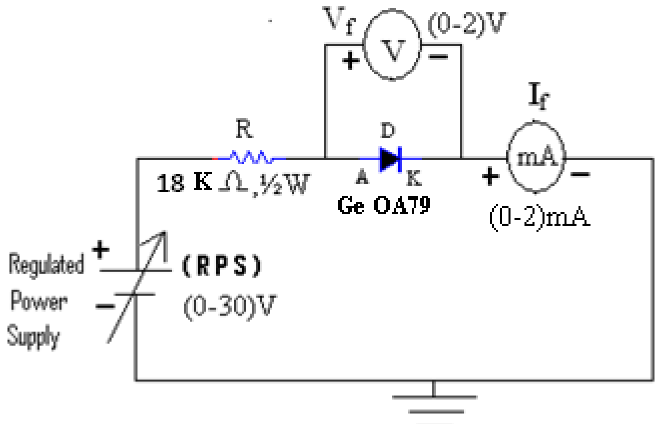


Figure: Circuit diagram of PN junction diode in forward bias using Germanium(Ge) diode

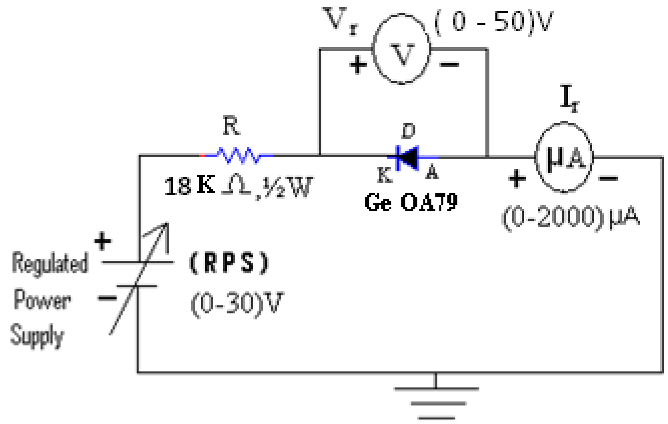


Figure: Circuit diagram of PN junction diode in reverse bias using Germanium(Ge) diode

PROCEDURE :

A). Forward bias using silicon (Si) diode:

1). Connected the circuit as shown in the circuit diagrams.

2). Connected the positive terminal of the RPS to the Anode(A), negative terminal of the RPS to the Cathode(C) of the diode respectively.

3). Then Switched ON the RPS and all the meters.

4). Varied the supply voltage (RPS voltage) in steps i.e. 0V, 0.2V, 0.4V, 0.6V, 0.8V, 1V, 1.2V,1.5V, 2V, 2.5V, 3V, 3.5V, 4V, 8V, 12V, 16V, 20V, 24V, 28V, 30V.

5). After completion of readings keep the RPS voltage at 0V immediately.

6). Switched OFF the RPS and all the meters.

7). Plotted the graph between *forward voltage*(V_f)on X-axis and *forward current* (I_f)on Y- axis.

8). Calculated the *static resistance* and *dynamic resistance* from the graph by using the formulasgiven under the heading of parameters.

B). Reversebias using silicon (Si) diode

1). Connected the circuit as shown in the circuit diagrams.

2). Connected the positive terminal of the RPS to the Cathode(C), negative terminal of the RPS to the Anode(A) of the diode respectively.

3). Then Switched ON the RPS and all the meters.

4). Varied the supply voltage (RPS voltage) in steps i.e. 0V, 1V, 4V, 8V, 12V, 16V, 20V, 24V, 28V, 30V.

5). After completion of readings keep the RPS voltage at 0V immediately.

6). Switched OFF the RPS and all the meters.

7). Plotted the graph between *reverse voltage* (V_r) on X-axis and *reverse current* (I_r) on Y- axis.

8). Calculated the *static resistance* and *dynamic resistance* from the graph by using the formulas given under the heading of parameters.

C). Forward bias using Germanium (Ge) diode :

1). Connected the circuit as shown in the circuit diagrams.

2). Connected the positive terminal of the RPS to the Anode(A), negative terminal of the RPS to the Cathode(C) of the diode respectively.

3). Then Switched ON the RPS and all the meters.

4). Varied the supply voltage (RPS voltage) in steps i.e. 0V, 0.2V, 0.4V, 0.6V, 0.8V, 1V, 1.2V,1.5V, 2V, 2.5V, 3V, 3.5V, 4V, 8V, 12V, 16V, 20V, 24V, 28V, 30V.

5). After completion of readings keep the RPS voltage at 0V immediately.

6). Switched OFF the RPS and all the meters.

7). Plotted the graph between *forward voltage*(V_f)on X-axis and *forward current* (I_f)on Y- axis.

8). Calculated the *static resistance* and *dynamic resistance* from the graph by using the formulas given under the heading of parameters.

D). Reversebias using Germanium (Ge) diode :

1). Connected the circuit as shown in the circuit diagrams.

2). Connected the positive terminal of the RPS to the Cathode(C), negative terminal of the RPS to the Anode(A) of the diode respectively.

3). Then Switched ON the RPS and all the meters.

4). Varied the supply voltage (RPS voltage) in steps i.e. 0V, 1V, 4V, 8V, 12V, 16V, 20V, 24V, 28V, 30V.

5). After completion of readings keep the RPS voltage at 0V immediately.

6). Switched OFF the RPS and all the meters.

7). Plotted the graph between *reverse voltage* (V_r) on X-axis and *reverse current* (I_r) on Y- axis.

8). Calculated the *static resistance* and *dynamic resistance* from the graph by using the formulas given under the heading of parameters.

TABULAR COLOUMNS :

A). Forward bias using silicon (Si) diode:

Sl. No.	Supply voltage(RPS voltage) In Volts.	Forward voltage(V_f) In Volts.	Forward current(I_f) In mA.
1	0.0		
2	0.2		
3	0.4		
4	0.6		
5	0.8		
6	1.0		
7	1.2		
8	1.5		
9	2.0		
10	2.5		
11	3.0		
12	3.5		
13	4.0		
14	8.0		
15	12.0		
16	16.0		
17	20.0		
18	24.0		
19	28.0		
20	30.0		

B). Reversebias using silicon (Si) diode :

Sl. No.	Supply voltage(RPS Voltage) In Volts.	Reverse voltage(V_r) In Volts.	Reverse Current (I_r) In µA
1	0.0		
2	1.0		
3	4.0		
4	8.0		
5	12.0		
6	16.0		
7	20.0		
8	24.0		
9	28.0		
10	30.0		

C). Forward bias using germanium (Ge) diode:

Sl. No.	Supply voltage(RPS voltage) In Volts.	Forward voltage(V_f) In Volts.	Forward current(I_f) In mA.
1	0.0		
2	0.2		
3	0.4		
4	0.6		
5	0.8		
6	1.0		
7	1.2		
8	1.5		
9	2.0		
10	2.5		
11	3.0		
12	3.5		
13	4.0		
14	8.0		
15	12.0		
16	16.0		
17	20.0		
18	24.0		
19	28.0		
20	30.0		

D). Reversebias using germanium dioede (Ge) diode :

Sl. No.	Supply voltage(RPS Voltage) In Volts.	Reverse voltage(V_r) In Volts.	Reverse Current (I_r) In μA
1	0.0		
2	1.0		
3	4.0		
4	8.0		
5	12.0		
6	16.0		
7	20.0		
8	24.0		
9	28.0		
10	30.0		

EXPECTED GRAPHS :

A). Forward bias using silicon (Si) diode:

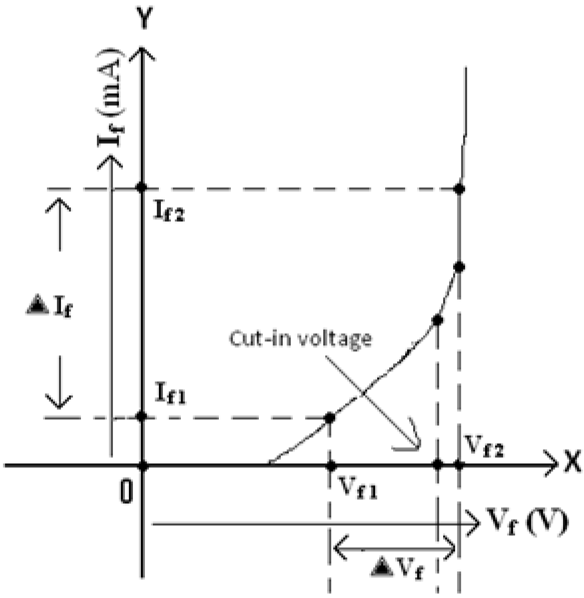


Figure: Forward bias characteristics of PN junction diode

A). Reverse bias using silicon (Si) diode:

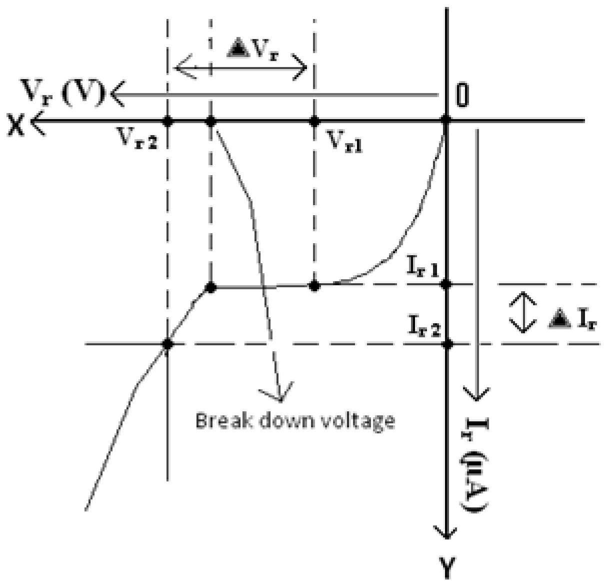


Figure: Reverse bias characteristics of PN junction diode

C). Forward bias using germanium (Ge) diode:

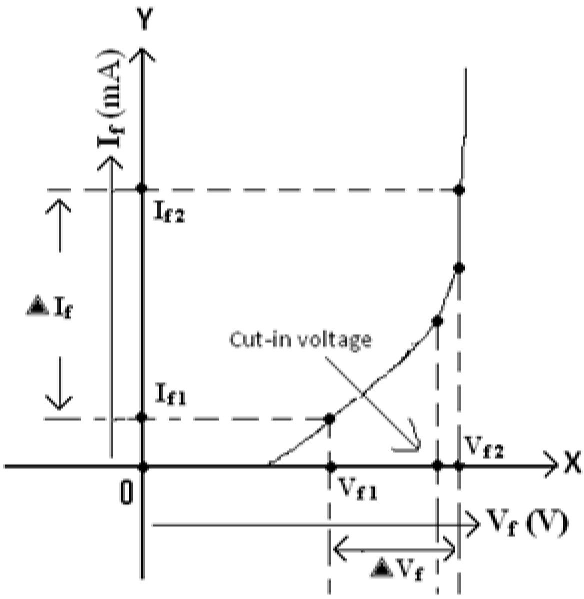


Figure: Forward bias characteristics of PN junction diode

D). Reverse bias using germanium (Ge) diode:

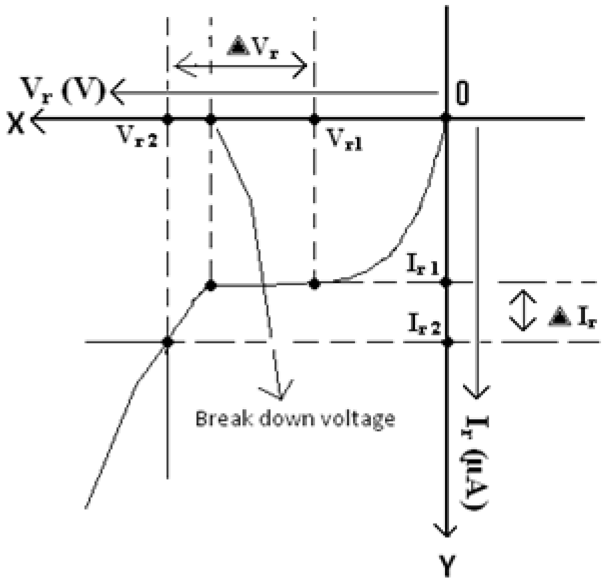


Figure: Reverse bias characteristics of PN junction diode

PARAMETERS :

A). Forward bias using silicon (Si) diode :

1). Static resistance : V_f / I_f =

2). Dynamic resistance : ▲V_f / I_f=

B). Reverse bias using silicon (Si) diode:

1). Static resistance : V_r / I_r =

2). Dynamic resistance : ▲V_r / I_r=

C). Forward bias using germanium (Ge) diode :

1). Static resistance : V_f / I_f =

2). Dynamic resistance : ▲V_f / I_f=

D). Reverse bias using germanium (Ge) diode:

1). Static resistance : V_r / I_r =

2). Dynamic resistance : ▲V_r / I_r=

RESULT :

We studied the V-I characteristics of *PN junction diode* in forward bias and reverse bias using silicon (Si) and germanium (Ge) diode.

VIVA VOCE Questions:

1. What is Semi Conductor?
2. What are the Classification of materials?
3. Explain Intrinsic and Extrinsic Semiconductors.
4. Define PN Diode.
5. What is the Cut- In- Voltage of Si and Ge Diodes?
6. Mention PN Junction Diode Applications.
7. What is the Diode current equation?
8. What is the Static Resistance?
9. What is the Dynamic Resistance?
10. What are the Temperature effects on PN Junction Diode?

Experiment No. : 2	**Date :**
Name of the Experiment : ZENER DIODE CHARACTERISTICS	

AIM :

1). To study the V-I characteristics of Zener diode
2). To obtain the regulation characteristics of a zener diode in the following conditions.
a). By varying the input (supply) voltage, b). By varying the load resistance.

APPARATUS :

1). Voltmeters : a). (0 – 10)V Digital / Analog DC Type ---- 1 No.
2). Ammeters : a). (0 – 50)mA Digital / Analog DC Type ---- 2 No.
3). Decade Resistance Box (DRB) ---- 1 No.
4). Regulated Power Supply (RPS) : (0-30)V, 1A Dual channel ---- 1 No.
5). Bread board ---- 1 No.
6). Connecting wires : ---- A few Nos.

COMPONENTS :

1). Zener Diode 1Z6.9V, 1W ---- 1 No.
1Z9.1V, 1W ---- 1No.
2). Carbon fixed resistor 560Ω (Ohm), ½W ---- 1 No.

THEORY :

Explanation

A Zener Diode, also known as a breakdown diode, is a heavily doped semiconductor device that is designed to operate in the reverse direction. When the voltage across the terminals of a Zener diode is reversed and the potential reaches the Zener Voltage (knee voltage), the junction breaks down and the current flows in the reverse direction. This effect is known as the Zener Effect.

Definition

A Zener diode is a heavily doped semiconductor device that is designed to operate in the reverse direction. Zener diodes are manufactured with a great variety of Zener voltages (Vz) and some are even made variable.

How does a Zener Diode work in reverse bias?

A Zener diode operates just like a normal diode when it is forward-biased. However, when connected in reverse biased mode, a small leakage current flows through the diode. As the reverse voltage increases to the predetermined breakdown voltage (Vz), current starts flowing through the diode. The current increases to a maximum, which is determined by the series resistor, after which it stabilizes and remains constant over a wide range of applied voltage.

There are two types of breakdowns for a Zener Diode:

- **Avalanche Breakdown**
- **Zener breakdown**

Avalanche Breakdown in Zener Diode

Avalanche breakdown occurs both in normal diode and Zener Diode at high reverse voltage. When a high value of reverse voltage is applied to the PN junction, the free electrons gain sufficient energy and accelerate at high velocities. These free electrons moving at high velocity collides other atoms and knocks off more electrons.

Due to this continuous collision, a large number of free electrons are generated as a result of electric current in the diode rapidly increases

This sudden increase in electric current may permanently destroy the normal diode, however, a Zener diode is designed to operate under avalanche breakdown and can sustain the sudden spike of current. Avalanche breakdown occurs in Zener diodes with Zener voltage (Vz) greater than 6V.

Zener Breakdown in Zener Diode

When the applied reverse bias voltage reaches closer to the Zener voltage, the electric field in the depletion region gets strong enough to pull electrons from their valence band. The valence electrons that gain sufficient energy from the strong electric field of the depletion region break free from the parent atom. At the Zener breakdown region, a small increase in the voltage results in the rapid increase of the electric current.

CIRCUIT DIAGRAMS :

A). VI Characteristics in reverse bias using 1Z6.9V & 1Z9.1V :

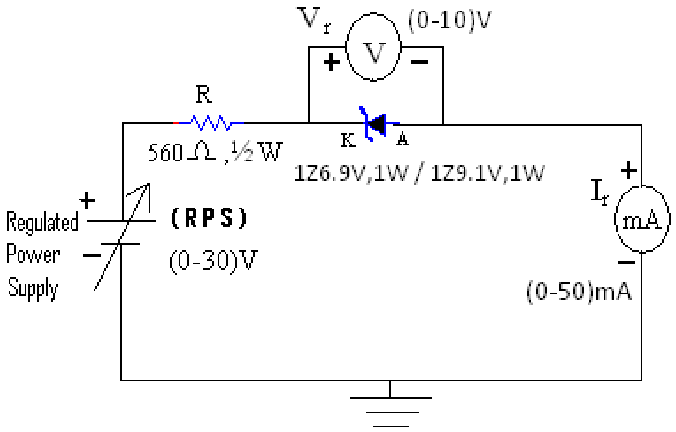


Figure: Circuit diagram of Zener diode in reverse bias using 1Z6.9V & 1Z9.1V

B). By varying input (supply) voltage using 1Z6.9V & 1Z9.1V :

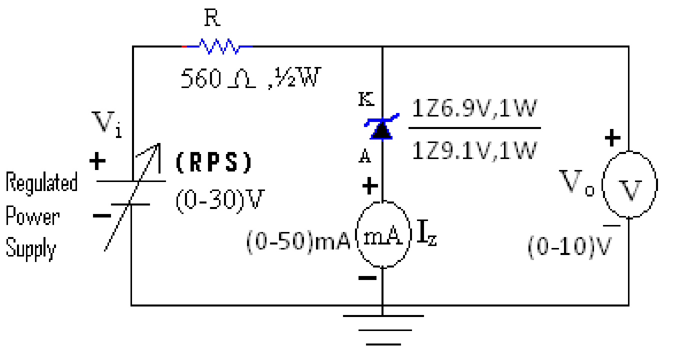


Figure: Circuit diagram of Zener diode as voltage regulator by varying input(supply) voltage using 1Z6.9V & 1Z9.1V.

C). By varying load resistance using 1Z6.9V & 1Z9.1V :

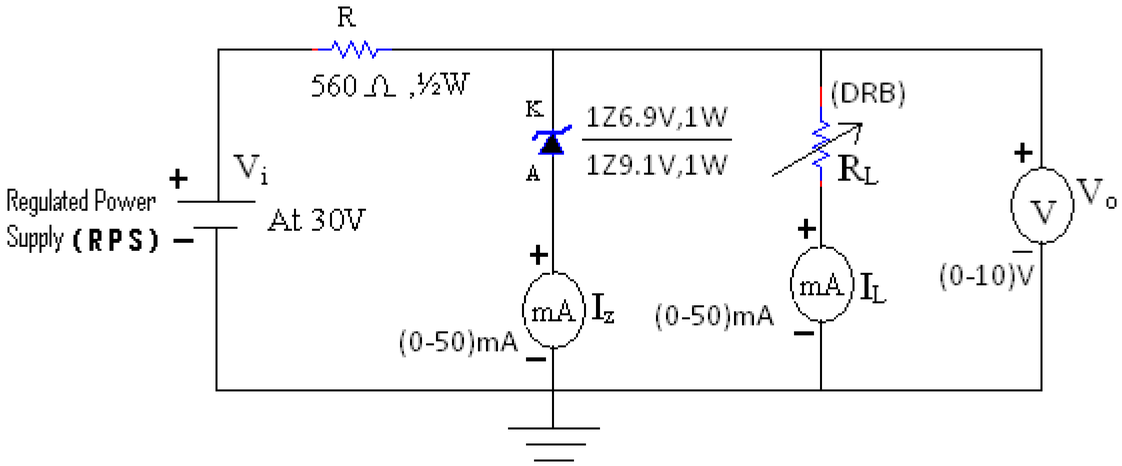


Figure: Circuit diagram of Zener diode as voltage regulator by varying load resistance using 1Z6.9V & 1Z9.1V.

PROCEDURE :

A). VI characteristics of Reverse bias for 1Z6.9V & 1Z9.1V:

1). Connected the circuit for diode *1Z6.9V* as shown in the circuit diagrams.
2). Connected the positive terminal of the RPS to the Anode(A), negative terminal of the RPS to the Cathode(C) of the Zener diode respectively.
3). Then Switched ON the RPS and all the meters.
4). Varied the supply voltage (RPS voltage) in steps i.e. 0V, 1V, 4V, 8V, 12V, 16V, 20V, 24V,28V, 30V and noted down the corresponding readings of voltmeter V_r(In volts) and millimeter I_r (In mA).
5). After completion of readings kept the RPS voltage at 0V immediately.
6). Then Switched OFF the RPS and all the meters.
7). Removed the diode 1Z6.9V from the circuit and connected the diode 1Z9.1V in the same place. But the remaining connections in the circuit are same.
8). Repeated the same procedure from step 2 to step 6 for diode 1Z9.1V.
9). Plotted the graph between *reverse voltage(* V_r) on X-axis and*reversecurrent (*I_r) on Y- axis in two separate graph sheets i.e. one for 1Z6.9V and another for1Z9.1V
10). Calculated the *static resistance* and *dynamic resistance* from each graph sheet by using the formulas which are given under the heading of parameters.

B). As voltage regulator by varying the Input (supply) voltage for 1Z6.9V &1Z9.1V :

1). Connected the circuit for diode *1Z6.9V* as shown in the circuit diagrams.
2). Then Switched ON the RPS and all the meters.
3). Varied the input voltage V_i (RPS voltage) in steps i.e. 0V, 2V, 4V, 6V, 8V, 10V,15V, 20V, 25V, 30V and noted down the corresponding readings of voltmeter V_O(In volts) and millimeter I_Z (In mA).
4). Up to the break down point the output voltage V_O will increase linearly withrespect to variation in the input voltage, after the break down voltage the output voltage V_O is constant.
5). After completion of readings keep the RPS voltage at 0V immediately.
6). Then Switched OFF the RPS and all the meters.

7). Removed the diode 1Z6.9V from the circuit and connected the diode 1Z9.1V in the same place. But the remaining connections in the circuit are same.
8). Repeated the same procedure from step 2 to step 6 for 1Z9.1V.
9). Plotted the graph between *input voltage (V_i)* on X-axis and *output voltage (V_O)* on Y- axis in two separate graph sheets one for 1Z6.9V and another for1Z9.1V

C). As voltage regulator by varying the load resistance for 1Z6.9V & 1Z9.1V :

1). Connected the circuit for diode *1Z6.9V* as shown in the circuit diagrams.
2). Then Switched ON the RPS and all the meters.
3). Kept the RPS voltage at constant value 30V up to the completion of readings.
4). Noted down the readings of Zener current (I_z), Load current (I_L) and Output voltage(V_O) by varying The load resistance in steps 90KΩ(Ohm), 60K Ω(Ohm),30KΩ(Ohm), 10K Ω(Ohm), 5K Ω(Ohm), 1KΩ(Ohm), 800Ω(Ohm), 600Ω(Ohm),400Ω(Ohm), 200Ω(Ohm), 100Ω(Ohm), 80Ω(Ohm), 60 Ω(Ohm), 40Ω(Ohm).

Note: i). The readings wouldnoted from down wards in the tabular form 90KΩ(Ohm) onwards as per mentioned above.
ii). Readings are noted very fast otherwise the components and equipment are connected in the circuit would damage.

5). After completion of readings kept the RPS voltage at 0V immediately.
6). Then switched OFF the RPS and all the meters.
7). Removed the diode 1Z6.9V from the circuit and connected the diode 1Z9.1V in the same place. But the remaining connections in the circuit are same.
8). Repeated the same procedure from step 2 to step 6 for 1Z9.1V.
9). Plotted the graph between *output voltage (V_O)* on X-axis and *load current (I_L)* on Y- axis in two separate graph sheets one for 1Z6.9V and another for 1Z9.1V

TABULAR COLOUMNS :

A). V-I Characteristics of Reverse bias using 1Z6.9V & 1Z9.1V :

Sl. No.	Input voltage (V_i) In Volts.	Reverse voltage (V_r) In Volts.		Reverse current(I_r) In mA.	
		Using1Z6.9V	Using 1Z9.1V	Using1Z6.9V	Using1Z9.1V
1	0.0				
2	1.0				
3	4.0				
4	8.0				
5	12.0				
6	16.0				
7	20.0				
8	24.0				
9	28.0				
10	30.0				

B). As voltage regulator by varying input (RPS) voltageusing 1Z6.9V & 1Z9.1V:

Sl. No.	Input voltage (V_i) In Volts.	Zener current (I_Z) in mA.		Output voltage (V_O) In Volts.	
		Using 1Z6.9V	Using 1Z9.1V	Using 1Z6.9V	Using 1Z9.1V
1	0.0				
2	2.0				
3	4.0				
4	6.0				
5	8.0				
6	10.0				
7	15.0				
8	20.0				
9	25.0				
10	30.0				

C). As voltage regulator by varying load resistance(R_L) using 1Z6.9V & 1Z9.1V:

Note: *Keep the input voltage (V_i) as constant as 30V.*

Sl. No.	Load Resistance (R_L) In KΩ / Ω	Zener current (I_Z) in mA.		Load current (I_L) In mA.		Output voltage (V_O) In Volts.	
		Using 1Z6.9V	Using 1Z9.1V	Using 1Z6.9V	Using 1Z9.1V	Using 1Z6.9V	Using 1Z9.1V
1	40Ω						
2	60Ω						
3	80Ω						
4	100Ω						
5	200Ω						
6	400Ω						
7	600Ω						
8	800Ω						
9	1 KΩ						
10	5 KΩ						
11	10 KΩ						
12	30 KΩ						
13	60 KΩ						
14	80 KΩ						
15	90 KΩ						

EXPECTED GRAPHS :

A). V-I Characteristics of Reverse bias using 1Z6.9V & 1Z9.1V :

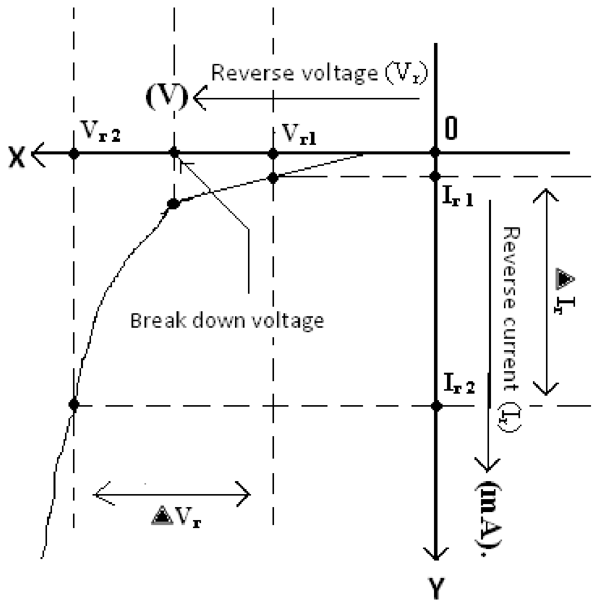


Figure: Reverse bias characteristics of Zener diode using 1Z6.9V

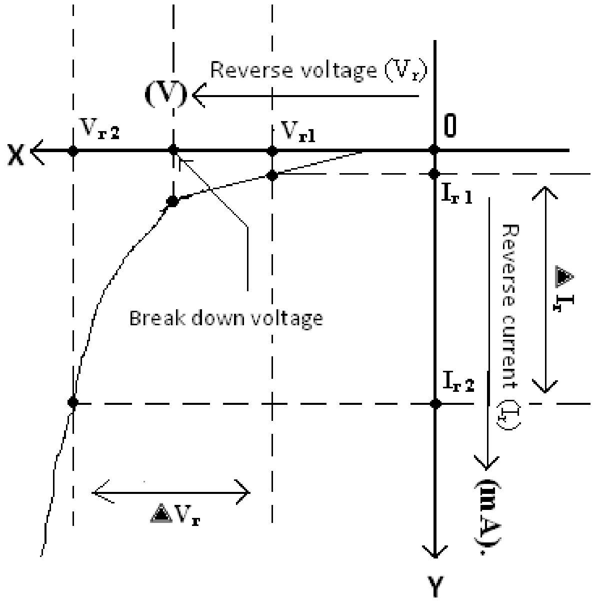


Figure: Reverse bias characteristics of Zener diode using 1Z9.1V

B). Regulation characteristics by varying input voltage using 1Z6.9V:

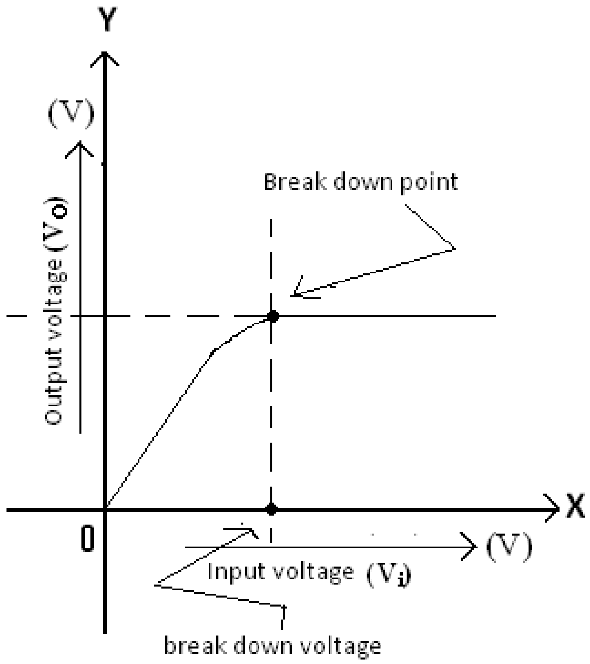


Figure: Regulation characteristics of zener diode by varying supply voltage using 1Z6.9V

C). Regulation characteristics by varying input voltage using 1Z9.1V:

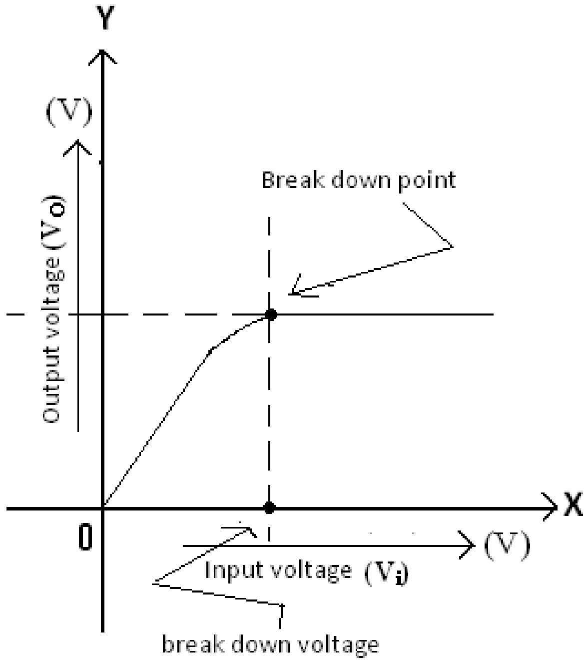


Figure: Regulation characteristics of zener diode by varying supply voltage using 1Z9.1V

D). Regulation characteristics by Varying load resistance using 1Z6.9V:

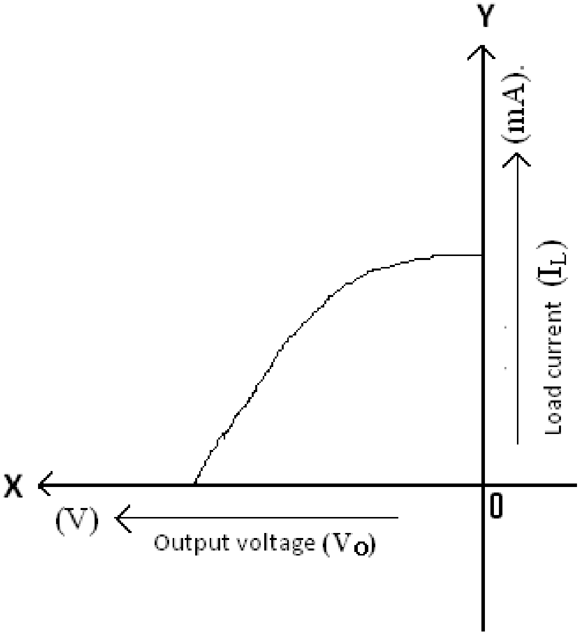


Figure: Regulation characteristics of Zener diode by varying load resistance using 1Z6.9V

E). Regulation characteristics by varying load resistance using 1Z9.1V:

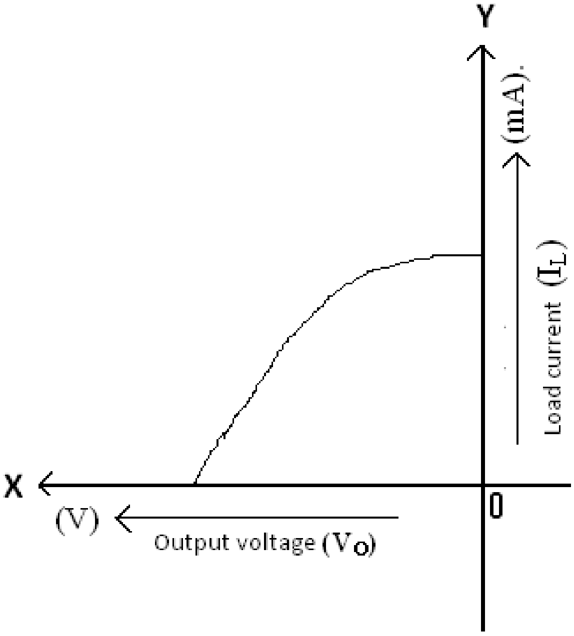


Figure: Regulation characteristics of Zener diode by varying load resistance using 1Z9.1V

PARAMETERS :

A). V-I Characteristics of Reverse bias using 1Z6.9V

1). Static resistance : V_r / I_r =

2). Dynamic resistance : ▲V_r / I_r=

B). V-I Characteristics of Reverse bias using 1Z9.1V

1). Static resistance : V_r / I_r =

2). Dynamic resistance : ▲V_r / I_r=

RESULT :

We studied the V-I characteristics of reverse bias and regulation characteristics for *Zener diode* using 1Z6.9V & 1Z9.1V. The values are given below,

1). Static resistance using 1Z6.9V :
2). Static resistance using 1Z9.1V :
3). Dynamic resistance using 1Z6.9V:
4). Dynamic resistance using 1Z9.1V:

VIVA VOCE Questions:

1. What is zener diode?
2. What is Regulator?
3. Difference between Zener diode and PN diode?
4. What is zener break down?
5. What is static resistance?
6. What is dynamic resistance?
7. Applications of zener diode?
8. What is the principle mechanism of zener diode?
9. What is Regulation?
10. Any Draw backs in zener diode?

Experiment No. : 3 . A **Date :**

Name of the Experiment : RECTIFIERS WITHOUT & WITH C - FILTER (HALF WAVE RECTIFIER)

AIM :

1). To study the characteristics of *Half wave rectifier with and without filter*.
2). To obtain the ripple factor and percentage of regulation of this same.

APPARATUS :

1). Voltmeter :	(0 – 20)V	Digital / Analog	DC Type	-----	1 No
2). Ammeters :	(0 – 500)mA	Digital / Analog	DC Type	-----	1 No.
3). Digital Multi Meter (DMM)				-----	1 No.
4). Decade Resistance Box (DRB)				-----	1 No.
5). Cathode Ray Oscilloscope (CRO)				-----	1 No.
6). Probes				-----	2 No.
7). Bread board				-----	1 No.
8). Connecting wires :				-----	A few Nos

COMPONENTS :

1). PN Diode 1N4007		-----	1 No.
2). Electrolytic capacitor (Filter)	i). 100µF, 25V	-----	1 No.
	ii). 1000µF,25V	-----	1No.
3). Centre tapped step down transformer	12-0-12V, 500mA	-----	1 No.

THEORY :

A simple Half Wave Rectifier is nothing more than a single pn junction diode connected in series to the load resistor. As you know a diode is to electric current like a one-way valve is to water, it allows electric current to flow in only one direction. This property of the diode is very useful in creating simple rectifiers which are used to convert AC to DC.

When a single rectifier diode unit is placed in series with the load across an ac supply, it converts alternating voltage into a uni-directional pulsating voltage, using one-half cycle of the applied voltage, the other half cycle being suppressed because it conducts only in one direction. Unless there is an inductance or battery in the circuit, the current will be zero, therefore, for half the time. This is called ***half-wave rectification***. As already discussed, a diode is an electronic device consisting of two elements known as cathode and anode. Since in a diode electrons can flow in one direction only *i.e.* from the cathode to anode, the diode provides the unilateral conduction necessary for rectification. This is true for diodes of all types-vacuum, gas-filled, crystal or semiconductor, metallic (copper oxide and selenium types) diodes. Semiconductor diodes, because of their inherent advantages are usually used as a rectifying device. However, for very high voltages, vacuum diodes may be employed.

Applications :

1. They are used for signal demodulation purpose
2. They are used for rectification applications
3. They are used for signal peak applications

Disadvantages :

1. Power loss
2. Low output voltage
3. The output contains a lot of ripples

CIRCUIT DIAGRAMS :

A).Half wave rectifier without Filter :

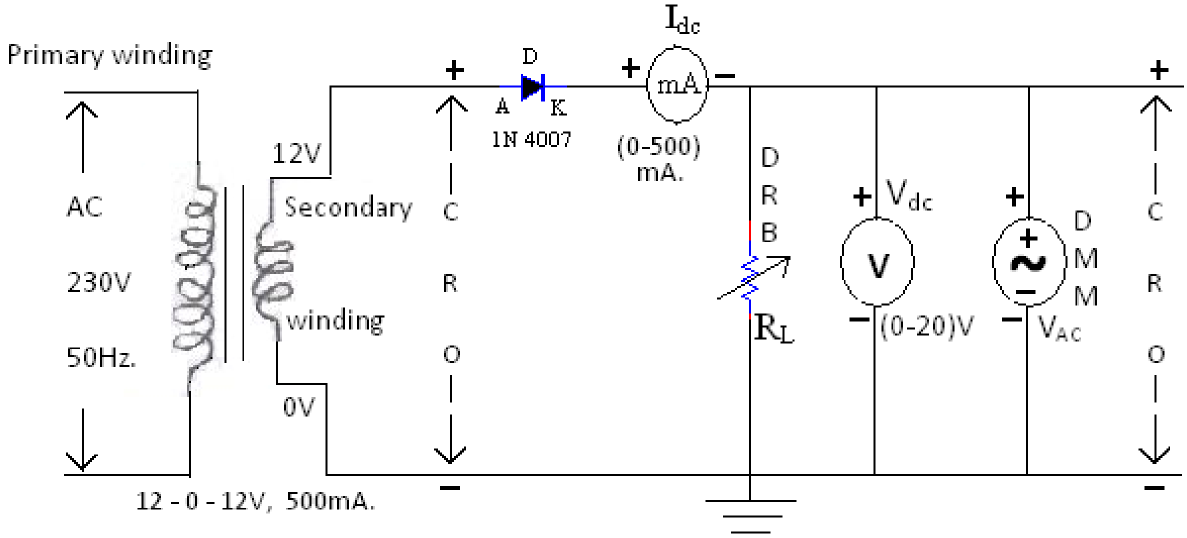


Figure: Circuit diagram of Half wave rectifier without filter.

B). Half wave rectifier with 100μF&1000μF Filter (Capacitor) :

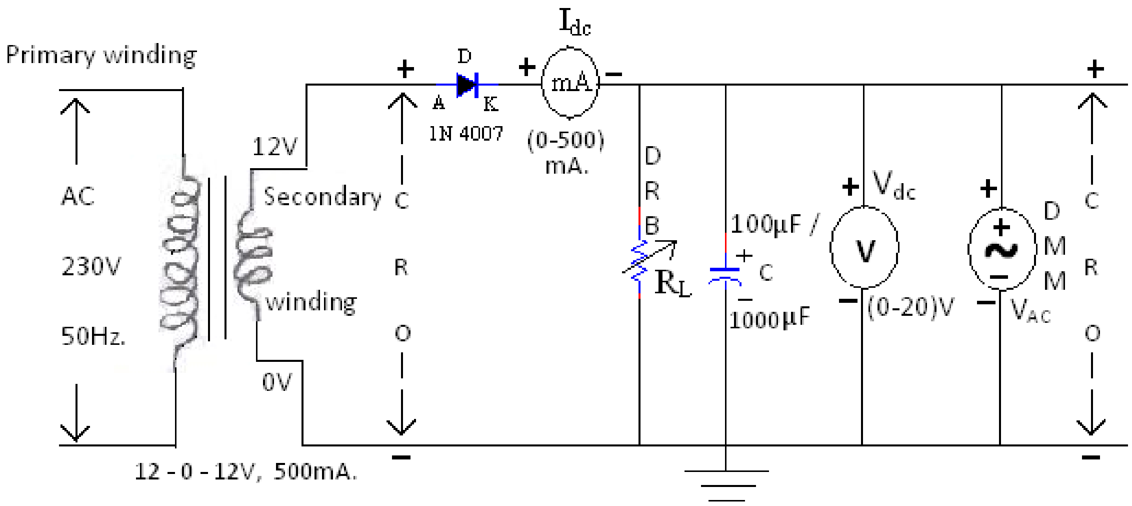


Figure: Circuit diagram of Half wave rectifier with filter using 100μF & 1000μF capacitors.

PROCEDURE :

A). Half wave rectifier without Filter :

1). Connected the circuit as shown in the circuit diagram.

2). Connected the channel1's probe of CRO across the secondary winding and channel2's probe of CRO across the output (DMM) side (as per shown in the circuit) to observe the input sine wave form and output signal respectively.

3). Removed the Decade resistance box (DRB) i.e. load resistance(R_L) from the circuit.

4). Then switched ON the transformer, and all the meters in the circuit,but don't switched ON the CRO.

5). Noted down the No load DC voltage(V_{NL}) in the given specified tabular form from the DMM.

6). After that kept the 100Ω resistance value in the DRB.

7). Now reconnected the DRB to the circuit.
8). Varied the DRB in steps of 100Ω, 200Ω, 400Ω, 600Ω,800Ω,1KΩ, 2KΩ, 4KΩ, 6KΩ, 8KΩ, 10KΩ, 30KΩ, 50KΩ, 70KΩ and 90KΩ and noted down the values of DC Current (I_{dc}), DC voltage(V_{dc}), AC voltage(V_{AC}) from the corresponding meters.
9). Took care about that DRB always is not at 0Ω resistance value while taking the readings otherwise components and instruments connected in the circuit may get damage.
10). Now kept the DRB at standard resistance value of 1KΩ.
11). Then switched ON the CRO.
12). Kept the *AC/GND/DC* switch of channel1 is at *AC* position and channel2 is at *DC* position.
13). Now kept the *channel position* switch of CRO is at dual mode.
14). Plotted the input sine wave (which is at secondary side & available in channel1) and output signal (which is across DMM & available in channel2) on single graph sheet by observing in the *CRO*.
15). Now switched OFF the transformer, CRO and all the meters in the circuit.
16). Calculated the ripple factor(RF) and % of load regulation by using the for given below,

$$RF = V_{ac} / V_{dc} \quad \text{and \% of load regulation} = \left[\frac{V_{NL} - V_L}{V_L}\right] \times 100$$

17). Plotted the graphs as per below,
a). DC current (I_{dc}) on X-axis and Ripple factor(RF) on Y-axis.
b). DC current (I_{dc}) on X-axis and % of regulation Y-axis.

B). Half wave rectifier with 100µF&1000µF Filter (Capacitor):

1). Connected the circuit by using 100µF filter (capacitor) as shown in the circuit diagrams.
2). Connected the channel1's probe of CRO across the secondary winding and channel2's probe of CRO across the output (DMM) side (as per shown in the circuit) to observe the input sine wave form and output signal respectively.
3). Removed the Decade resistance box (DRB) i.e. load resistance(R_L) from the circuit.
4). Then switched ON the transformer, and all the meters in the circuit.
5). But don't switched ON the CRO.
6). Noted down the No load DC voltage(V_{NL}) in the given specified tabular form from the DMM.
7). After that kept the 100Ω resistance value in the DRB.
8). Now reconnected the DRB to the circuit.
9). Varied the DRB in steps of 100Ω, 200Ω, 400Ω, 600Ω,800Ω,1KΩ, 2KΩ, 4KΩ, 6KΩ 8KΩ, 10KΩ, 30KΩ, 50KΩ, 70KΩ and 90KΩ and noted down the values of DC Current (I_{dc}), DC voltage(V_{dc}), AC voltage(V_{AC}) from the corresponding meters.
10). Took care about that DRB always is not at 0Ω resistance value while taking the readings otherwise components and instruments connected in the circuit may get damage.
11). Now kept the DRB at standard resistance value of 1KΩ.
12). Then switched ON the CRO.
13). Kept the *AC/GND/DC* switch of channel1 is at *AC* position and channel2 is at *DC* position.
14). Now kept the *channel position* switch of CRO is at dual mode.
15). Plotted the input sine wave (which is at secondary side & available in channel1) and output signal (which is across DMM & available in channel2) on single graph sheet by observing in the *CRO*.

16). Now switched OFF the transformer, CRO and all the meters in the circuit.
17). Then disconnected the 100µF capacitor and reconnect the 1000µF in the same place.
18). Repeated the same procedure from step 3 To step 15.
19). Calculated the ripple factor(RF) and % of load regulation for 100µF and 1000µF by using the formulas given below,

$$RF = V_{ac} / V_{dc} \quad \text{and } \% \text{ of load regulation} = \left[\frac{V_{NL} - V_L}{V_L}\right] \times 100$$

20). Drawn the following 4 graphs for each time when 100µF and 1000µF capacitors are connected, (It means 4 graphs when 100µF and another 4 graphs when 1000µF capacitors are connected).

a). DC current (I_{dc}) on X-axis and Ripple factor(RF) on Y-axis.
b). DC current (I_{dc}) on X-axis and % of regulation Y-axis.
c). Load resistance(R_L) on X-axis and Ripple Factor (RF) on Y-axis.
d). Load resistance(R_L) on X-axis and % of Load regulation (RF) on Y-axis.

<u>TABULAR COLOUMNS :</u>

A). Half wave rectifier without Filter :

No Load dc voltage (V_{NL}) = ______________ In volts.

Sl. No.	Load Resistance R_L Ω/KΩ	DC current (I_{dc}) in mA.	DC voltage (V_{dc} / V_L) in Volts.	AC voltage (V_{ac}) in Volts.	Ripple Factor (R_F) = V_{ac}/V_{dc}	% Of Regulation $= \left[\frac{V_{NL}-V_L}{V_L}\right]\times 100$
1.	100Ω					
2.	200Ω					
3.	400Ω					
4.	600Ω					
5.	800Ω					
6.	1KΩ					
7.	2KΩ					
8.	4KΩ					
9.	6KΩ					
10.	8KΩ					
11	10KΩ					
12.	30KΩ					
13.	50KΩ					
14.	70KΩ					
15.	90KΩ					

B). Half wave rectifier with 100μF capacitor filter :

No Load dc voltage (V_{NL}) = ______________ In volts.

Sl. No.	Load Resistance (R_L) In Ω/KΩ	DC current (I_{dc}) in mA.	DC voltage (V_{dc}/ V_L) InVolts.	AC voltage (V_{ac}) in Volts.	Theoretical Ripple Factor (R_F) = $\frac{1}{2\sqrt{3}\,(F \times C \times R_L)}$	Practical Ripple Factor(R_F) =V_{ac}/V_{dc}	% Of Regulation $=\left[\frac{V_{NL}-V_L}{V_L}\right]\times 100$
1.	100Ω						
2.	200Ω						
3.	400Ω						
4.	600Ω						
5.	800Ω						
6.	1KΩ						
7.	2KΩ						
8.	4KΩ						
9.	6KΩ						
10.	8KΩ						
11	10KΩ						
12.	30KΩ						
13.	50KΩ						
14.	70KΩ						
15.	90KΩ						

C). Half wave rectifier with 1000μF capacitor filter :

No Load dc voltage (V_{NL}) = ______________ In volts.

Sl. No.	Load Resistance (R_L) In Ω/KΩ	DC current (I_{dc}) in mA.	DC voltage (V_{dc}/ V_L) InVolts.	AC voltage (V_{ac}) in Volts.	Theoretical Ripple Factor (R_F) = $\frac{1}{2\sqrt{3}\,(F \times C \times R_L)}$	Practical RippleFactor (R_F)=V_{ac}/V_{dc}	% Of Regulation $=\left[\frac{V_{NL}-V_L}{V_L}\right]\times 100$
1.	100Ω						
2.	200Ω						
3.	400Ω						
4.	600Ω						
5.	800Ω						
6.	1KΩ						
7.	2KΩ						
8.	4KΩ						
9.	6KΩ						
10.	8KΩ						
11	10KΩ						
12.	30KΩ						
13.	50KΩ						
14.	70KΩ						
15.	90KΩ						

EXPECTED WAVEFORMS (Half wave rectifier) :

A). Without Filter :

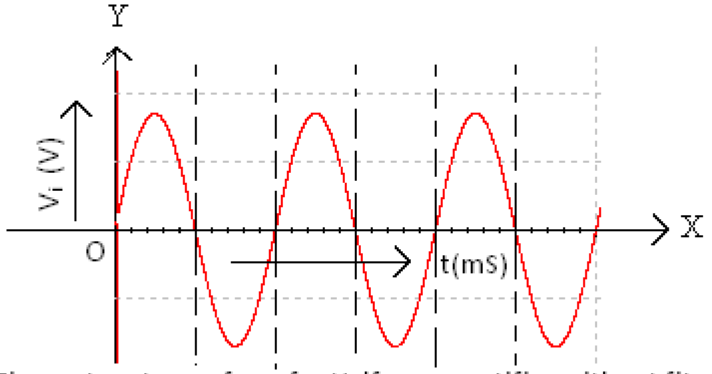


Figure: Input waveform for Half wave rectifier without filter

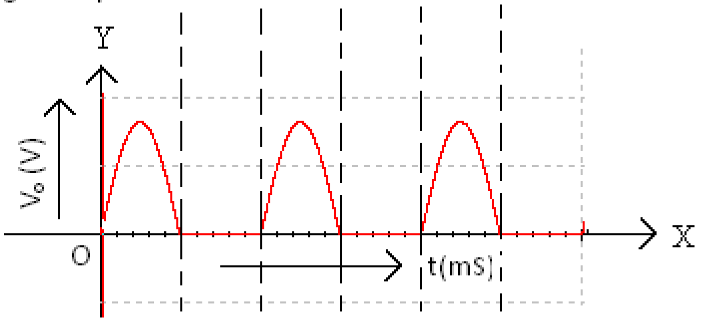


Figure: Output waveform for Halfwave rectifier without Filter at R_L=1 KΩ

B). With 100µF Filter (capacitor), at R_L=1KΩ :

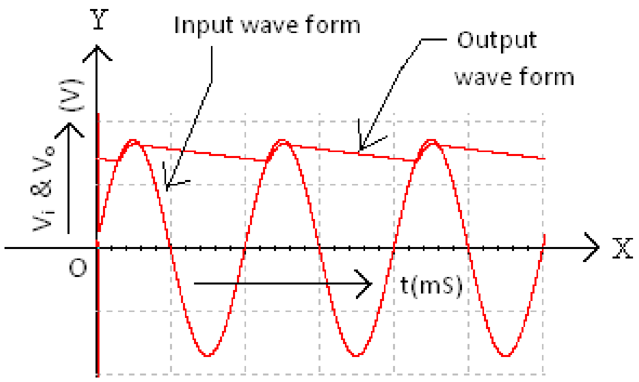


Figure: Input & output waveform for Half wave rectifier when 100µF filter(capacitor) is connected at R_L=1 KΩ

C). With 1000µF Filter (capacitor), at R_L=1KΩ :

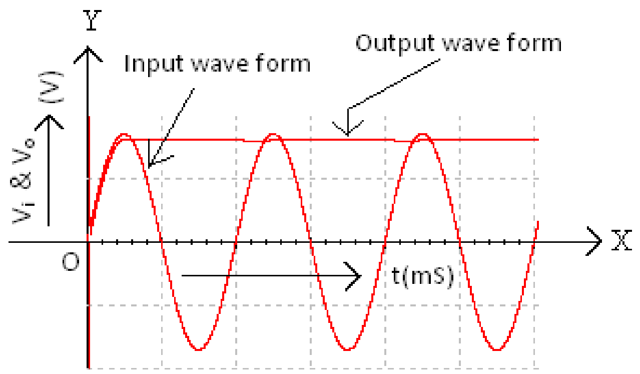
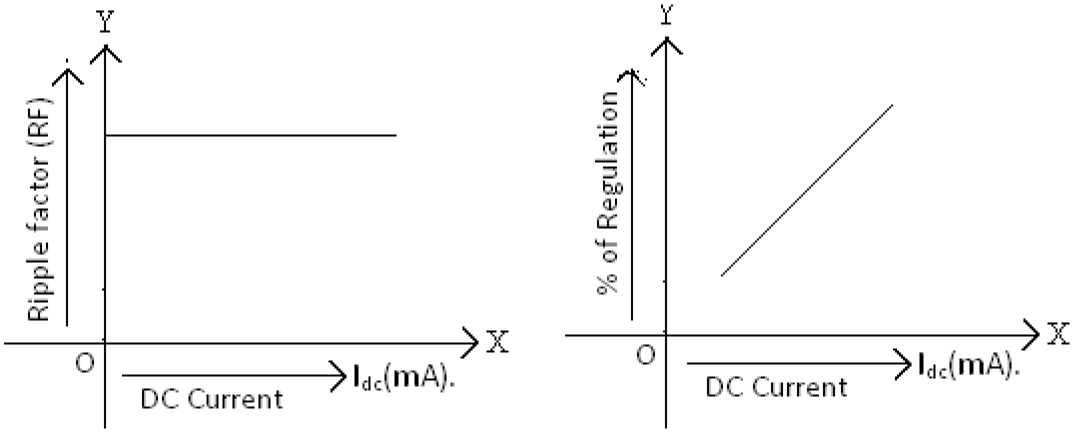


Figure: Input & output waveform for Half wave rectifier when 1000 µF filter(capacitor) is connected at R_L=1 KΩ

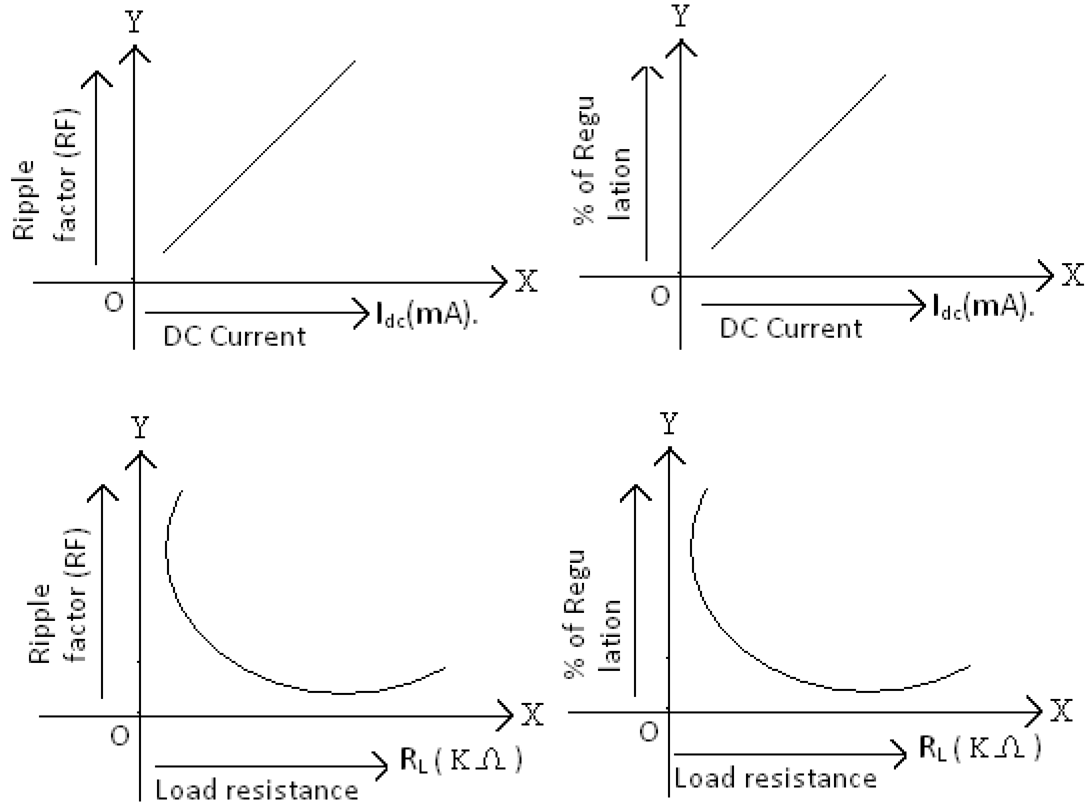
EXPECTED GRAPHS (Half wave rectifier):

A). Without Filter :



B). With 100µF & 1000µF Filter (capacitor) :

Note: Drawn the separate graph sheets for 100µF & 1000µF capacitors. i.e 4 graphs for 100µF and another 4 graphs for 1000µF capacitors as per given below,



PARAMETERS (Half wave rectifier):

THEORETICAL VALUES	PRACTICAL VALUES
A). Without Filter: Ripple factor (RF) = 1.1	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*
B). With 100μF capacitor: Ripple factor (RF) = $\frac{1}{2\sqrt{3}\,(F \times C \times R_L)}$ Where, F = 50Hz., C=100μF, R_L=1KΩ	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*
C). With 1000μF capacitor: Ripple factor (RF) = $\frac{1}{2\sqrt{3}\,(F \times C \times R_L)}$ Where, F = 50Hz., C=1000μF, R_L=1KΩ	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*

RESULT :

A). Without filter:

We studied the characteristics of *Half wave rectifier without filter and* obtained the ripple factor , % of regulation at R_L=1KΩ. The values are given below,

1). Ripple factor(RF) =
2). % of regulation =

B). With 100μF & 1000μF filter (capacitor) :

We studied the characteristics of *Half wave rectifier with filter* and obtained the ripple factor , % of regulation at R_L=1KΩ., The values are given below,

1). Ripple factor(RF) for 100μF =
2). % of regulation for 100μF =
3). Ripple factor(RF) for 1000μF =
4). % of regulation for 1000μF =

VIVA VOCE Questions:

1. What is Rectifier?

2. Classification of Rectifiers.

3. What is the Ripple Factor of HWR?

4. What is TUF of HWR?

5. HWR consists of how many diodes?

6. Mention the applications of Rectifier.

7. What is the Efficiency of HWR?

8. What is the Peak factor of HWR?

9. What is the function of filter in Rectifiers?

10. Mention the properties of L and C components.

Experiment No. : 3 . B **Date :**

Name of the Experiment : RECTIFIERS WITHOUT & WITH C - FILTER (FULL WAVE RECTIFIER)

AIM :

1). To study the characteristics of *Full wave rectifier with and without filter*.
2). To obtain the ripple factor and percentage of regulation of this same.

APPARATUS :

1). Voltmeter :	(0 – 20)V	Digital / Analog	DC Type	---------1 No
2). Ammeters :	(0 – 500)mA	Digital / Analog	DC Type	---------1 No.
3). Digital Multi Meter (DMM)				---------1 No.
4). Decade Resistance Box (DRB)				---------1 No.
5). Cathode Ray Oscilloscope (CRO)				---------1 No.
6). Probes				---------2 No.
7). Bread board				---------1 No.
8). Connecting wires :				---------A few Nos.

COMPONENTS :

1). PN Diode 1N4007		-------- 2 No.
2). Electrolytic capacitor (Filter)	i). 100µF, 25V	-------- 1 No.
	ii). 1000µF,25V	-------- 1No.
3). Centre tapped step down transformer	12-0-12V, 500mA	-------- 1 No.

THEORY :

Defination :

A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC.

Working of Full Wave Rectifier :

The input AC supplied to the full wave rectifier is very high. The step-down transformer in the rectifier circuit converts the high voltage AC into low voltage AC. The anode of the centre tapped diodes is connected to the transformer's secondary winding and connected to the load resistor. During the positive half cycle of the alternating current, the top half of the secondary winding becomes positive while the second half of the secondary winding becomes negative.

During the positive half cycle, diode D_1 is forward biased as it is connected to the top of the secondary winding while diode D_2 is reverse biased as it is connected to the bottom of the secondary winding. Due to this, diode D_1 will conduct acting as a short circuit and D_2 will not conduct acting as an open circuit

During the negative half cycle, the diode D_1 is reverse biased and the diode D_2 is forward biased because the top half of the secondary circuit becomes negative and the bottom half of the circuit becomes positive. Thus in a full wave rectifiers, DC voltage is obtained for both positive and negative half cycle.

Advantages of Full Wave Rectifier

- The rectification efficiency of full wave rectifiers is double that of half wave rectifiers. The efficiency of half wave rectifiers is 40.6% while the rectification efficiency of full wave rectifiers is 81.2%.
- The ripple factor in full wave rectifiers is low hence a simple filter is required. The value of ripple factor in full wave rectifier is 0.482 while in half wave rectifier it is about 1.21.
- The output voltage and the output power obtained in full wave rectifiers are higher than that obtained using half wave rectifiers.

CIRCUIT DIAGRAMS :

A). Full wave rectifier without Filter :

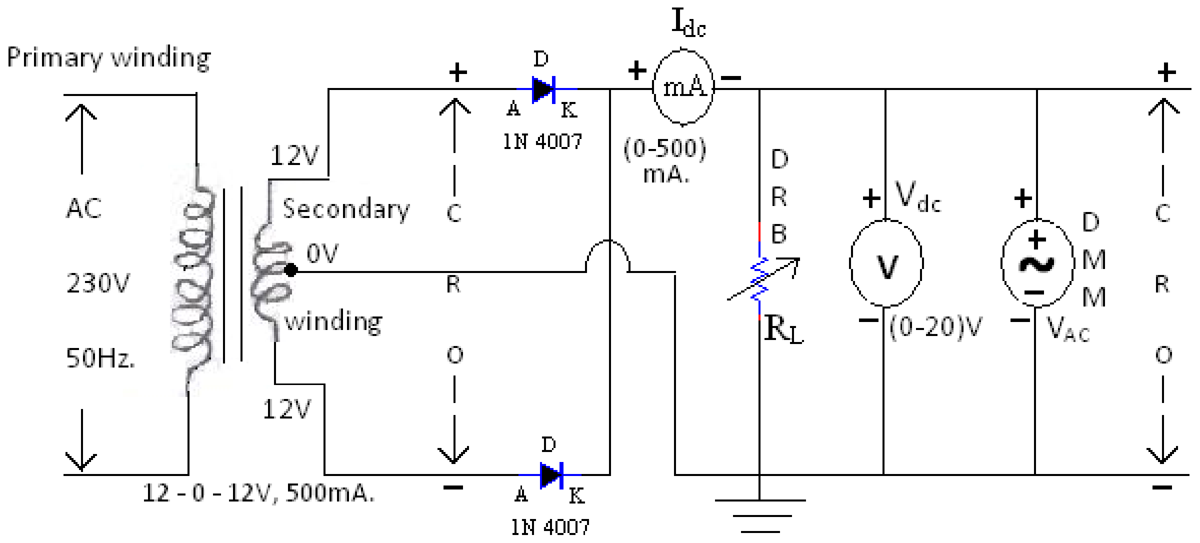


Figure: Circuit diagram of Full wave rectifier without filter

B). Full wave rectifier with 100μF&1000μF Filter (Capacitor):

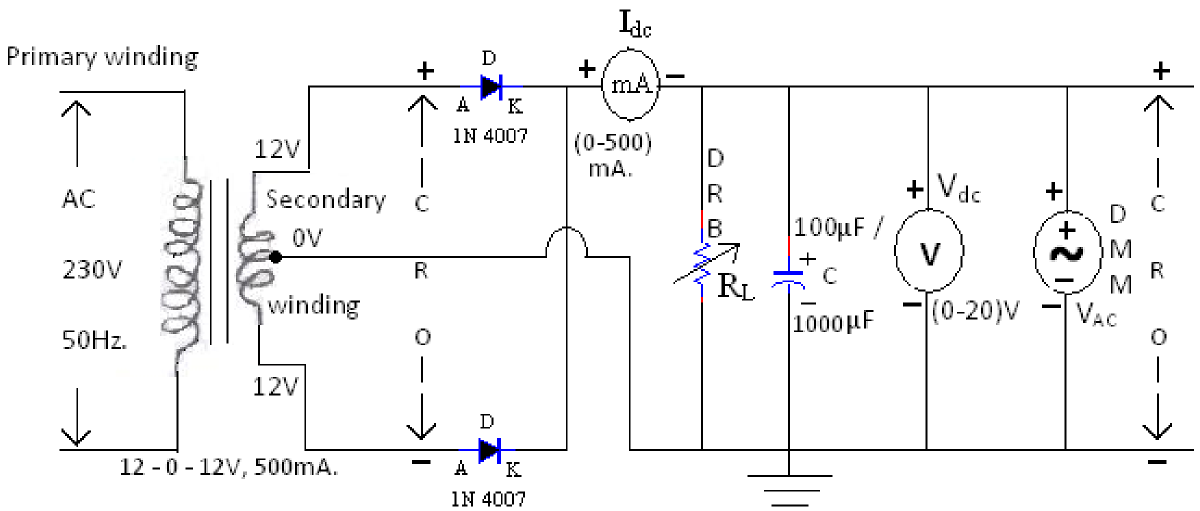


Figure: Circuit diagram of full wave rectifier with filter using 100 µF & 1000 µF capacitors

PROCEDURE :

A). Full wave rectifier without Filter :

1). Connected the circuit as shown in the circuit diagram.

2). Connected the channel1's probe of CRO across the secondary winding and channel2's probe of CRO across the output (DMM) side (as per shown in the circuit) to observe the input sine wave form and output signal respectively.

3). Removed the Decade resistance box (DRB) i.e. load resistance(R_L) from the circuit.

4). Then switched ON the transformer, and all the meters in the circuit,but don't switched ON the CRO.

5). Noted down the No load DC voltage(V_{NL}) in the given specified tabular form from the DMM.

6). After that kept the 100Ω resistance value in the DRB.

7). Now reconnected the DRB to the circuit.

8). Varied the DRB in steps of 100Ω, 200Ω, 400Ω, 600Ω,800Ω,1KΩ, 2KΩ, 4KΩ, 6KΩ,8KΩ, 10KΩ, 30KΩ, 50KΩ, 70KΩ and 90KΩ and noted down the values of D Current (I_{dc}), DC voltage(V_{dc}), AC voltage(V_{AC}) from the corresponding meters.

9). Took care about that DRB always is not at 0Ω resistance value while taking the readings otherwise components and instruments connected in the circuit may get damage.

10). Now kept the DRB at standard resistance value of 1KΩ.

11). Then switched ON the CRO.

12). Kept the *AC/GND/DC* switch of channel1 is at *AC* position and channel2 is at *DC* position.

13). Now kept the *channel position* switch of CRO is at dual mode.

14). Plotted the input sine wave (which is at secondary side & available in channel1) and output signal (which is across DMM & available in channel2) on single graph sheet by observing in the *CRO*.

15). Now switched OFF the transformer, CRO and all the meters in the circuit.

16). Calculated the ripple factor(RF) and % of load regulation by using the formulas given below,

$$RF = V_{ac} / V_{dc} \quad \text{and \% of load regulation} = \left[\frac{V_{NL} - V_L}{V_L}\right] \times 100$$

17). Plotted the graphs as per below,

a). DC current (I_{dc}) on X-axis and Ripple factor(RF) on Y-axis.

b). DC current (I_{dc}) on X-axis and % of regulation Y-axis.

B). Full wave rectifier with 100µF & 1000µF Filter (Capacitor) :

1). Connected the circuit by using 100µF filter (capacitor) as shown in the circuit diagrams.

2). Connected the channel1's probe of CRO across the secondary winding and channel2's probe of CRO across the output (DMM) side (as per shown in the circuit) to observe the input sine wave form and output signal respectively.

3). Removed the Decade resistance box (DRB) i.e. load resistance(R_L) from the circuit.

4). Then switched ON the transformer, and all the meters in the circuit.

5). But don't switched ON the CRO.

6). Noted down the No load DC voltage(V_{NL}) in the given specified tabular form from the DMM.

7). After that kept the 100Ω resistance value in the DRB.

8). Now reconnected the DRB to the circuit.

9). Varied the DRB in steps of 100Ω, 200Ω, 400Ω, 600Ω,800Ω,1KΩ, 2KΩ, 4KΩ, 6KΩ, 8KΩ, 10KΩ, 30KΩ, 50KΩ, 70KΩ and 90KΩ and noted down the values of DC Current (I_{dc}), DC voltage(V_{dc}), AC voltage(V_{AC}) from the corresponding meters.

10). Took care about that DRB always is not at 0Ω resistance value while taking the readings otherwise components and instruments connected in the circuit may get damage.

11). Now kept the DRB at standard resistance value of 1KΩ.

12). Then switched ON the CRO.

13). Kept the *AC/GND/DC* switch of channel1 is at *AC* position and channel2 is at *DC* position.

14). Now kept the *channel position* switch of CRO is at dual mode.

15). Plotted the input sine wave (which is at secondary side & available in channel1) and output signal (which is across DMM & available in channel2) on single graph sheet by observing in the *CRO*.

16). Now switched OFF the transformer, CRO and all the meters in the circuit.

17). Then disconnected the 100µF capacitor and reconnect the 1000µF in the same place.

18). Repeated the same procedure from step 3 To step 15.

19). Calculated the ripple factor(RF) and % of load regulation for 100µF and 1000µF by using the formulas given below,

$$RF = V_{ac} / V_{dc} \quad \text{and \% of load regulation} = \left[\frac{V_{NL} - V_L}{V_L}\right] \times 100$$

20). Drawn the following 4 graphs for each time when 100µF and 1000µF capacitors are connected, (It means 4 graphs when 100µF and another 4 graphs when 1000µF capacitors are connected).

a). DC current (I_{dc}) on X-axis and Ripple factor(RF) on Y-axis.

b). DC current (I_{dc}) on X-axis and % of regulation Y-axis.

c). Load resistance(R_L) on X-axis and Ripple Factor (RF) on Y-axis.

d). Load resistance(R_L) on X-axis and % of Load regulation (RF) on Y-axis.

TABULAR COLUMNS :

A). Full wave rectifier without Filter :

No Load dc voltage (V_{NL}) = _____________ In volts.

Sl. No.	Load Resistance R_L Ω/KΩ	DC current (I_{dc})in mA.	DC voltage (V_{dc}/V_L) inVolts.	ACvoltage (V_{ac}) in Volts.	RippleFactor $R_F=V_{ac}/V_{dc}$	% Of Regulation $=\left[\frac{V_{NL}-V_L}{V_L}\right]\times 100$
1.	100Ω					
2.	200Ω					
3.	400Ω					
4.	600Ω					
5.	800Ω					
6.	1KΩ					
7.	2KΩ					
8.	4KΩ					
9.	6KΩ					
10.	8KΩ					
11	10KΩ					
12.	30KΩ					
13.	50KΩ					
14.	70KΩ					
15.	90KΩ					

B). Full wave rectifier with 100μF capacitor filter :

No Load dc voltage (V_{NL}) = _____________ In volts.

Sl. No.	Load Resistance (R_L) In Ω/KΩ	DC current (I_{dc}) in mA.	DC Voltage (V_{dc}/ V_L) in Volts.	AC voltage (V_{ac}) in Volts.	Theoretical Ripple Factor (R_F) = $\frac{1}{4\sqrt{3}\,(F \times C \times R_L)}$	Practical RippleFactor(R_F)= V_{ac}/V_{dc}	% Of Regulation $= \left[\frac{V_{NL}-V_L}{V_L}\right] \times 100$
1.	100Ω						
2.	200Ω						
3.	400Ω						
4.	600Ω						
5.	800Ω						
6.	1KΩ						
7.	2KΩ						
8.	4KΩ						
9.	6KΩ						
10.	8KΩ						
11	10KΩ						
12.	30KΩ						
13.	50KΩ						
14.	70KΩ						
15.	90KΩ						

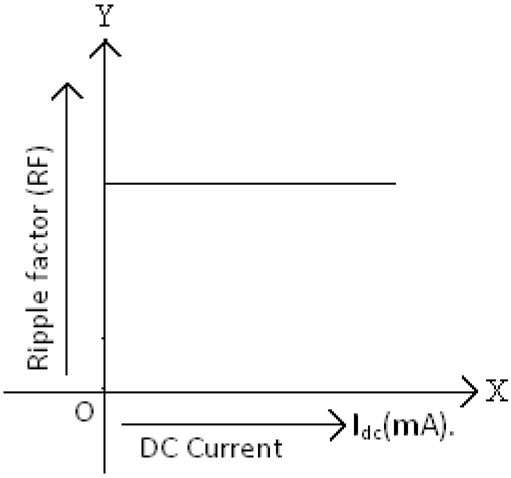
C). Full wave rectiferwith1000μF capacitor filter :

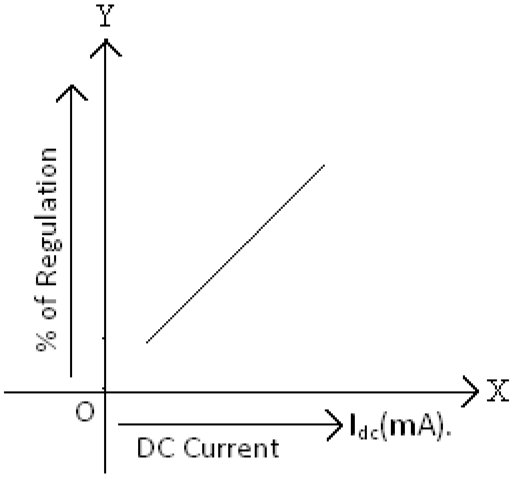
No Load dc voltage (V_{NL}) = _____________ In volts.

Sl. No.	Load Resistance (R_L) In Ω/KΩ	DC current (I_{dc}) in mA.	DC voltage (V_{dc} / V_L) in Volts.	AC voltage (V_{ac}) in Volts.	Theoretical Ripple Factor (R_F) = $\frac{1}{4\sqrt{3}\,(F \times C \times R_L)}$	Practical Ripple Factor (R_F)= V_{ac}/V_{dc}	% Of Regulation $= \left[\frac{V_{NL}-V_L}{V_L}\right] \times 100$
1.	100Ω						
2.	200Ω						
3.	400Ω						
4.	600Ω						
5.	800Ω						
6.	1KΩ						
7.	2KΩ						
8.	4KΩ						
9.	6KΩ						
10.	8KΩ						
11	10KΩ						
12.	30KΩ						
13.	50KΩ						
14.	70KΩ						
15.	90KΩ						

EXPECTED GRAPHS :

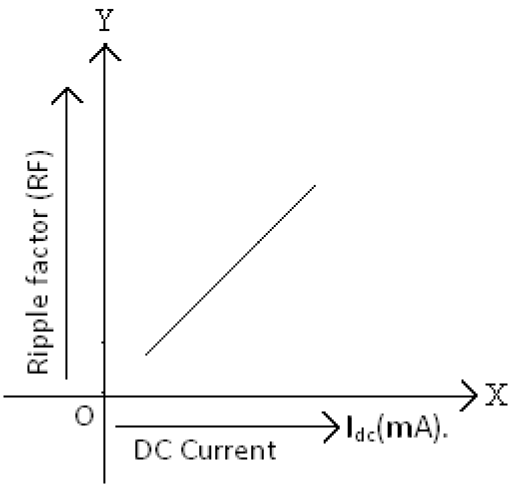
A). Full wave rectifier without filter :

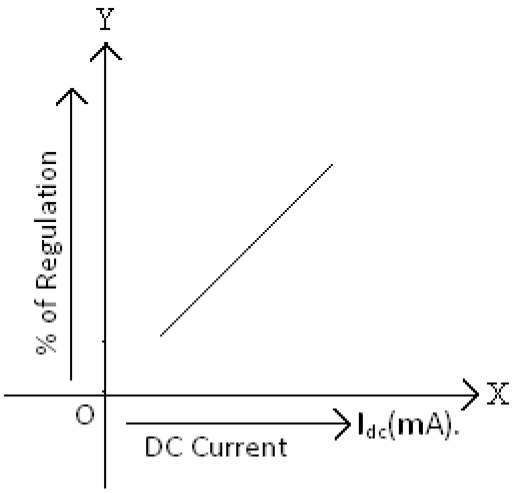


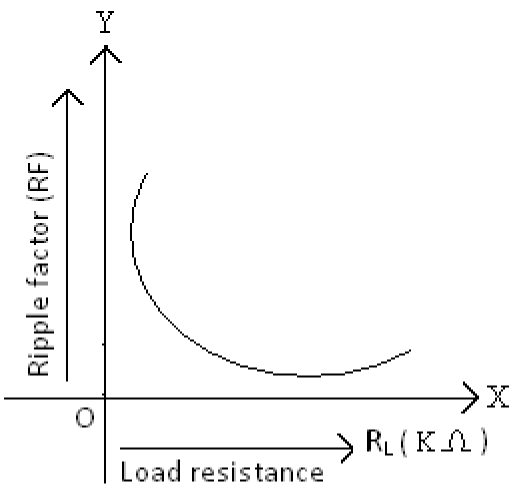


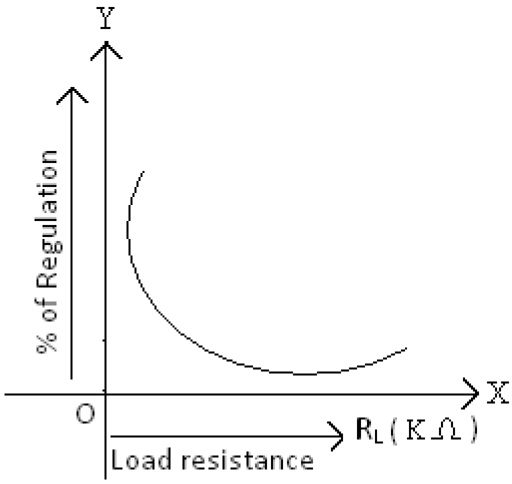
B). Full wave rectifier With 100µF & 1000µF Filter (capacitor):

Note: Drawn the separate graph sheets for 100µF & 1000µF capacitors. i.e 4 graphs for 100µF and another 4 graphs for 1000µF capacitors as per given below,









EXPECTED WAVEFORMS:

A). Full wave rectifier without Filter :

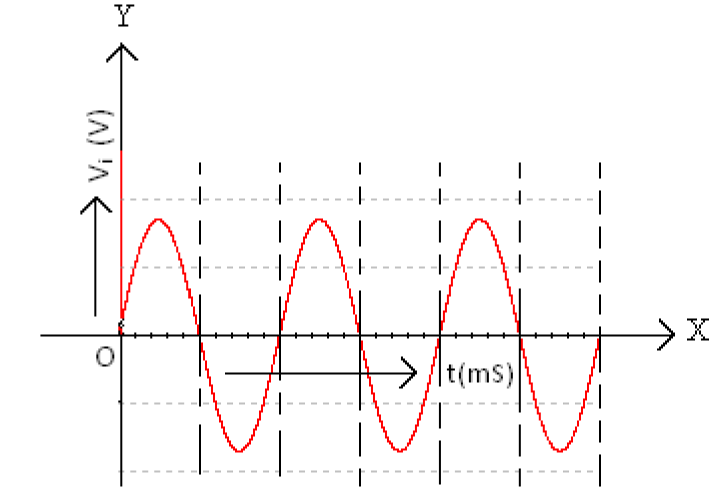


Figure: Input wave form for Full wave rectifier without filter

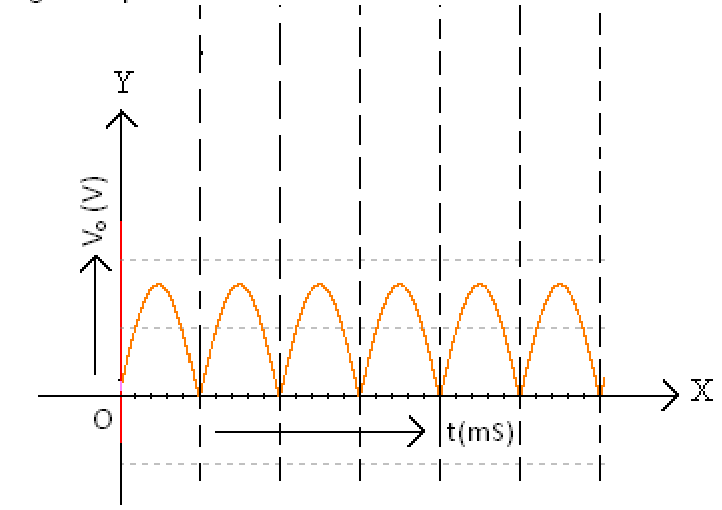


Figure: Output wave form for Full wave rectifier without filter , at R_L=1 KΩ

B). Full wave rectifier with 100μF Filter (capacitor), at R_L=1KΩ:

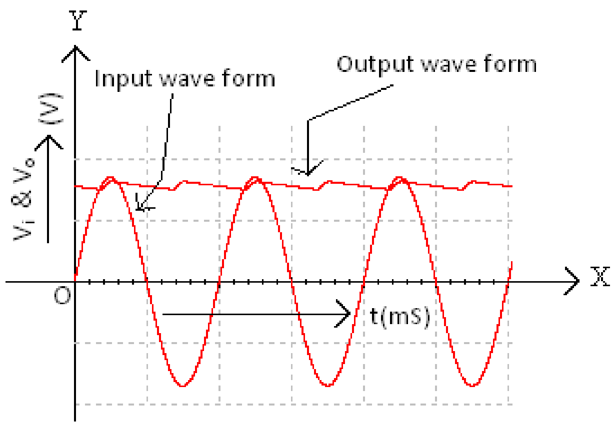


Figure: Input&Output waveforms for Full wave rectifier when 100 μF Filter (Capacitor) is connected at R_L=1 KΩ

C). Full wave rectifier with 1000μF Filter (capacitor), at R_L=1KΩ:

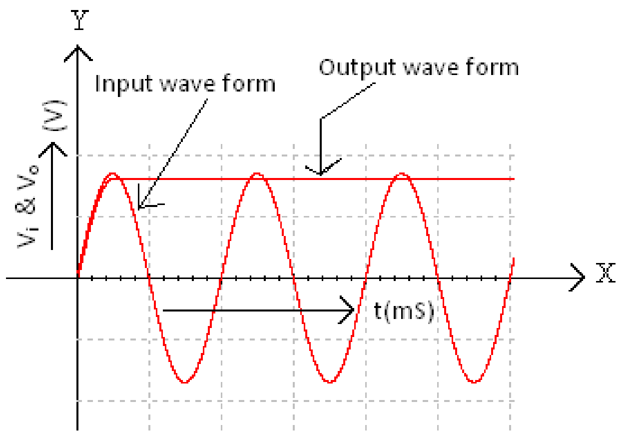


Figure: Input&Output waveforms for Full wave rectifier when 1000 μF Filter (Capacitor) is connected at R_L=1 KΩ

PARAMETERS OF FULL WAVE RECTIFEIR:

THEORETICAL VALUES	PRACTICAL VALUES
A). Without Filter: Ripple factor (RF) = 0.45	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*
B). With 100μF capacitor: Ripple factor $RF = \frac{1}{4\sqrt{3}\,(F \times C \times R_L)} =$ Where, F = 50Hz., C=100μF, R_L=1KΩ	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*
C). With 1000μF capacitor: Ripple factor $RF = \frac{1}{4\sqrt{3}\,(F \times C \times R_L)} =$ Where, F = 50Hz., C=1000μF, R_L=1KΩ	Ripple factor (RF) when R_L is at 1KΩ = *(Noted down from the tabular column).*

RESULT :

A). Without filter :

We studied the characteristics of *full wave rectifier without filter* and obtained the ripple factor , % of regulation at R_L=1KΩ. The values are given below,

1). Ripple factor(RF) =
2). % of regulation =

B). With 100μF & 1000μF filter (capacitor) :

We studied the characteristics of *full wave rectifierwith filter* and obtained the ripple factor , % of regulation at R_L=1KΩ. The values are given below,

1). Ripple factor(RF) for 100μF =
2). % of regulation for 100μF =
3). Ripple factor(RF) for 1000μF =
4). % of regulation for 1000μF =

VIVA VOCE Questions :

1. What is Rectifier?

2. Classification of Rectifiers.

3. PIV for FWR is ________________.

4. What is the Ripple Factor FWR?

5. What are the differences between Full Wave Center Tapped and Bridge Rectifier.

6. FWR consists of how many diodes?

7. What is the function of RPS?

8. What is the Efficiency of FWR?

9. What is the function of filter in Rectifiers?

10. Mention the properties of L and C components.

Experiment No. : 4 **Date :**

Name of the Experiment : BJT CHARACTERISTICS IN COMMON BASE (CB) CONFIGURATION

AIM :

To obtain the input and output characteristics of transistor in *Common Baseconfiguration.*

APPARATUS :

1). Voltmeters : a). (0 – 2)V Digital DC Type --------- 1 No.
b). DMM Digital --------------- 1 No.
2). Ammeters : a). (0 – 50)mA Digital / Analog DC Type --------- 1 No.
b). (0-20)mA Digital DC Type ---------1 No.
3). Regulated Power Supply (RPS) : Dual channel, (0-30)V, 1A ----------- 1 No.
4). Bread board -- 1 No.
5). Connecting wires : -- A few Nos.

COMPONENTS :

1). Transistor : BC 547 -- 1 No.
2) Carbon fixed resistors a). 1 KΩ ,½W -- 2 No.

THEORY :

In this configuration we use base as common terminal for both input and output signals. The configuration name itself indicates the common terminal. Here the input is applied between the base and emitter terminals and the corresponding output signal is taken between the base and collector terminals with the base terminal grounded. Here the input parameters are V_{EB} and I_E and the output parameters are V_{CB} and I_C. The input current flowing into the emitter terminal must be higher than the base current and collector current to operate the transistor, therefore the output collector current is less than the input emitter current.

The current gain is generally equal or less than to unity for this type of configuration. The input and output signals are in-phase in this configuration. The amplifier circuit configuration of this type is called as non-inverting amplifier circuit. The construction of this configuration circuit is difficult because this type has high voltage gain values.

The input characteristics of this configuration are looks like characteristics of illuminated photo diode while the output characteristics represents a forward biased diode. This transistor configuration has high output impedance and low input impedance. This type of configuration has high resistance gain i.e. ratio of output resistance to input resistance is high. The voltage gain for this configuration of circuit is given below.

$$A_V = V_{out}/V_{in} = (I_C*R_L) / (I_E*R_{in})$$

Current gain in common base configuration is given as

$$\alpha = \text{Output current/Input current}$$

$$\alpha = I_C/I_E$$

The common base circuit is mainly used in single stage amplifier circuits, such as microphone pre amplifier or radio frequency amplifiers because of their high frequency response. The common base transistor circuit is given below.

CIRCUIT DIAGRAM :

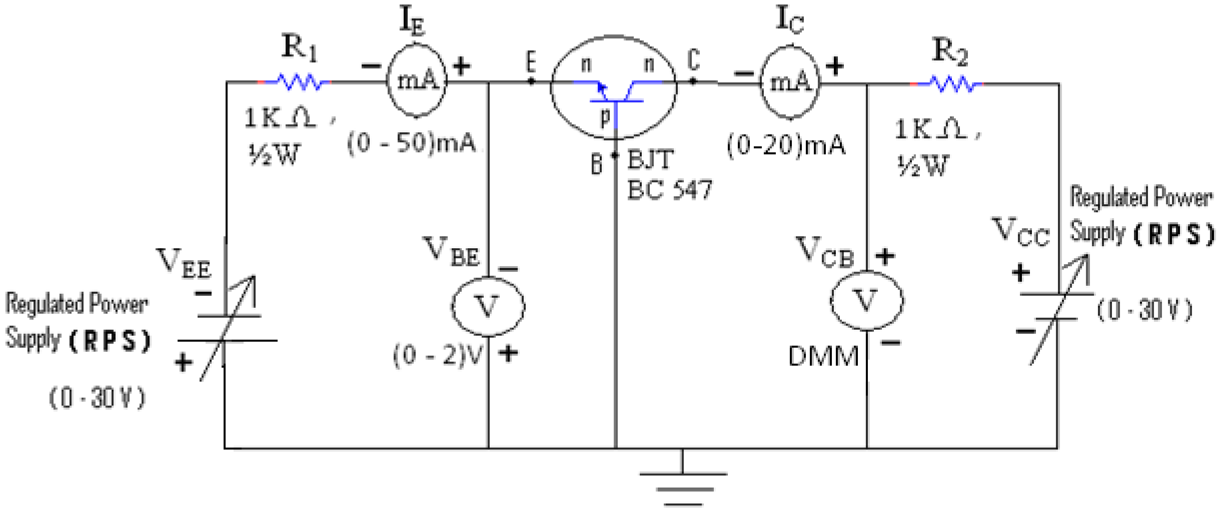


Figure: Circuit diagram of Common Base (CB) configuration.

PROCEDURE :

A). Input characteristics :

1). Connected the circuit as shown in the circuit diagram.

2). Now Switched *ON* the *RPS* and all the meters.

3). Kept the V_{CB} = 0V by adjusted the V_{CC}.

4). Varied the supply voltage V_{EE} in steps of 00.00V, 00.50V, 01.00V, 02.00V, 05.00V, 10.00V, 15.00V, 20.00V, 25.00V, 30.00V and noted down the corresponding readings of V_{BE} and I_E the meters.

5). Kept the V_{EE} at 0V.

6). Repeated the same procedure from steps 4 to 5 for each time independently when V_{CB} = 2V & V_{CB} = 4V by varying the V_{CC}.

7). Now switched OFF the RPS and all the meters.

8). Took care that ,

a). The values of V_{BE} when V_{CB} = 2V are lesser than the values of V_{BE} when V_{CB}=0V from 5^{th} reading onwards in the tabular column.

b). The values of V_{BE} when V_{CB} = 4V are lesser than the values of V_{BE} when V_{CB}=2V from 5^{th} reading onwards in the tabular column.

9). Plotted the graph between V_{BE} on *X*-axis and I_E on *Y*-axis.

Note: *Do not vary the supply voltage* V_{CC} *unless* V_{EE} *is kept at 0 Volts.*

B). Output characteristics :

1). Connected the circuit as shown in the circuit diagram.

2). Now Switched *ON* the *RPS* and all the meters.

3). Kept the I_E = 2mA by varying the supply voltage V_{EE}

4). Varied the supply voltage V_{CC} in steps 00.00V, 00.50V, 01.00V, 02.00V, 05.00V, 10.00V, 15.00V, 20.00V, 25.00V, 30.00V and noted down the corresponding readings of V_{CB} and I_C meters.

5). Now kept the V_{CC} at 0V.

6). Repeated the same procedure from steps 4 to 5 for each time independently when I_E=4mA & I_E=6mA by varying the V_{EE}.

7). Now switched OFF the RPS and all the meters.

8). Took care that ,

a). The values of V_{CB} when I_E = 4mA are lesser than the values of V_{CB} when I_E = 2mA from 5th reading onwards in the tabular column.

b). The values of V_{CB} when I_E = 6mA are lesser than the values of V_{CB} when I_E = 4mA from 5th reading onwards in the tabular column.

c). The values of I_C when I_E = 4mA are greater than the values of I_C when I_E = 2mA from 5th reading onwards in the tabular column.

d). The values of I_C when I_E = 6mA are greater than the values of I_C when I_E = 4mA from 5th reading onwards in the tabular column.

9). Plotted the graph between V_{CB} on *X*-axis and I_C on *Y*-axis.

Note: *Do not vary the supply voltage V_{EE} unless V_{CC} is kept at 0 Volts.*

TABULAR COLUMNS :

A). Input Characteristics :

SL.No.	V_{EE} (V)	V_{CB}=0V		V_{CB}=2V		V_{CB}=4V	
		V_{BE} (V)	I_E(mA)	V_{BE} (V)	I_E(mA)	V_{BE} (V)	I_E(mA)
1	00.00						
2	00.50						
3	01.00						
4	02.00						
5	05.00						
6	10.00						
7	15.00						
8	20.00						
9	25.00						
10	30.00						

B). Output Characteristics :

SL.No.	V_{CC} (V)	I_E = 2mA		I_E = 4mA		I_E = 6mA	
		V_{CB} (V)	I_C(mA)	V_{CB} (V)	I_C(mA)	V_{CB}(V)	I_C(mA)
1	00.00						
2	00.50						
3	01.00						
4	02.00						
5	05.00						
6	10.00						
7	15.00						
8	20.00						
9	25.00						
10	30.00						

EXPECTED GRAPHS :

A). Input Characteristics :

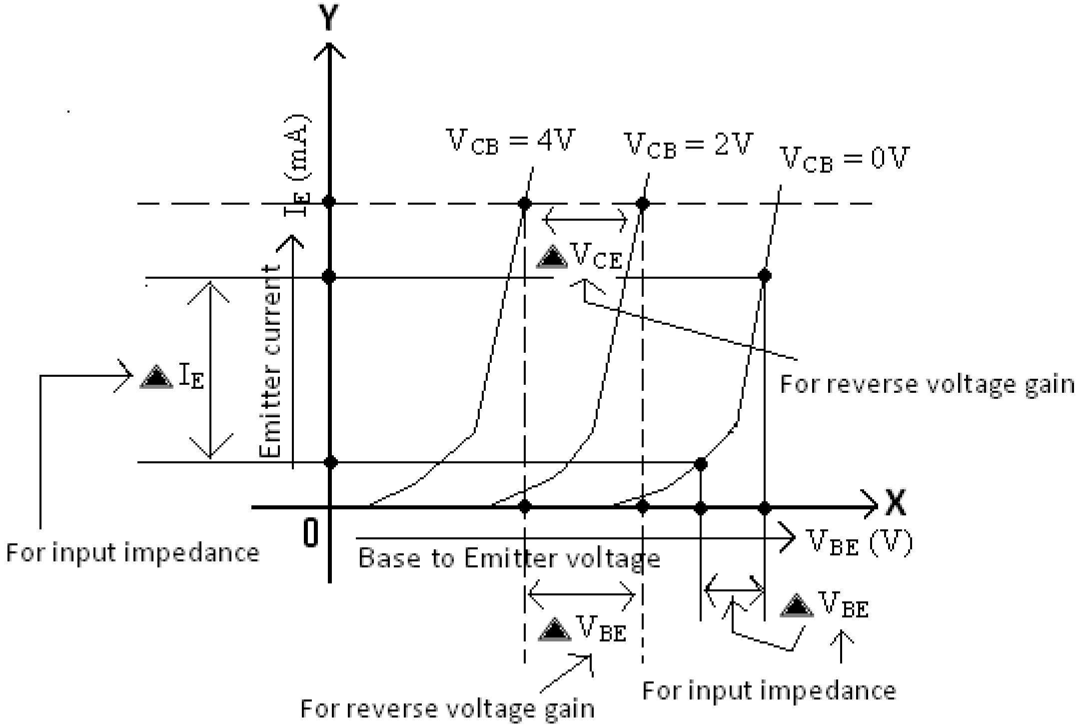


Figure: Measurement of h-parameters of input characteristics in CB configuration.

B). Output Characteristics :

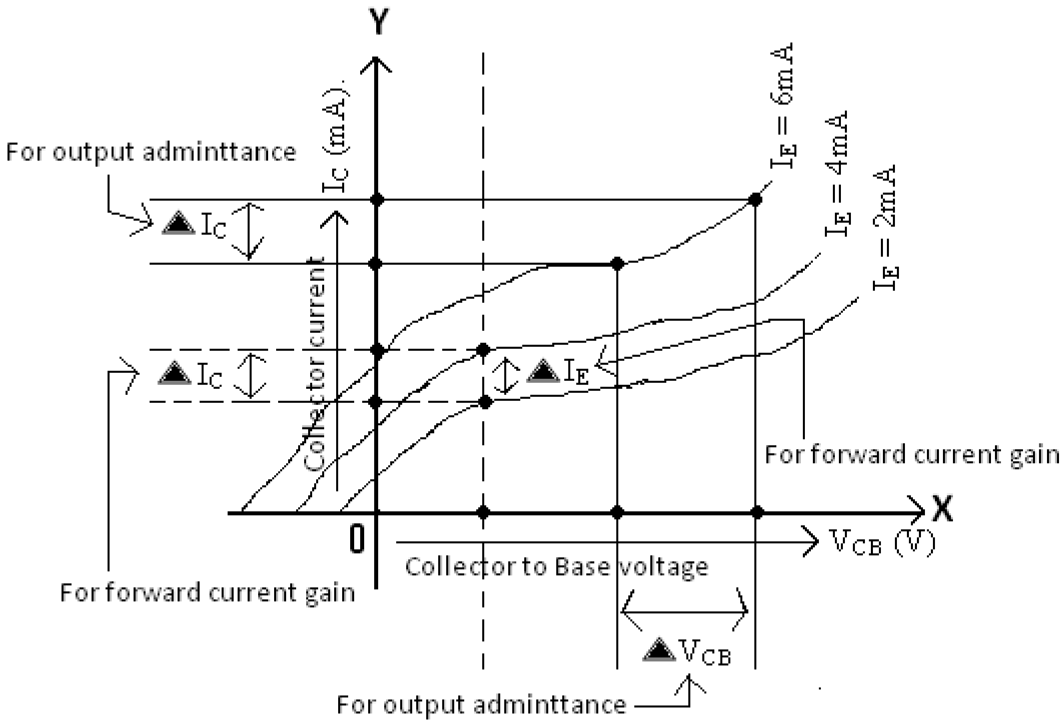


Figure: Measurement of h- parameters of output characteristics in CB configuration.

.**PARAMETERS :**

A). Common base (CB) configuration :

1). Input impedance **(h_{ib})** = **$\Delta V_{BE} / \Delta I_E$** = = Here **$V_{CB}$** is constant.

2). Reverse voltage gain **(h_{rb})** = **$\Delta V_{BE} / \Delta V_{CB}$** = Here **$I_E$** is constant.

Note : *The above two parameters are calculated from input characteristics curve of CB configuration.*

3). Output admittance **(h_{ob})** = **$\Delta I_C / V_{CB}$** = Here **I_E** is constant.

4). Forward current gain **(h_{fb})** =**$\Delta I_C / \Delta I_E$** = Here **V_{CB}** is constant.

Note : *The above two parameters are calculated from output characteristics curve of CB configuration.*

5). Forward voltage gain = **$1 / h_{rb}$.** =

6). Output resistance =**$1 / h_{ob}$** =

RESULT :

The input and output characteristics of a transistor in *Common Base configuration* are studied

VIVA VOCE Questions :

1. Mention the characteristics of CB Amplifier.

2. Define alpha DC amplification factors of BJT.

3. Explain the transistor operation with the help of four regions.

4. Compare CB, CE, CC configurations of a transistor.

5. What is the need of biasing?

6. Define stability factor of transistor.

7. What are the advantages of using potential divider bias?

8. Why we use h-parameters to describe a transistor?

9. For Amplifier, Transistor operation which region?

10. Briefly explain reach through effect.

Experiment No. : 5 **Date :**

Name of the Experiment : BJT CHARACTERISTICS - COMMON EMITTER (CE) CONFIGURATION

AIM :

To obtain the input and output characteristics of transistor in *Common Emitterconfiguration.*

APPARATUS :

1). Voltmeters :	a). (0 – 2)V	Digital	DC Type	------- 1 No.
	b). (0 – 50)V	Digital / Analog	DC Type	------- 1 No.
2). Ammeters :	a). (0 – 20)mA	Digital / Analog	DC Type	------- 1 No.
	b). (0 – 2000)µA	Digital only	DC Type	------- 1 No.
3). Regulated Power Supply (RPS) :	(0-30)V, 1A	Dual channel		--------1 No.
4). Bread board				-------- 1 No.
5). Connecting wires :				-------- A few Nos.

COMPONENTS :

1). Transistor :	BC 547		-------- 1 No.
2) Carbon fixed resistors	a). 1 KΩ ,½W		-------- 1 No.
	b). 33 KΩ, ½W		-------- 1 No.

THEORY :

The transistor is a two junction, three terminal semiconductor device which has three regions namely the emitter region, the base region, and the collector region. There are two types of transistors. An npn transistor has an n type emitter, a p type base and an n type collector while a pnp transistor has a p type emitter, an n type base and a p type collector. The emitter is heavily doped, base region is thin and lightly doped and collector is moderately doped and is the largest. The current conduction in transistors takes place due to both charge carriers- that is electrons and holes and hence they are named Bipolar Junction Transistors (BJT).

BJTs are used to amplify current, using a small base current to control a large current between the collector and the emitter. This amplification is so important that one of the most noted parameters of gain, β (or hFE), which is the ratio of collector current to base current. When the BJT is used with the base and emitter terminals as the input and the collector and emitter terminals as the output, the current gain as well as the voltage gain is large. It is for this reason that this common-emitter (CE) configuration is the most useful connection for the BJT in electronic systems

Operation regions and characteristics curves: Depending upon the biasing of the two junctions, emitter-base (EB) junction and collectorbase(CB) the transistor is said to be in one of the four modes of operation. as described below:

Operating region	B-E Junction	B-C Junction	Features			
Cut-off	Reverse	Reverse	IB ≈ IC≈IE≈0	Off state – no current (VBE<0.7V)		
Saturation	Forward	Forward	Conducting structure	VBE=0.7V	VCE ≈ 0.2V	
Active	Forward	Reverse	Amplifier Gain: 100-1000	(IC=βIB)	VBE=0.7V	VCE >0.2V
Reverseactive	Reverse	Forward	Limited use Gain< 1	(IB >IC)		

NOTE : VBE will vary from 0.6 to 0.7 V

The most important characteristics of transistor in any configuration are input and output characteristics. A. Input Characteristics: - It is the curve between input current IB and input voltage VBE constant collector emitter voltage VCE. The input characteristic resembles a forward biased diode curve. After cut in voltage the IB increases rapidly with small increase in VBE. It means that dynamic input resistance is small in CE configuration. It is the ratio of change in VBE to the resulting change in base current at constant collector emitter voltage. It is given by ΔVBE / ΔIB B. Output Characteristics: - This characteristic shows relation between collector current IC and collector voltage for various values of base current. The change in collector emitter voltage causes small change in the collector current for the constant base current, which defines the dynamic resistance and is given as ΔVCE / ΔIC at constant IB. The output characteristic of common emitter configuration consists of three regions: Active, Saturation an

Active region: In this region base-emitter junction is forward biased and base-collector junction is reversed biased. The curves are approximately horizontal in this region.

Saturation region: In this region both the junctions are forward biased.

Cut-off : In this region, both the junctions are reverse biased. When the base current is made equal to zero, the collector current is reverse leakage current ICEO. The region below IB = 0 is the called the cutoff region.

CIRCUIT DIAGRAM :

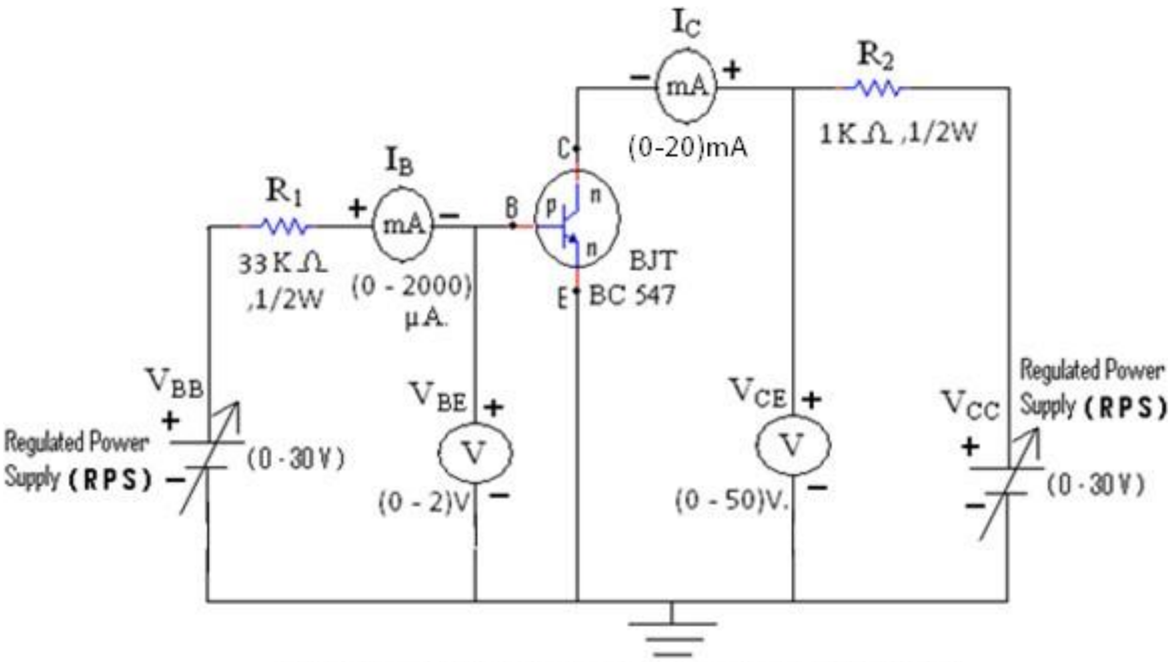


Figure: Circuit diagram of Common emitter configuration.

PROCEDURE :

A). Input characteristics:

1). Connected the circuit as shown in the circuit diagram.

2). Now Switched *ON* the *RPS* and all the meters.

3). Kept the V_{CE} = 0V by adjusted theV_{CC}.

4). Varied the supply voltage V_{BB} in steps of 0.0V, 0.50V, 1V, 2V, 4V, 6V, 8V, 10V, 15V,20V, 25V, 30V and noted down the corresponding readings of V_{BE} and I_B the meters.

5). Kept the V_{BB} at0V.

6). Repeated the same procedure from steps 4 to 5 for each time independently when V_{CE} = 1V & V_{CE} = 2V which are kept by varying theV_{CC}.

7). Now switched OFF the RPS and all the meters.

8). 8). Took carethat

a). The values of V_{BE} when V_{CE} = 1V are greater than the values of V_{BE} when V_{CE}=0V from 5th reading onwards in the tabularcolumn.

b). The values of V_{BE} when V_{CE} = 2V are greater than the values of V_{BE} when V_{CE}=1V from 5th reading onwards in the tabularcolumn.

9). Plotted the graph between V_{BE}on *X*-axis and $I_B$on *Y*-axis.

Note: Do not vary the supply voltage V_{CC} unless V_{BB} is kept at 0 Volts.

10). We did the same experiment in multisim also, and noted down the corresponding values in tabular column (A).

B). *Output characteristics:*

1). Connected the circuit as shown in the circuit diagram.
2). Now Switched *ON* the *RPS* and all the meters.
3). Kept the I_B = 20µA by varying the supply voltage V_{BB}
4). Varied the supply voltage V_{CC} in steps 0.0V, 0.50V, 1V, 2V, 4.V, 6.V, 8.V, 10V, 15V, 18V, 20V, 22V, 24V, 26V, 28V, 30V and noteddown the corresponding readings of V_{CE} and meters.
5). Now kept the V_{CC} at0V.
6). Repeated the same procedure from steps 4 to 5 for each time independently when I_B=40µA & I_B=40µA which are kept by varying theV_{BB}.
7). Now switched OFF the RPS and all the meters.
8). Took care that,
   a). The values of I_C when I_B = 40µA are greater than the values of I_C when I_B = 20µA from 5th reading onwards in the tabularcolumn.
   b). The values of I_C when I_B = 40µA are greater than the values of I_C when I_B = 60µA. from 5th reading onwards in the tabularcolumn.
9). Plotted the graph between VC_Eon *X*-axis and $I_C$on*Y*-axis.
   Note: Do not vary the supply voltage V_{BB} unless V_{CC} is kept at 0 Volts.
10). We did the same experiment in multisim also, and noted down the corresponding values in tabular column

(B).

A). Input Characteristics :

	V_{BB} (V)	V_{CE}=0V		V_{CE}=1V		V_{CE}=2V	
		V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)
1	00.00						
2	00.50						
3	01.00						
4	02.00						
5	04.00						
6	06.00						
7	08.00						
8	10.00						
9	12.00						
10	14.00						
11	16.00						
12	18.00						
13	20.00						
14	22.00						
15	24.00						
16	26.00						
17	28.00						
18	30.00						

B). Output Characteristics :

SL.No.	V_{CC} (V)	I_B = 20μA (0.02mA)		I_B = 40μA (0.04mA)		I_B = 60μA (0.06mA)	
		V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)
1	00.00						
2	00.50						
3	01.00						
4	02.00						
5	04.00						
6	06.00						
7	08.00						
8	10.00						
9	12.00						
10	14.00						
11	16.00						
12	18.00						
13	20.00						
14	22.00						
15	24.00						
16	26.00						
17	28.00						
18	30.00						

EXPECTED GRAPHS :

A). Input characteristics with '*h*' parameters :

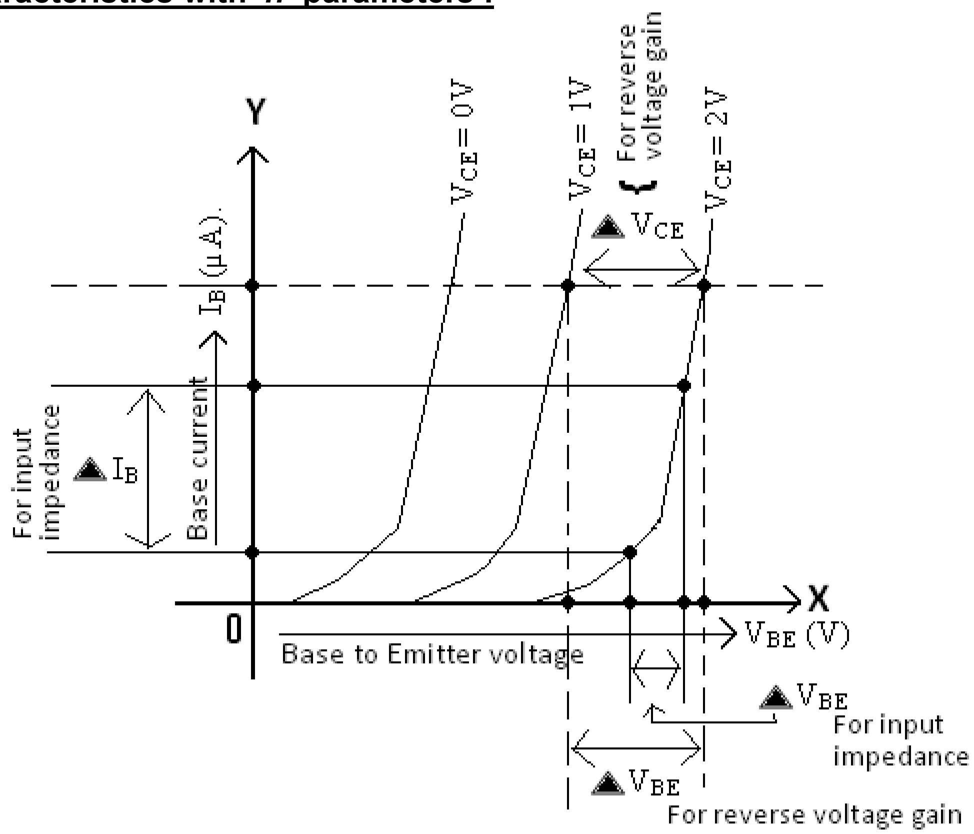


Figure: Measurement of h-parameters of input characteristics in CE configuration.

B). Output characteristics with '*h*' parameters :

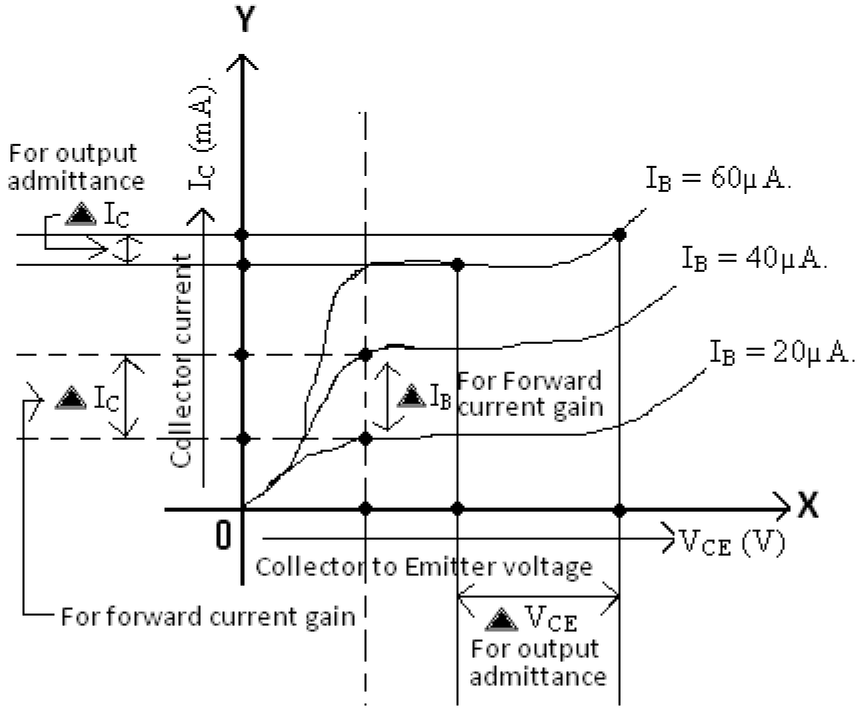


Figure: Measurement of h-parameters of output characteristics in CE configuration.

PARAMETERS :

Common emitter (CE) configuration :

1). Input impedance **(h_{ie})** = **$\Delta V_{BE} / \Delta I_B$** = Here **$V_{CE}$** is constant.

2). Reverse voltage gain **(h_{re})** = **$\Delta V_{BE} / \Delta V_{CE}$** = Here **$I_B$** is constant.

Note : The above two parameters are calculated from input characteristics curve of CE configuration.

3). Output admittance **(h_{oe})** = **$\Delta I_C / V_{CE}$** = Here **I_B** is constant.

4). Forward current gain **(h_{fe})** = **$\Delta I_C / \Delta I_B$** = Here **V_{CE}** is constant.

Note : The above two parameters are calculated from output characteristics curve of CE configuration.

5). Forward voltage gain = **$1 / h_{re}$.** =

6). Output resistance =**$1 / h_{oe}$.** =

RESULT :

The input , output characteristics and '*h*' parameters of a transistor in *Common Emitter configuration* are studied.

VIVA VOCE Questions:

1. Define beta DC amplification factors of BJT.
2. Briefly explain reach through effect.
3. Explain the transistor operation with the help of four regions.
4. Compare CB,CE, CC configurations of a transistor.
5. What is the need of biasing?
6. Define stability factor of transistor.
7. What are the advantages of using potential divider bias?
8. Why we use h-parameters to describe a transistor?
9. Mention the characteristics of CE Amplifier.
10. For Amplifier, Transistor operation which region?

Experiment No. : 6	**Date :**
Name of the Experiment : FET CHARACTERISTICS - COMMON SOURCE (CS) CONFIGURATION)	

AIM :

1). To study the static and transfer characteristics of the FET
2). To calculate the following FET parameters
(a). Drain resistance (r_d) (b). Trans conductance (gm) (c). Amplification factor (μ)

APPARATUS :

1). Voltmeters :	a). (0 – 2)V	Digital	DC Type	--------- 1 No.
	b). (0 – 50)V	Digital/Anolog	DC Type	--------- 1 No.
2). Ammeters :	a). (0 – 20)mA	Digital / Analog	DC Type	--------- 1 No.
3). Regulated Power Supply (RPS) :	(0-30)V, 1A	Dual channel		--------- 1 No.
4). Bread board				--------- 1 No.
5). Connecting wires :				--- A few Nos.

COMPONENTS :

1). Field Effect Transistor (FET) :	BF W11	--------- 1 No.
2) Carbon fixed resistors	a). 22Ω, ½W	--------- 1 No.
	b). 1 KΩ ,½W	--------- 1 No.

THEORY :

The Field Effect Transistor or Simply FET uses the voltage that is applied to their input terminal, called the Gate to control the current flowing through them resulting in the output current being proportional to the input voltage, the Gates to source junction of the FET is always reversed biased. As their operation relies on an electric field (hence the name field effect) generated by the input Gate voltage, this then makes the Field Effect Transistor a "VOLTAGE" operated device.

The Field Effect Transistor is a three terminal unipolar semiconductor device that has very similar characteristics to those of their Bipolar Transistor counterpart's i.e., high efficiency, instant operation, robust and cheap and can be used in most electronic circuit applications to replace their equivalent bipolar junction transistors (BJT).

The Field Effect Transistor has one major advantage over its standard bipolar transistor, in that input impedance, (Rin) is very high, (thousands of Ohms). This very high input impedance makes them very sensitive to input voltage signals.

There are two basic configurations of junction field effect transistor, the N-channel JFET and the P-channel JFET. The N-channel JFET's channel is doped with donor impurities meaning that the flow of current through the channel is negative (hence the term N-channel) in the form of electrons.

A FET is a three terminal device, having the characteristics of high input impedance and less noise, the Gate to Source junction of the FET is always reverse biased.

In amplifier application, the FET is always used in the region beyond the pinch-off.

CIRCUIT DIAGRAM :

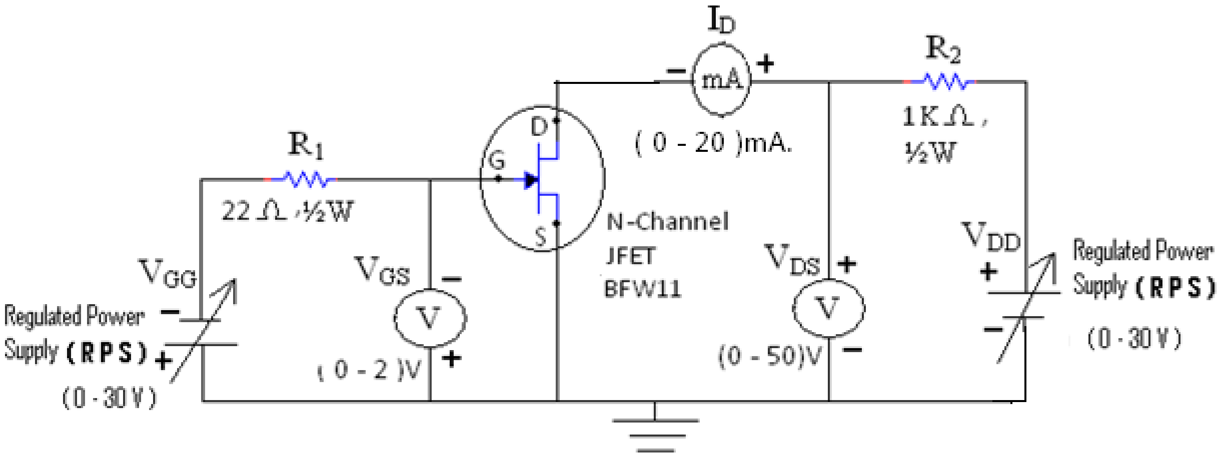


Figure: Circuit diagram of FET characteristics

PROCEDURE :

A). Transfer characteristics :

1). Connected the circuit as per the circuit diagram.

2). Switched ON the RPS and all the meters.

3). Kept the V_{DS} voltage at constant 2V by varying the drain forward voltage i.e. V_{DD}.

4). Varied the gate reverse voltage V_{GG} in steps of 0.00V, 0.20V, 0.40V, 0.60V, 0.80V, 1.00V, 1.2V, 1.4V, 1.6V, 1.8V, 2V and noted down the corresponding readings of V_{GS} and I_D meters.

5). Now kept the V_{GG} is at 0V.

6). Repeated the same procedure from step 4 to step 5 for V_{DS}=4V by varied the V_{DD}.

7). Switched OFF the RPS and all the meters.

8). Plotted the graph between V_{GS} on X-axis and I_D on Y-axis.

9). Calculated the *transconductance* value from the graph as per the formula which is given under the heading of *parameters.*

Note:*Do not vary the supply voltage V_{DD} unless V_{GG} is kept at 0 Volts.*

B). Static/Drain characteristics :

1). Connected the circuit as shown in the circuit diagram.

2). Now Switched *ON* the *RPS* and all the meters.

3). Kept the V_{GS} = 0V by varying the supply voltage V_{GG}.

4). Varied the supply voltage V_{DD} in steps of 00.00V, 00.50V, 01.00V, 02.00V, 04.00V, 06.00V,08.00V, 10.00V, 12.00V, 14.00V, 16.00V, 18.00V, 20.00V, 24.00V, 28.00V, 30.00V and noted down the corresponding readings of V_{DS} and I_D meters.

5). Now kept the V_{DD} is at 0V.

6). Repeated the same procedure from steps 4 to 5 for each time independently when V_{GS} = -0.5V& V_{GS} = - 01.00V by varying the V_{GG}.

7). Now switched OFF the RPS and all the meters.

Note:*Do not vary the supply voltage V_{GG} unless V_{DD} is kept at 0 Volts.*

8). Plotted the graph between V_{DS} on X-axis and I_D on Y-axis.

9). Calculated the *drain resistance* value from the graph and *amplification factor* as per the formulas which are given under the heading of *parameters.*

TABULAR COLUMNS :

A). Transfer Characteristics :

SL.No.	V_{GG} (V)	V_{DS}=2V		V_{DS}=4V	
		V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)
1	00.00				
2	00.20				
3	00.40				
4	00.60				
5	00.80				
6	01.00				
7	01.20				
8	01.40				
9	01.60				
10	01.80				
11	02.00				

B). Static / Drain Characteristics :

SL.No.	V_{DD} (V)	V_{GS} = 0V		V_{GS} = -0.5V		V_{GS} = -1V	
		V_{DS} (V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)
1	00.00						
2	00.50						
3	01.00						
4	02.00						
5	04.00						
6	06.00						
7	08.00						
8	10.00						
9	12.00						
10	14.00						
11	16.00						
12	18.00						
13	20.00						
14	24.00						
15	28.00						
16	30.00						

EXPECTEDGRAPHS :

A). Transfer characteristics :

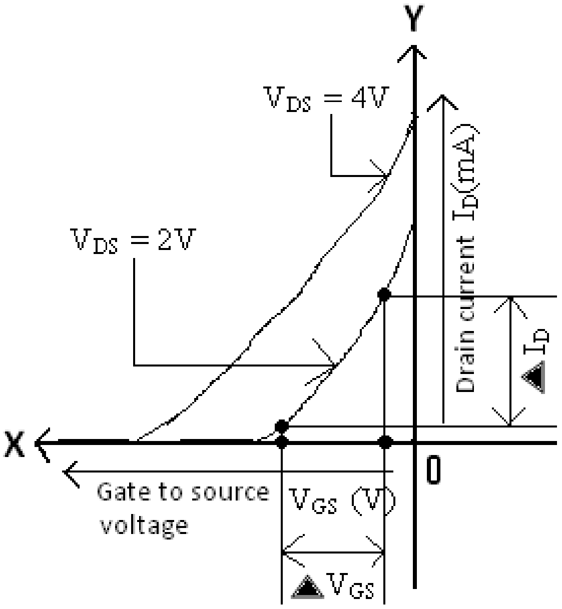


Figure: Measurement of h- parameters of FET in transfer characteristics.

B). Static/drain characteristics :

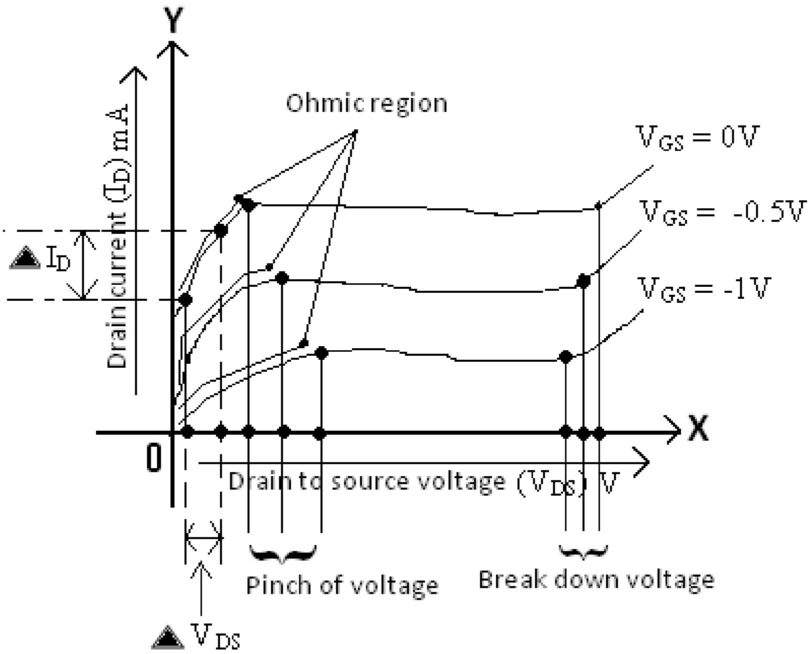


Figure: Measurement of h- parameters of FET in static/drain characteristics.

PARAMETERS :

1). Transconductance(g_m)= ΔI_D / ΔV_{GS} At V_{DS} is constant.
=

(Calculated from transfer characteristics curve)

2). Drain resistance (r_d) = ΔV_{DS} / ΔI_D At V_{GS} is constant.
=

(Calculated from static/drain characteristics curve)

3). Amplification factor (g_m) = Drain resistance (r_d) × Transconductance(g_m).
=

RESULT :

The *transfer* and *static/drain* characteristics are observed. The parameters *drain resistance (r_d)*, *transconductance (g_m)* and *amplification factor (μ)* are calculated.

VIVA VOCE QUESTIONS:

1. What is the Difference between BJT and FET?
2. What are the transfer characteristics?
3. What are the drain characteristics?
4. What are the applications of FET?
5. FET is which controlled device?
6. Mention FET characteristics.
7. What are the configurations of FET?
8. What are the classifications of FET?
9. Which configuration mostly used in FET?
10. What are the advantages of FET?

Experiment No. : 7 **Date :**

Name of the Experiment : UNI JUNCTION TRANSISTOR (UJT) CHARACTERISTICS

AIM :

To draw the volt ampere / static characteristics of ***UJT.***

APPARATUS :

1. Regulated power supply (RPS) : (0-30)V, 1A		Dual channel	----------	1 No.
2.Voltmeters :	i). (0-10) V	Analog	----------	1No.
3. Ammeters :				
	i). (0-20) mA	Digital	----------	1 No.
4. Bread board			----------	1 No.
5. Connecting wires			----------	A few Nos.

COMPONENTS :

1. UJT 2N2646		---------	1No.
2. Resistors :--			
	i). 2 . 2 KΩ, 1/2W	---------	1 No.

THEORY :

A Uni junction Transistor (UJT) is an electronic semiconductor device that has only one junction. It has three terminals an emitter (E) and two bases (B1 and B2). The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p-type and it is heavily doped. The resistance between B1 and B2, when the emitter is opencircuit is called interbase resistance. The original UJT, is a simple device that is essentially a bar of N type semiconductor material into which P type material has been diffused somewhere along its length.

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

CIRCUIT DIAGRAM :

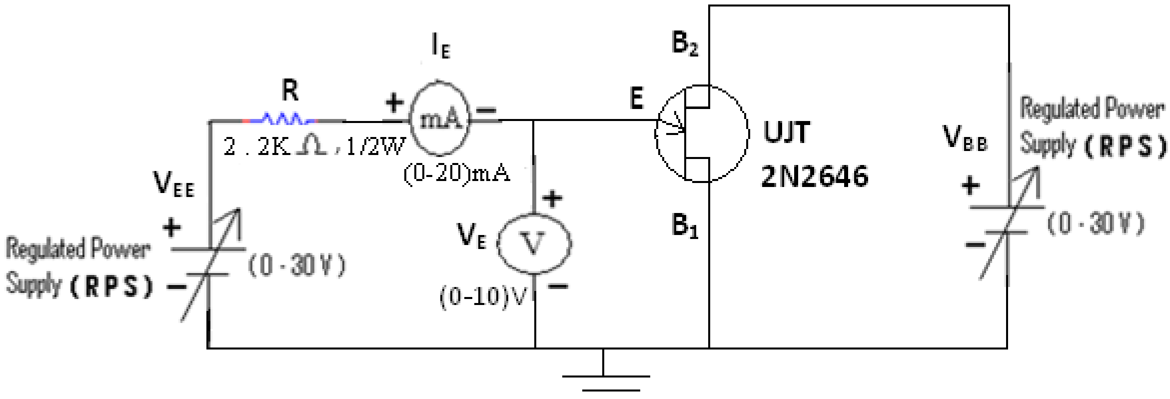


Figure: Circuit diagram of Unijunction transistor characteristics.

PROCEDURE :

1. Connections are made as per the circuit diagram.
2. Kept the $\mathbf{V_{BB}}$ at **4V** by varying the $\mathbf{V_{BB}}$i.e. Regulated Power Supply(RPS).
3. By varied the V_{EE}I observed that in $V_E$at one certain peak (max.) point itis suddenly fallen and noted the two readings of V_{EE}, V_E, I_E at which the V_E is falling just from its maximum point& after the fallen,in the table form-1.
4. Now Kept the V_{EE} at 0V.
5. By varied the $\mathbf{V_{EE}}$ in steps i.e 0V, 2.6V, 2.7V, 2.8V, 2.9V, 3.0V, 5.5V, 5.6V, 5.7V, 5.8V, 5.9V, 6.0V, 6.2V, 6.4V, 10V, 20V, 30V I have noted down the corresponding readings of $\mathbf{V_E}$&$\mathbf{I_E}$into thetabular form-2.
6. Inserted the readings which are available in tabular form-1 into the tabular form-2 in ascending order.
7. After completed of taken the readings, kept the $\mathbf{V_{EE}}$ at **0V**.
8. Now I have kept the $\mathbf{V_{BB}}$at **8V**olts by varying $\mathbf{V_{BB}}$i.e. Regulated Power Supply(RPS).
9. Repeat the same steps from 3 to 7 .
10. After completed of taken the readings, kept the $\mathbf{V_{EE}}$&$\mathbf{V_{BB}}$at **0V**.
11. Finally switched **OFF** the RPS and all meters.
12. Plotted the graph by taken the Emitter current $\mathbf{I_E}$ on **X** – axis and Emitter voltage $\mathbf{V_E}$ on **Y-**axis using the readings in tabular form – 2.
13. Calculated the *Negative resistance* and *Intrinsic stand of ratio* from the graph, according to the formulas, which are given under the heading of **PARAMETERS**

TABULAR FORM - 1 :

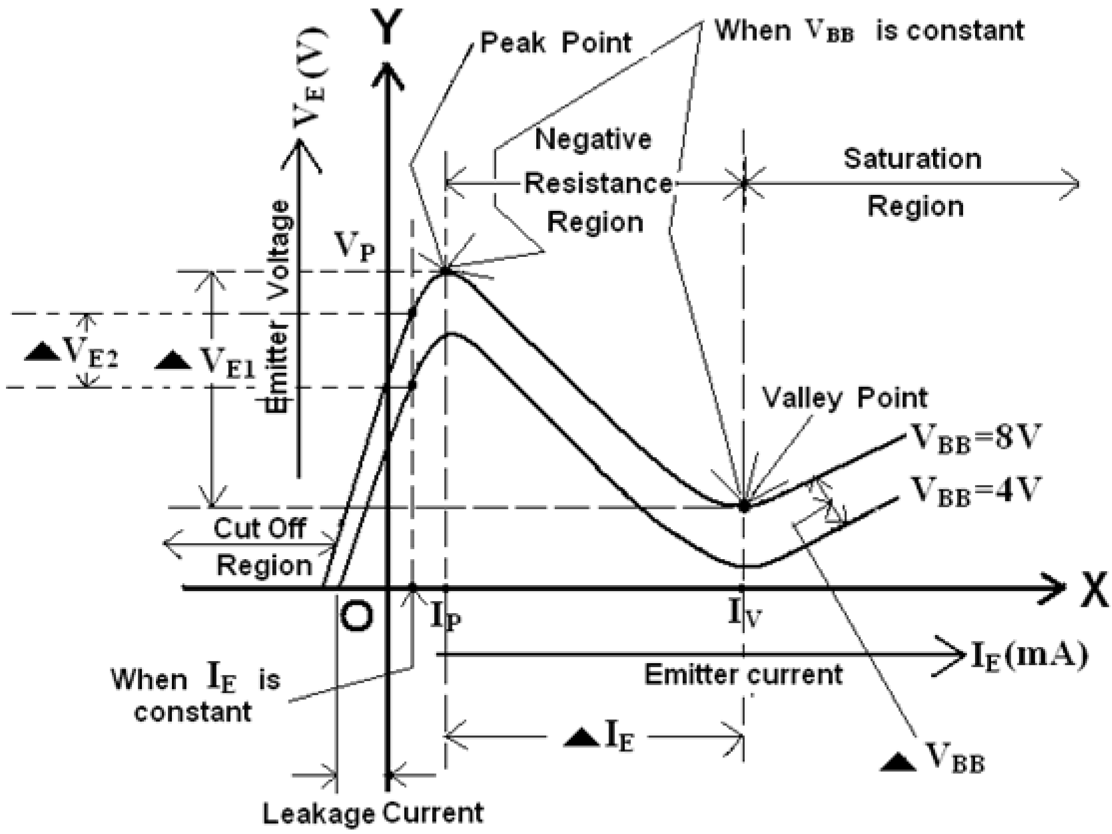
Sl.No.	V_{BB} = 4 Volts			V_{BB} = 8 Volts		
	V_{EE} in volts	V_E in Volt	I_E in mA	V_{EE} in volts	V_E in Volts	I_E in mA
1. Just before the max point at which suddenly fallen in V_E						
2. Just after fallen from max. point in $\mathbf{V_E}$						

TABULAR FORM - 2 :

Sl.No.	V_{BB} = 4 Volts			V_{BB} = 8 Volts		
	V_{EE} in volts	V_E in Volt	I_E in mA	V_{EE} in volts	V_E in Volts	I_E in mA
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						

EXPECTED GRAPH :

The following graph shows for ***Uni junction Transistor Characteristics.***



PARAMETERS :

1. Negtive resistance $= \dfrac{\Delta V_{E1}}{\Delta I_E}$ When, V_{BB} is constant

2. Intrinsic stand off ratio $\eta = \dfrac{\Delta V_{E2}}{\Delta V_{BB}}$ When, I_E is constant

Note: The typical value of ***Intrinsic stand off ratio*** is 0.51 to 0.82

RESULT :

We have drawn the graph for volt ampere characteristics of *Unijunction Transistor*.

VIVA VOCE Questions:

1. What is UJT?

2. Which device used in relaxation oscillators?

3. UJT operating in which resistive region?

4. Mention the UJT Applications.

5. What is the intrinsic standoff ratio?

6. Mention typical value of intrinsic standoff ratio.

7. P-side Emitter in UJT is___________doped. (heavily or lightly)

8. When Emitter terminal of UJT is open then the resistance of the base terminal is ______ (very high or very low).

9. How many terminals are there in a UJT?

10. Which type of material is the channel

Experiment No. : 8 **Date :**

Name of the Experiment :CATHODE RAY OSCILLOSCCOPE (CRO) OPERATION & ITS MEASUREMENTS

AIM : To study the operation of Cathode Ray Oscilloscope (CRO).

APPARATUS :

1). Cathode Ray Oscilloscope (CRO) -- 1 No.
2). Function Generator -- 1 No.
3). Probes --- 1 No.
4). Connecting wires : --- A few Nos.

1). CATHODE RAY OSCILLOSCOPE (CRO) :

The following figure shows the front panel diagram of the *CRO*.

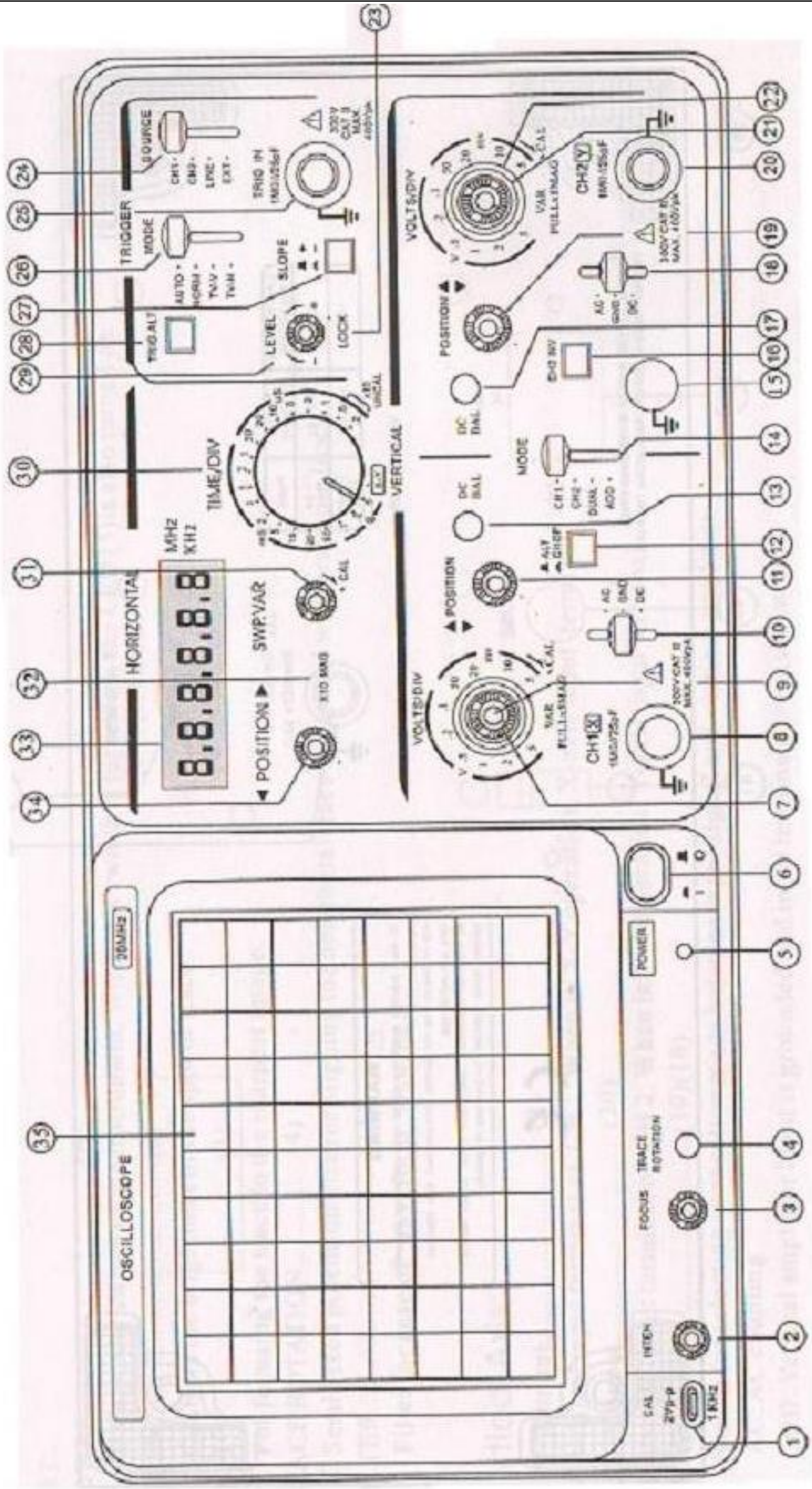


Figure: Front pannel controls of CRO

1.1). APPLICATIONS OF CRO :

The CRO mainly can be used to calculate the,
1). Time period and Frequency measurement of the signal.
2). Voltage or Amplitude measurement of the signal.
3). Current measurement of the signal.

1.2). FUNCTIONS OF CONTROLS, CONNECTORS AND INDICATORS OF CRO:

Before turning this instrument on familiarize yourself with the controls, connectors and indicators and other features described in this section. The following description are keyed to the items called out in the figure, which is in the next page.

SI. No.	Name of the Control / Item.	Control No/ Item No.	Function
1	POWER	6	Main power switch of the instrument. When this switch is turned ON, the LED (5) is also turned ON.
2	INTENSITY	2	Controls the brightness of the spot or trace.
3	FOCUS	3	For focusing the trace to the sharpest image.
4	TRACE ROTATION	4	Semi – fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.
5	FILTER	35	Filter for ease of waveform viewing.
6	CH1 (X) input	8	Vertical input terminal of CH1. When in X-Y operation, X-axis input terminal.
7	CH1 (Y) input	20	Vertical input terminal of CH2. When in Y- operation, Y-axis input terminal.
8	AC-GND-DC	10,18	Switch for selecting connection mode between input signal and vertical amplifier. **AC** : AC coupling **GND** : Vertical amplifier input is grounded and input terminals are disconnected. **DC** : DC coupling
9	VOLTS/DIV	7,22	Select the vertical axis sensitivity, from 5mV/DIV to 5V/DIV in10 ranges.
10	VARIABLE	9,21	Fine adjustment of sensitivity, with a factor of ½.5 of the indicated value. When in the CAL position, sensitivity is calibrated to indicated value. When this knob is pulled out (x5 MAG state), the amplifier sensitivity is multiplied by 5.
11	CH1 & CH2 DC BAL.	13,17	These are used for the attenuator balance adjustment.
12	VERTICAL POSITION	11,19	Vertical position control of trace or spot.
13	VERT MODE	14	Select the operation modes of CH1 & CH2 amplifiers. **CH1** : The oscilloscope operates as a single channel instrument with CH1 alone. **CH2** : The oscilloscope operates as a single channel instrument with CH2 alone.

P.T.O.

Continued for description of CRO controls.

SI. No.	Name of the Control / Item.	Control No/ Item No.	Function
14	ALT/CHOP	12	When this switch is released in the dual-trace mode, the channel 1 and channel 2 inputs are alternately displayed (Normally used at faster sweep speeds). When this switch is engaged in the dual-trace mode, the channel 1 and channel 2 inputs are chopped and displayed simultaneously (normally used at slower sweep speeds).
15	CH2 INV	16	Inverts the CH2 input signal when the CH2INV switch mode is pushed in. The channel2 input signal in ADD mode and the channel2 trigger signal pick off are also inverted.
16	EXT TRIG IN	25	Input terminal is used for external triggering signal. To use this terminal, set SOURCE switch (24) to the EXT position.
17	SOURCE	24	Select the internal triggering source signal, and the EXT TRIG IN input signal **CH1**: When the VERT MODE switch (14) is set in the DUAL or ADD state, select CH1 for the internal triggering source signal. **CH2**: When the VERT MODE switch (14) is set in the DUAL or ADD state, select CH2 for the internal triggering source signal. **LINE**: To select the AC power line frequency signal as the triggering signal. **EXT**: The external signal applied through EXT TRIG IN input terminal (25) is used for the external triggering source signal.
18	TRIG.ALT	28	When the VERT MODE switch (14) is set in the DUAL or ADD state, and the SOURCE switch (24) is selected at CH1 or CH2, with the engagement of the TRIG.ALT switch (28), it will alternately select CH1 & CH2 for the internal triggering source signal.
19	CAL	1	This terminal delivers the calibration voltage of $2V_{p-p}$ approx. 1KHz, positive square wave.
20	GND	15	Ground terminal of oscilloscope mainframe.
21	FREQUENCY METER	33	Display a synchronized signal frequency (models have this function only).
22	SLOPE	27	Select the triggering slope. **"+"** : Triggering occurs when the triggering signal crosses the triggering level in positive-going direction. **"-"** : Triggering occurs when the triggering signal crosses the triggering level in negative-going direction.
23	LEVEL	29	To display a synchronized stationary waveform and set a start point for the waveform Towards "+": The triggering level moves upward on the display waveform. Towards "-": The triggering level moves downward on the display waveform.

P.T.O.

Continued for description of CRO controls

SI. No.	Name of the Control / Item.	Control No/ Item No.	Function
24	LOCK	23	Click LEVEL by fully clockwise position, then triggering level is automatically maintained at optimum value irrespective of the signal amplitude, requiring no manual adjustment of triggering level.
25	TRIGGER MODE	26	Select the desired trigger mode. **AUTO**: When no triggering signal is applied or when triggering signal frequency is less than 25Hz, sweep runs in the free run mode. **NORM:** When no triggering signal is applied, sweep is in a ready state and the trace is blanked out. Used primarily for observation of signal 25Hz. **TV-V:** This setting is used when observing the entire vertical picture of television signal. **TV-H:** This setting is used when observing the entire horizontal picture of television signal. (Both TV-V & TV-H synchronize only when the synchronizing signal is negative.)
26	TIME/DIV	30	Sweep time ranges are available in 20 steps from 0.2µs/DIV to 0.5S/DIV. **X-Y**: This position is used when using the instrument as an X-Y oscilloscope.
27	SWAP.VAR	31	Vernier control of sweep time. This control works as CAL and the sweep time is calibrated to the value indicated by TIME/DIV of sweep can be varied continuously when shaft is out of CAL position. Then the control is rotated in the direction of arrow to the full, the CAL state is produced and the sweep time is calibrated to the value indicated by TIME/DIV. Counterclockwise rotation to the full delays the sweep by 2.5 times or more.
28	×10 MAG	32	When the button is pushed in, a magnification of 10 occurs.
29	POSITION	34	Horizontal positioning control of the trace or spot.

1.3). RULES TO OPERATE THE CRO:

The following rules should be follows before operate the CRO.

1. Keep the following controls at middle position or vary until the electron beamis generated.

   a) INTENSITY b) FOCUS c) ◀▶ (Horizontal position)
   (Horizontal position common for both channels)

   d) ▲▼POSITION e) LEVEL (Trigger Level)
   (Verticalposition individual per each channel)

2. Keep the following controls at maximum position.
   a) **VARIABLE** controls of VOLTS/DIV switch in both channels.
   b) **SWP.VAR** (Sweep Variation)

3. Keep the following switches at releasing mode.
   a) ×10 MAG b) TRIG.ALT c) SLOPE d) ALT/CHOP e) CH2 INV

4. Initially should keep the **TIME/DIV** control at 1mS position, later can change this switch depending upon our requirement , i.e. if we can't get the signal clearly on the CRT, then we can vary this switch until to get the signal.
5. Set the channel selector control **MODE** at the appropriate position i.e. if we want to see the signal in channel1, set this control at CH1, in channel2 set at CH2, in both channels set at DUAL. To add the signals (algebraically sum or difference) available in both channels set at ADD.
6. **AC/GND/DC**: Before setting the signals on CRT, first we should keep the electron beam on reference line. To set this beam on reference line, keep this control at GND position and then vary vertical position control until to get the beam on the reference line. After that to see the applied signals, keep this control at AC or DC positions.
7. Always keep the **TRIGGER MODE** control at AUTO position.
8. Keep the **SOURCE** control at approximate channel. It means if MODE control is selected to CH1, then the SORCE control should select to CH1. If MODE control at CH2, set the SOURCE control at CH2. If MODE control at DUAL or ADD, set the SOURCE control either at CH1 or CH2.

1.4). PRECAUTIONS TO BE TAKEN TO OPERATE THE CRO:

Always should maintain the Intensity/Brightness enough to visible electron beam. Otherwise either the intensity is low or high then the life of the CRT can decreases.

NOTE:If the signal is in running movement, then should maintain the signal at constant by adjusting the **TRIGGER LEVEL** control and by setting the **SOURCE** control at appropriate channel position.

1.5). FREQUENCY MEASUREMENT:

The following instructions should be followed to calculate the frequency of the given signal either it is sine wave, square wave, triangle wave or saw tooth wave.

1. Keep the **AC/GND/DC** control at **GND**.
2. Set the electron beam at the reference line.
3. Keep the **AC/GND/DC** control at **AC**.
4. Apply the any signal from the function generator.
5. Count the no. of units (divisions) occupied by the one complete cycle i.e. one positive half cycle and one negative half cycle of the signal.
6. Multiply these units with present factor of the **TIME/DIV** control, then the result becomes as ***time period*** of the signal. The time period can defined as the signal which can take the time to complete one cycle (One +ve and –ve half cycles) of the signal.
7. Once calculated the time period it is easy to calculate the *frequency*. The *frequency* can calculate by usingthe following formula,

f = 1 / time period

1.6). VOLTAGE (AMPLITUDE) MEASUREMENT:

The following instructions should be followed to calculate the AC voltage (AC amplitude)and DC voltage (DC amplitude) of the given signal either *sine wave, square wave, triangle wave or saw tooth wave.*

AC Voltage Measurement:

1. Keep the **AC/GND/DC** control at **GND.**
2. Set the electron beam at the reference line.
3. Keep the **AC/GND/DC** control at **AC.**
4. Apply the any signal from the function generator.
5. Count the no. of units or divisions occupied from positive peak to negative peak of the signal.
6. Multiply these units with factor of **VOLTS/DIV** control. Then the resultant value is said as peak to peak voltage OR peak to peak amplitude of that signal.
7. To get the peak voltage OR peak amplitude just divide the peak to peak voltage with *2*.

DC Voltage Measurement:

1. Keep the **AC/GND/DC** control at **GND.**
2. Set the electron beam at the reference line.
3. Keep the **AC/GND/DC** control at **DC.**
4. Apply the DC voltage signal from the Regulated Power Supply(RPS).
5. Count the no. of units or divisions occupied from reference line by the signal.
6. Multiply these units with factor of **VOLTS/DIV** control. Then the resultant value is said as DC voltage OR DC amplitude of that signal.

1.6). CURRENT MEASUREMENT:

It is not possible directly to calculate the Current measurement of the signal. It can calculate by using the **Ohm's Law (I=V/R)** through applying the voltage (From Voltage source or Battery) to the small value of the resistor.

RESULT:

We have studied about the theory and operation of the *Cathode Ray Oscilloscope.*

VIVA VOCE Questions:

1. What is CRO is used for?

2. Which part is called the heart of CRO?

3. What are the basic unit of CRO?.

4. Why is delay line used in CRO?

5. What is the role of an inverter in a CRO?

6. What is XY mode in CRO?

7. How many direction the electron beam is deflection in CRO?

8. What are the control knobs of CRO?

9. What is difference between CRO and CRT?

10. How can you increase the sensitivity of CRO?

Experiment No. : 9 **Date :**

Name of the Experiment: FET - COMMON SOURCE (CS) AMPLIFIER

AIM :

1). To obtain the frequency response of *Common Source FET amplifier.*
2). To calculate the band width of this amplifier.

APPARATUS :

1). Function generator(***FG***)		-------------	1No.
2). Cathode Ray Oscilloscope(***CRO***)		-------------	1 No.
3). Regulated Power Supply (***RPS***) :	Dual channel, (0-30)V, 1A	-------------	1 No.
4). Probes		-------------	1 No.
5). Bread board		-------------	1 No.
6). Connecting wires :		-------------	A few Nos.

COMPONENTS :

1). Transistor BC 547
2) Carbon fixed resistors a). 1.8KΩ, ½W ------------- 1 No.
b). 2.2KΩ , ½W ------------- 2 No.
c). 100KΩ , ½W ------------- 1 No.
3). Capacitors a). 22μF ------------- 2 No.
b). 33μF ------------- 1 No.

THEORY :

Common source FET configuration is probably the most widely used of all the FET circuit configurations for many applications, providing a high level of all round performance.

The common source circuit provides a medium input and output impedance levels. Both current and voltage gain can be described as medium, but the output is the inverse of the input, i.e. 180° phase change. This provides a good overall performance and as such it is often thought of as the most widely used configuration.

CIRCUIT DIAGRAM :

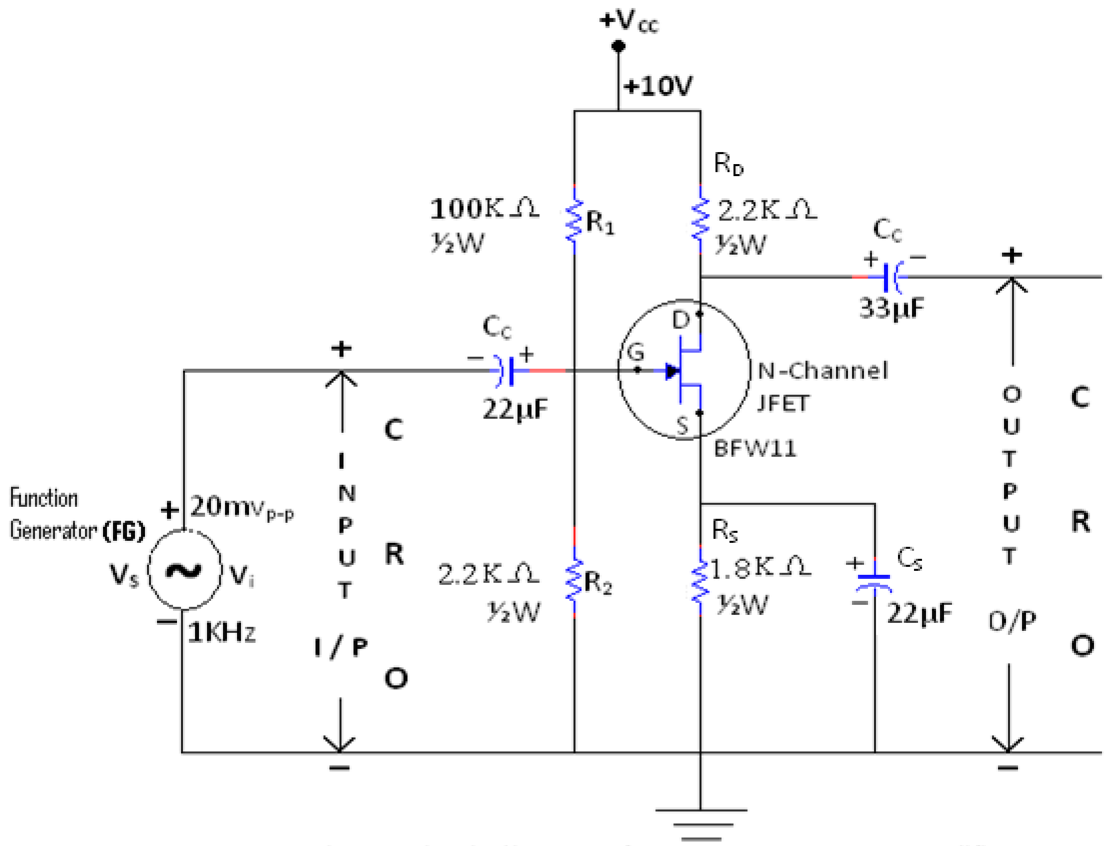


Figure: Circuit diagram of *Common Source FET* amplifier.

PROCEDURE :

1). Connected the circuit as per the circuit diagram.
2). Removed the probe of *CRO* from output (O/P) side and connected it at input (I/P) side to set the input ssignal i.e. sine wave having the value of $20mV_{p-p}$&1KHz.
3). Then switched ON the *function generator* and *CRO*; but don't switched ON the *RPS*.
4). Now Kept the *AC/GND/DC* switch is at *AC* position.
5). Now applied the input signal i.e. sine wave by pressing the sine wave function key in the *function generator*.
6). Initially kept the 1KHz. frequency by varying the frequency control in the *function generator*.
7). Now applied the peak to peak amplitude of a sine wave is of $20mV_{p-p}$ by varying the amplitude control in the *function generator* through observing in the *CRO*.
8). Kept this value of input signal as constant up to the completion of the experiment Otherwise the wrong output would occurred.
9) Then removed the probe of *CRO* from the input side and connected it across the output Side (At *drain* terminal).
10). Now switched ON the *RPS* and set the 10V in it i.e. V_{CC} = 10V.
11). Varied the different frequency steps of 5Hz, 10Hz, 20Hz, 50Hz, 100Hz, 500Hz, 1KHz, 10KHz, 20KHz, 50KHz, 100KHz, 200KHz, 400KHz, 500KHz, 800KHz, 1MHz. by adjusted the frequency control in the *function generator* and noted down the corresponding values of output signal i.e. peak to peak amplitude (voltage) of sine wave by observing in the *CRO*.

12). Now switched OFF the *RPS*, *function generator* and *CRO.*

13). Then calculated the *voltage gain* $A_V = V_O/V_i$ & *gain in dB* = $20\log10(A_V)$ and noted down the values in the specified columns of the tabular column.

14). Plotted the graphs (frequency response curves) as per below,

a). frequency on X-axis & gain in dB on Y-axis.

b). frequency on X-axis & voltage gain on Y-axis.

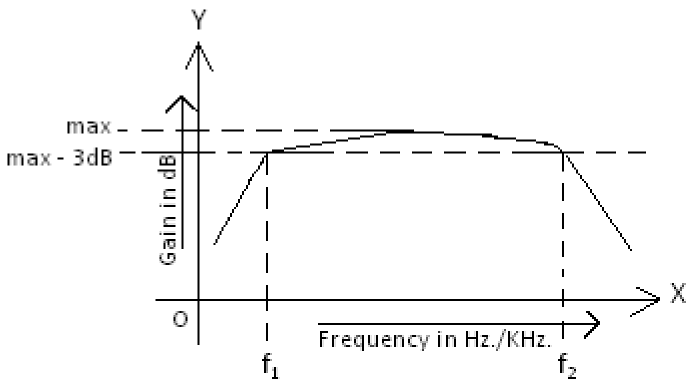
15) Calculated the *band width* from the above two (frequency response curves) graphs by using the formula $f_2 - f_1$ which is given under the heading of *parameters*.

TABULAR COLUMNS :

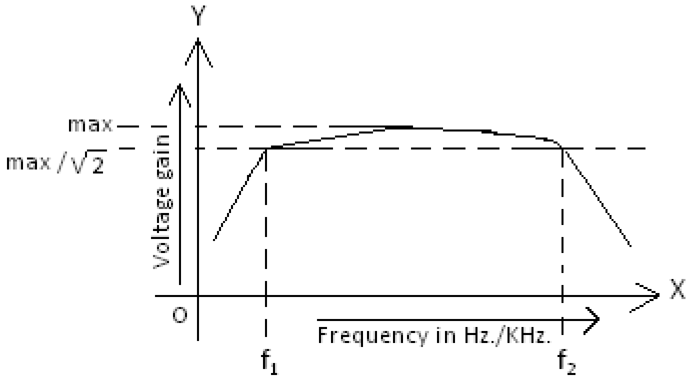
Sl.No.	InputVoltage(V_i) In m.Volts (peak to peak)	Frequency In Hz/KHz.	OutputVoltage(V_O) In Volts.	Voltage gain $A_V = V_o/V_i$	Gain in dB = $20\log_{10}(A_V)$
1	20mV	5Hz.			
2	20mV	10 Hz.			
3	20mV	20 Hz.			
4	20mV	50 Hz.			
5	20mV	100 Hz.			
6	20mV	500 Hz.			
7	20mV	1 KHz.			
8	20mV	10 KHz.			
9	20mV	20 KHz.			
10	20mV	50 KHz.			
11	20mV	100 KHz.			
12	20mV	200 KHz.			
13	20mV	400 KHz.			
14	20mV	500 KHz.			
15	20mV	800 KHz.			
16	20mV	1 MHz.			

EXPECTEDGRAPHS :

A). Frequency response curve for For frequency verses gain in dB.



B). Frequency response curve for For frequency verses voltage gain.



PARAMETERS :

1). Band width of frequency response curve for frequency verses gain in dB. = $f_2 - f_1$

=

2) Band width of frequency response curve for frequency verses voltage gain = $f_2 - f_1$

=

RESULT :

We have obtained the frequency response curves of *Common Source FETAmplifier* (CSFET) for frequency verses gain in dB & frequency verses voltage gain and calculated the band width of both of them. The band width values are given below,

1). Band width of frequency response curve for frequency verses gain in dB. =

2) Band width of frequency response curve for frequency verses voltage gain =

VIVA VOCE Questions :

1. How does common source amplifier work?
2. What are three terminals of FET?
3. What is the advantage of common source FET amplifier?
4. What are the characteristics of common source amplifier?
5. Where are common source amplifiers used?
6. What are the advantages of FET over BJT?
7. What is voltage gain of common source amplifier?
8. Which parameters affect the voltage gain of a common source JFET amplifier?
9. Which JFET configuration is good voltage amplifier?
10. Which is better FET or BJT?
11. What is the difference between FET and BJT
12. What is the difference between mosfet and FET?

Experiment No. : 10 **Date :**

Name of the Experiment: BJT - COMMON EMITTER (CE) AMPLIFIER

AIM :

1). To obtain the frequency response of *Common Emitter amplifier.*
2). To calculate the band width of this amplifier.

APPARATUS :

1). Function generator(***FG***) -------- 1No.
2). Cathode Ray Oscilloscope(***CRO***) -------- 1 No.
3). Regulated Power Supply (***RPS***) : (0-30)V, 1A Dual channel -------- 1 No.
4). Probes -------- 1 No.
5). Bread board -------- 1 No.
6). Connecting wires : -------- A few Nos.

COMPONENTS :

1). Transistor BC 547

2) Carbon fixed resistors a). 100Ω, ½W -------- 1 No.
b). 3.3KΩ , ½W -------- 1 No.
c). 10KΩ , ½W -------- 1 No.
d). 100KΩ , ½W -------- 1 No.
3). Capacitors a). 22µF -------- 2 No.
b). 33µF -------- 1 No.

THEORY :

This is one among the three configurations of these terminals. This configuration is the most widely preferred one because it has both current and the voltage gains which produces the high power gain value. When it operates in between cut-off and the region of saturation the transistor is said to be working as switch. In order to make function as amplifier it must be operating in the region that is active.

A transistor in which the emitter terminal is made common for both the input and the output circuit connections is known as common emitter configuration. When this configuration is provided with the supply of the alternating current (AC) and operated in between the both positive and the negative halves of the cycle in order to generate the specific output signal is known as **common emitter amplifier**.

In this type of configuration the input is applied at the terminal base and the considered output is to be collected across the terminal collector. By keeping emitter terminal is common in both the cases of input as well as output.

Working of Common Emitter Amplifier

Let us considered a CE circuit is provided with the divider circuit of the voltage such that it is provided with the two resistors connected at the input side. In this type of configuration the base is considered to be the input terminal whereas the collector is for collecting the output.

Other than this there are various electronic components are to be included in this circuit. One is the resistor R1 that is the one to make the transistor to function in the forward biasing mode. The R2 is responsible to make the biasing possible. There is the load resistor and the resistor that is connected at the emitter so that it controls the stability related to thermal issue. The resistors R1 and R2 connected across the

terminal base as it is the input side. The load resistor is connected at the output side that is across the collector terminal.

There are capacitors as well in the circuit. The capacitor C1 is at the input side and the capacitor C2 is connected across the emitter resistor. The C1 capacitor is responsible to separate the value of the AC signals from that of DC signals. There exists the inverse relation between the R1 resistor and the biasing.

As R2 tends to increase the biasing tends to increase and vice-versa.Hence this is the reason it is known as CE amplifier.

CIRCUIT DIAGRAM :

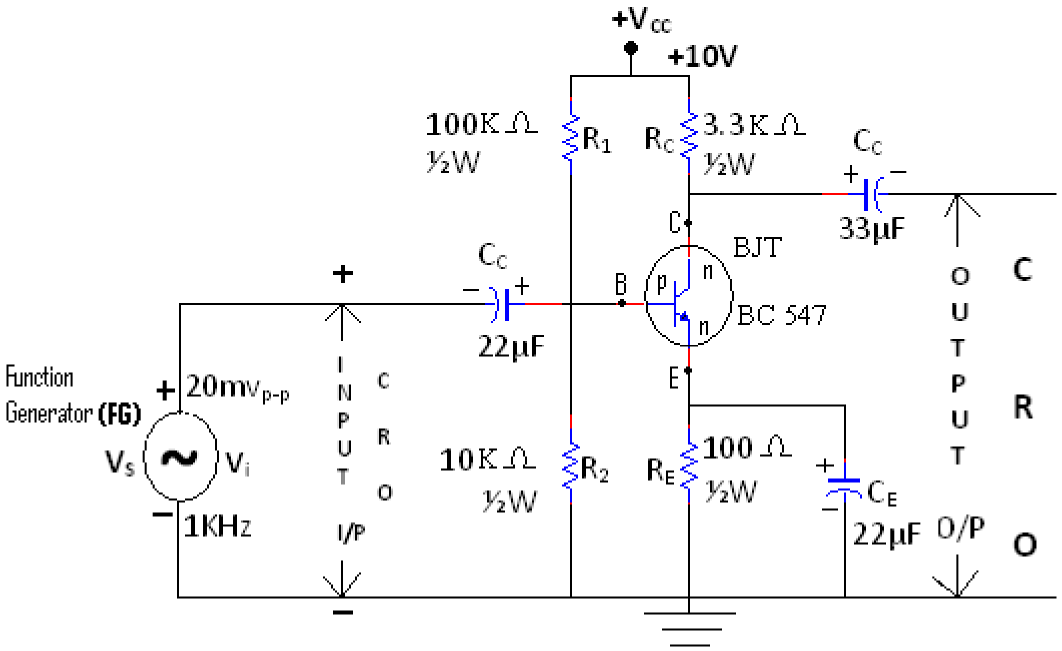


Figure: Circuit diagram of Common Emitter(CE) amplifier.

PROCEDURE :

1). Connected the circuit as per the circuit diagram.

2). Removed the probe of *CRO* from output (O/P) side and connected it at input (I/P) side to set the input signal i.e. sine wave having the value of 20mV$_{p-p}$&1KHz.

3). Then switched ON the *function generator* and *CRO*; but don't switched ON the *RPS*.

4). Now Kept the *AC/GND/DC* switch is at *AC* position.

5). Now applied the input signal i.e. sine wave by pressing the sine wave function key in the *function generator*.

6). Initially kept the 1KHz. frequency by varying the frequency control in the *function generator*.

7). Now applied the peak to peak amplitude of a sine wave is of 20mV$_{p-p}$ by varying the amplitude control in the *function generator* through observing in the *CRO*.

8). Kept this value of input signal as constant up to the completion of the experiment Otherwise the wrong output would occurred.

9) Then removed the probe of *CRO* from the input side and connected it across the output side.

10). Now switched ON the *RPS* and set the 10V in it i.e. V_{CC} = 10V.

11). Varied the different frequency steps of 5Hz, 10Hz, 20Hz, 50Hz, 100Hz, 500Hz, 1KHz,10KHz, 20KHz, 50KHz, 100KHz, 200KHz, 400KHz, 500KHz, 800KHz, 1MHz. by adjusted the frequency control in the *function generator* and noted down the corresponding values of output signal i.e. peak to peak amplitude (voltage) of sine wave by observing in the *CRO*.

12). Now switched OFF the *RPS*, *function generator* and *CRO*.

13). Then calculated the *voltage gain* $A_V = V_O/V_i$ & *gain in dB* = $20log10(A_V)$ and noted down the values in the specified columns of the tabular column.

14). Plotted the graphs (frequency response curves) as per below,

a). frequency on X-axis & gain in dB on Y-axis.

b). frequency on X-axis & voltage gain on Y-axis.

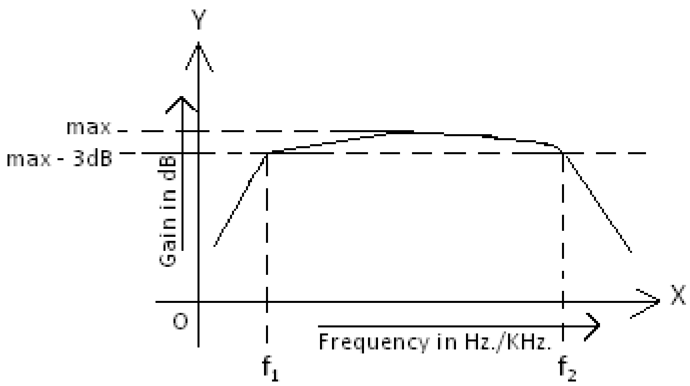
15) Calculated the *band width* from the above two (frequency response curves) graphs by using the formula $f_2 – f_1$ which is given under the heading of *parameters*.

TABULAR COLUMNS :

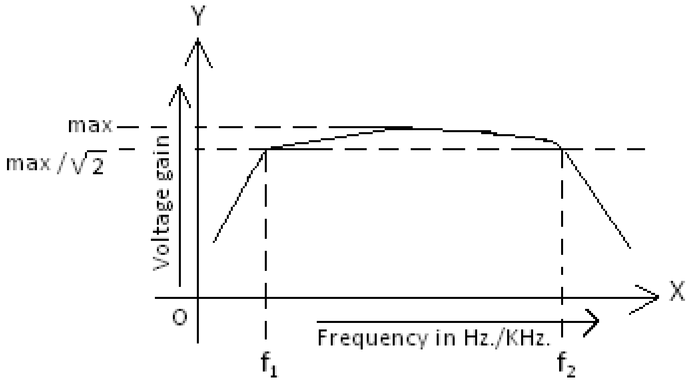
Sl.No.	InputVoltage(V_i) In milli Volts (peak to peak)	Frequency In Hz/KHz.	Output Voltage(V_O) In Volts.	Voltage gain $A_V = V_o/V_i$	Gain in dB = $20log_{10}(A_V)$
1	20mV	5Hz.			
2	20mV	10 Hz.			
3	20mV	20 Hz.			
4	20mV	50 Hz.			
5	20mV	100 Hz.			
6	20mV	500 Hz.			
7	20mV	1 KHz.			
8	20mV	10 KHz.			
9	20mV	20 KHz.			
10	20mV	50 KHz.			
11	20mV	100 KHz.			
12	20mV	200 KHz.			
13	20mV	400 KHz.			
14	20mV	500 KHz.			
15	20mV	800 KHz.			
16	20mV	1 MHz.			

EXPECTEDGRAPHS :

A). Frequency response curve for For frequency verses gain in dB.



B). Frequency response curve for For frequency verses voltage gain.



PARAMETERS :

1). Band width of frequency response curve for frequency verses gain in dB. = $f_2 - f_1$ =

2) Band width of frequency response curve for frequency verses voltage gain = $f_2 - f_1$=

RESULT :

We have obtained the frequency response curves of *Common Emitter Amplifier* (CE) for frequency verses gain in dB & frequency verses voltage gain and calculated the band width of both of them. The band width values are given below,

1). Band width of frequency response curve for frequency verses gain in dB. =

2) Band width of frequency response curve for frequency verses voltage gain =

VIVA VOCE Questions:

1. Define beta DC amplification factors of BJT.
2. Briefly explain reach through effect.
3. Explain the transistor operation with the help of four regions.
4. Compare CB,CE, CC configurations of a transistor.
5. What is the need of biasing?
6. Define stability factor of transistor.
7. What are the advantages of using potential divider bias?
8. Why we use h-parameters to describe a transistor?
9. Mention the characteristics of CE Amplifier.
10. For Amplifier, Transistor operation which region?

Experiment No. : 11 **Date :**

Name of the Experiment : EMITTER FOLLOWER - COMMON COLLECTOR (CC) AMPLIFIER

AIM :

1). To obtain the frequency response of *Common Collector amplifier.*
2). To calculate the band width of this amplifier.

APPARATUS :

1). Function generator(***FG***) ------- 1No.
2). Cathode Ray Oscilloscope(***CRO***) ------- 1 No.
3). Regulated Power Supply (***RPS***) : (0-30)V, 1A Dual channel ------- 1 No.
4). Probes ------- 1 No.
5). Bread board ------- 1 No.
6). Connecting wires : ------- A few Nos.

COMPONENTS :

1). Transistor BC 547
2) Carbon fixed resistors a). 100Ω, ½W ------- 1 No.
b). 3.3KΩ , ½W ------- 1 No.
c). 10KΩ , ½W ------- 1 No.
d). 100KΩ , ½W ------- 1 No.
3). Capacitors a). 22µF -------- 2 No.

THEORY :

Common Collector Amplifier that it gets its name because the collector terminal of the BJT is common to both the input and output circuits as there is no collector resistance, R_C.

The voltage gain of the common collector amplifier is approximately equal to unity ($A_v \cong 1$) and that its current gain, A_i is approximately equal to Beta, ($A_i \cong \beta$) which depending on the value of the particular transistors Beta value can be quiet high.

We have also seen through calculation, that the input impedance, Z_{IN} is high while its output impedance, Z_{OUT} is low making it useful for impedance matching (or resistance-matching) purposes or as a buffer circuit between a voltage source and a low impedance load.

As the the common collector (CC) amplifier receives its input signal to the base with the output voltage taken from across the emitter load, the input and output voltages are "in-phase" (0^o phase difference) thus the common collector configuration goes by the secondary name of *Emitter Follower* as the output voltage (emitter voltage) follows the input base voltage.

CIRCUIT DIAGRAM :

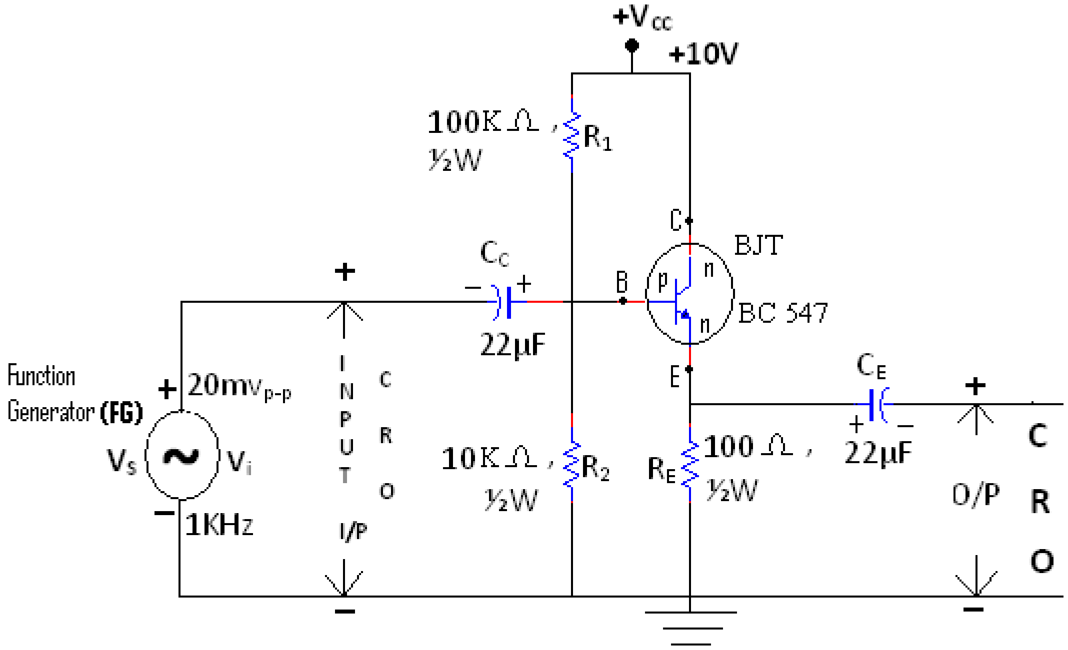


Figure: Circuit diagram of Common collector amplifier.

PROCEDURE :

1). Connected the circuit as per the circuit diagram.
2). Removed the probe of *CRO* from output (O/P) side and connected it at input (I/P) side to set the input signal i.e. sine wave having the value of 20mV$_{p-p}$&1KHz.
3). Then switched ON the *function generator* and *CRO*; but don't switched ON the *RPS*.
4). Now Kept the *AC/GND/DC* switch is at *AC* position.
5). Now applied the input signal i.e. sine wave by pressing the sine wave function key in the *function generator*.
6). Initially kept the 1KHz. frequency by varying the frequency control in the *function generator*.
7). Now applied the peak to peak amplitude of a sine wave is of 20mV$_{p-p}$ by varying the amplitude control in the *function generator* through observing in the *CRO*.
8). Kept this value of input signal as constant up to the completion of the experiment Otherwise the wrong output would occurred.
9) Then removed the probe of *CRO* from the input side and connected it across the output side.
10) Now switched ON the *RPS* and set the 10V in it i.e. V_{CC} = 10V.
11). Varied the different frequency steps of 5Hz, 10Hz, 20Hz, 50Hz, 100Hz, 500Hz, 1KHz, 10KHz, 2 20KHz, 50KHz, 100KHz, 200KHz, 400KHz, 500KHz, 800KHz, 1MHz. by adjusted the frequency control in the *function generator* and noted down the corresponding values of output signal i.e. peak to peak amplitude (voltage) of sine wave by observing in the *CRO*.
12). Now switched OFF the *RPS*, *function generator* and *CRO*.
13). Then calculated the *voltage gain* $A_V = V_O/V_i$ & *gain in dB* = $20\log10(A_V)$ and noted down the values in the specified columns of the tabular column.
14). Plotted the graphs (frequency response curves) as per below,
   a). frequency on X-axis & gain in dB on Y-axis.
   b). frequency on X-axis & voltage gain on Y-axis.
15) Calculated the *band width* from the above two (frequency response curves) graphs by

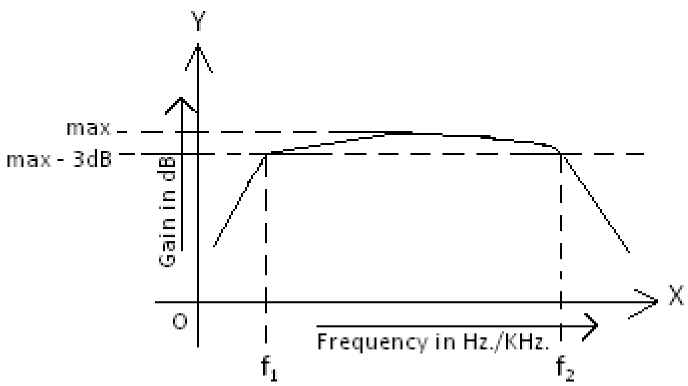
using the formula $f_2 - f_1$ which is given under the heading of *parameters*.

TABULAR COLUMNS :

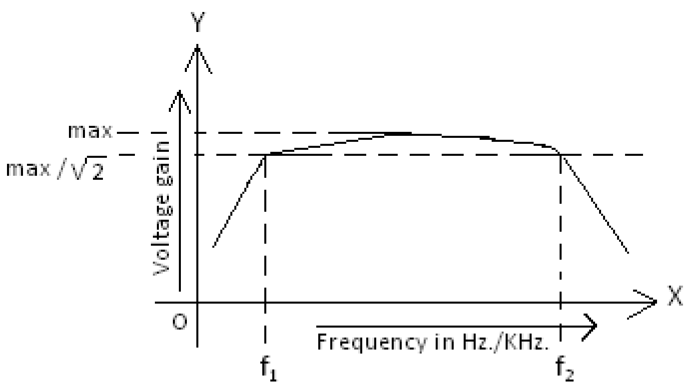
Sl.No.	InputVoltage(V_i) In milli Volts (peak to peak)	Frequency In Hz/KHz.	Output Voltage(V_O) In Volts.	Voltage gain $A_V = V_o/V_i$	Gain in dB = $20\log_{10}(A_V)$
1	20mV	5Hz.			
2	20mV	10 Hz.			
3	20mV	20 Hz.			
4	20mV	50 Hz.			
5	20mV	100 Hz.			
6	20mV	500 Hz.			
7	20mV	1 KHz.			
8	20mV	10 KHz.			
9	20mV	20 KHz.			
10	20mV	50 KHz.			
11	20mV	100 KHz.			
12	20mV	200 KHz.			
13	20mV	400 KHz.			
14	20mV	500 KHz.			
15	20mV	800 KHz.			
16	20mV	1 MHz.			

EXPECTEDGRAPHS :

A). Frequency response curve for For frequency verses gain in dB.



B). Frequency response curve for For frequency verses voltage gain.



PARAMETERS :

1). Band width of frequency response curve for frequency verses gain in dB. = $f_2 - f_1$ =

2) Band width of frequency response curve for frequency verses voltage gain = $f_2 - f_1$ =

RESULT :

We have obtained the frequency response curves of *Common Collector Amplifier* (CC) for frequency verses gain in dB & frequency verses voltage gain and calculated the band width of both of them. The band width values are given below,

1). Band width of frequency response curve for frequency verses gain in dB. =

2) Band width of frequency response curve for frequency verses voltage gain =

VIVA VOICE QUESTIONS:

1. In Emitter follower, which configuration used___________________________(CE or CB or CC)

2. Compare CE, CB, CC Amplifiers.

3. Which one is Buffer Amplifier? (CE or CB or CC)

4. Example for voltage series feedback amplifier.

5. What are the CC Amplifier characteristics?

6. Which Amplifier is having Unity Gain? (CE or CB or CC)

7. What is Band Width?

8. Explain the transistor operation with the help of four regions.

Experiment No. : 12		**Date :**
Name of the Experiment :	**BJT AS A SWITCH**	

AIM :

To design the Switch with self bias using BJT.

APPARATUS :

1). Regulated power supply (RPS)	:(0-30)V, 1A	Dual channel		------	1 No.
2). Ammeter	:(0-2000)μA	Digital	DC Type	------	1 No.
	:(0-20)mA	Digital	DC Type	------	1 No.
3). Digital Multi Meter (DMM)	:	Digital		------	1 No.
4). Bread Board	:			------	1 No.
5). Connecting wires	:			------	A few Nos.
6). System with Multisim software	:			------	1 No.

COMPONENTS :

1). Resistors1/2W	:	1KΩ, 400KΩ, 1MΩ	------	Each 1 No.
2). Bipolar Junction Transistor (BJT)	:	BC547-npn	------	1 No.
3). Buzzer	:		------	1 No.

THEORY :

Bipolar junction transistor (BJT) has three terminals and two junctions. The function of the transistor is to amplify the signal. The three terminals of BJT are base, emitter and collector. BJT is either a PNP transistor or NPN transistor based on the doping type of the three terminals. Using the transistor as a switch is the simplest application of transistors.

How does a BJT act as a switch? A transistor has three modes: active region, cut off region and the saturation region. The transistor acts as a switch in the cut-off mode and the saturation mode. The transistor is fully off in the cutoff region and fully on the saturation region. A transistor can also be used as a switch since a small electric current flowing through one part of it can cause larger current flow through the other part of the transistor.

Design : Design a suitable circuit for switch using BJT, to ON buzzer. The data sheet of Buzzer is given below,

V_{CCmax} = 12V, I_C = 4mA, V_{BE} = 0.75V, β or h_{FE} = 360.

Sol :

$I_C = \beta I_B$

$I_B = I_C / \beta = (4\times10^{-3})/360$

$I_B = 11.11\mu A$

$$R_B = \frac{V_{BB} - V_{BE}}{I_B} = \frac{5-0.75}{11.11\times10^{-6}}$$

$R_B = 382K\Omega$

Choose $R_B = 400K\Omega$

→ In the formula $R_B = \frac{V_{BB} - V_{BE}}{I_B}$

decreased. if R_B increases, I_B decreases

then in $I_C = \beta . I_B$ if β is constant I_B decreases

then I_C is decreased.

→ If we followed to the above condition,

select $R_B >>> 400K$, I choosed R_B = 1M, Now,

$$R_B = \frac{V_{BB} - V_{BE}}{I_B} \Rightarrow \frac{1\times10^6}{1} = \frac{4.25}{I_B}$$

$$I_B = \frac{4.25}{1\times10^6} \Rightarrow \boxed{I_B = 4.25\mu A}$$

$$I_C = \beta . I_B \Rightarrow I_C = 360\times4.25\times10^{-6}$$

$$\boxed{I_C = 1.53mA}$$

→ As per our problem to switched ON Buzzer I_C should 4mA, But if R_B =1M ,then we got I_C = 1.5mA. So this current value could not sufficient. At this condition the buzzer could switched OFF.

CIRCUIT DIAGRAM :

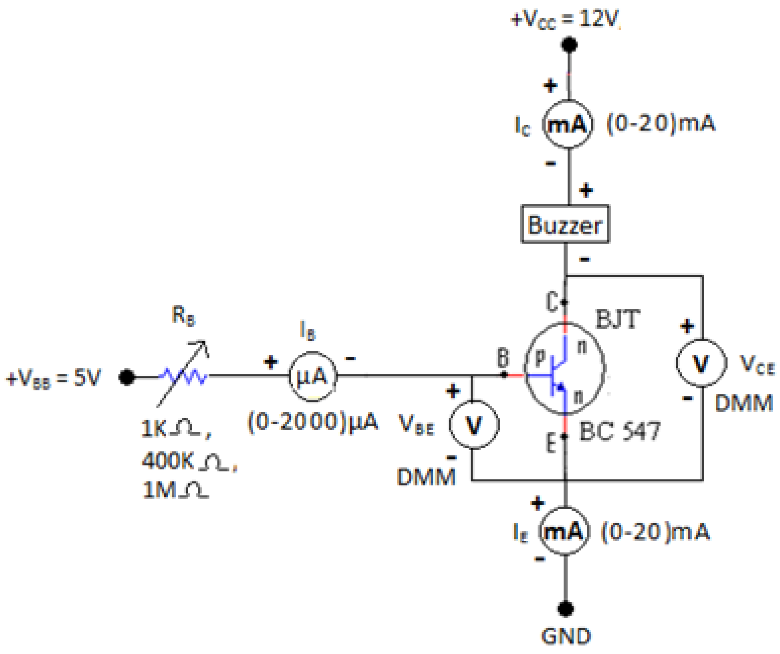


Figure : Circuit diagram of a switch using BJT

PROCEDURE :

1). Connected the circuit as per shown in the circuit diagram.
2). Kept the RPS at 12V as V_{CC}.
3). Kept R_B =1KΩ and noted down the corresponding values in the tabular column.
4). Repeated the above procedure from step 2 to step 3 for R_B = 400KΩ and 1MΩ.
5). Observed that, at R_B = 1KΩ and 400KΩ the BJT is biased why because the V_{BE}>=0.75V and the I_C value is more at R_B =1KΩ as compared to R_B =400KΩ . At these two conditions the Buzzer is switched ON.
6). But BJT didn't bias at R_B = 1MΩ why because the V_{BE}<0.75V and I_C=1.53mA. This current would not sufficient to switched ON the Buzzer.
7). Repeated the same procedure in Multisim software also, and noted down the the corresponding values in the tabular column

TABULAR COLUMN :

		Using Hardware						Using Software				
Sl.No.	**R_B in Ω**	**V_{BE} in Volts**	**V_{CE} in Volts**	**I_C in Volts**	**I_E in Volts**	**I_B in Volts**		**V_{BE} in Volts**	**V_{CE} in Volts**	**I_C in Volts**	**I_E in Volts**	**I_B in Volts**
01	1KΩ											
02	400KΩ											
03	1MΩ											

RESULT :

I have designed the Switch with self bias using BJT.

VIVA VOCE Questions:

1. In which Region Transistor act as Switch? (Active or saturation or cut-off)

2. When Base current is zero, Then Transistor act as________________(Switch off or switch on).

3. What is Early effect in BJT?

4. Compare BJT switch and FET switch.

5. Explain the transistor operation with the help of four regions.

6. What is the Cut- In-Voltage of Transistor?

7. Classification of Transistors.

8. Mention the Transistor applications.

9. What is the importance of biasing in Transistors?

10. Compare CB,CE, CC configurations of a transistor.

Experiment No. : 13 **Date :**

Name of the Experiment : CLIPPING AND CLAMPING CIRCUITS

AIM :

To verify the various clipping and clamping circuits using PN junction diode in Hardware as well U**sing multisim software**

APPARATUS :

1). Regulated power supply ------ 1No.
2). Function generator ------ 1 No.
3). Cahode Ray Oscilloscope (CRO) ------ 1 No.
4). System with Multisim software ------ 1 No.

COMPONENTS :

1). PN junction diode : 1N4007
2). Carbon fixed resistors 10 Ω ,½W, 10 KΩ , ½W ------ Each 1 No.

THEORY :

Diode Clippers :

Most of the electronic circuits like amplifiers, modulators and many others have a particular range of voltages at which they have to accept the input signals. Any of the signals that have an amplitude greater than this particular range may cause distortions in the output of the electronic circuits and may even lead to damage of the circuit components.

As most of the electronic devices work on a single positive supply, the input voltage range would also be on the positive side. Since the natural signals like audio signals, sinusoidal waveforms and many others contain both positive and negative cycles with varying amplitude in their duration.

These waveforms and other signals have to be modified in such a way that the single supply electronic circuits can be able to operate on them.

The clipping of a waveform is the most common technique that applies to the input signals to adapt them so that they may lie within the operating range of the electronic circuits. The clipping of waveforms can be done by eliminating the portions of the waveform which crosses the input range of the circuit.

Clippers can be broadly classified into two basic types of circuits. They are:

- Series Clippers
- Shunt or Parallel Clippers

Series clipper circuit contains a power diode in series with the load connected at the end of the circuit. The shunt clipper contains a diode in parallel with the resistive load.

CIRCUIT DIAGRAM :

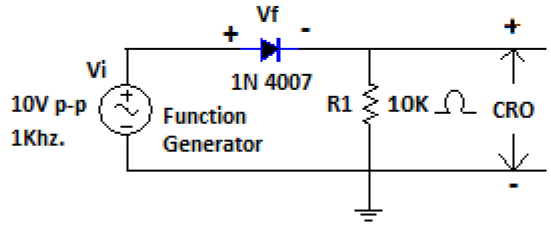


Fig (a) : Negative Series Clipper

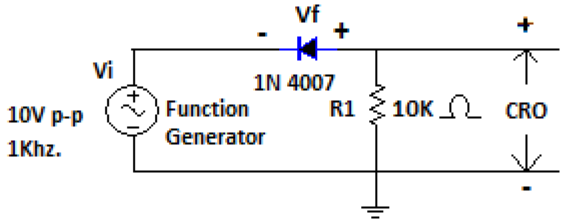


Fig (b) : Positive Series Clipper

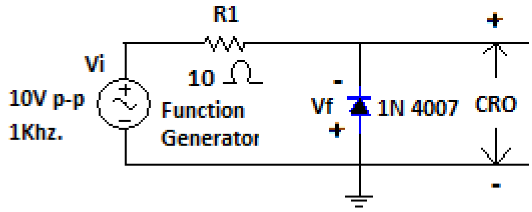


Fig (c) : Negative shunt Clipper

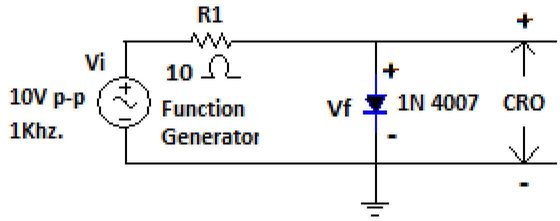


Fig (d) : Positive shunt Clipper

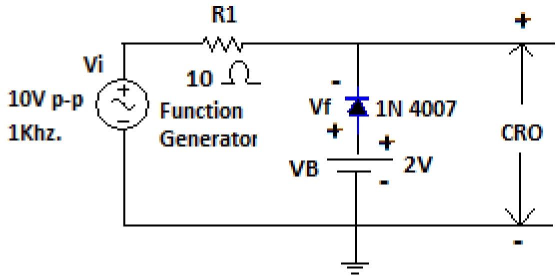


Fig (e) : Biased Clipper

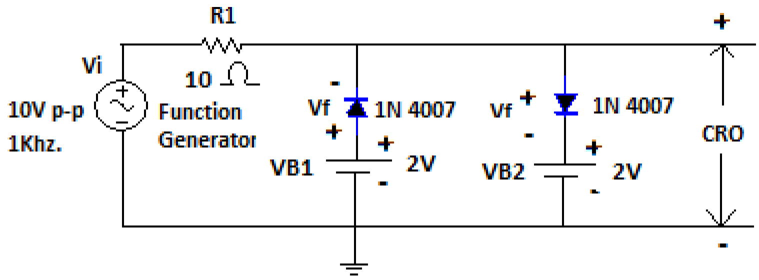


Fig (f) : Two level Clipper

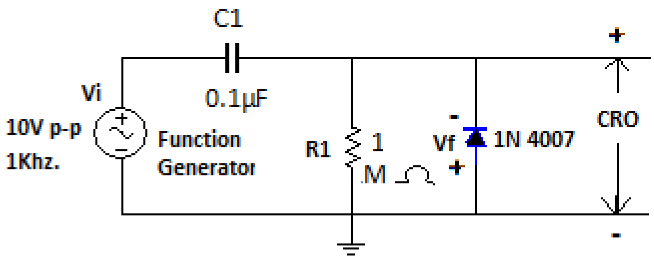


Fig (g) : Positive Clamper

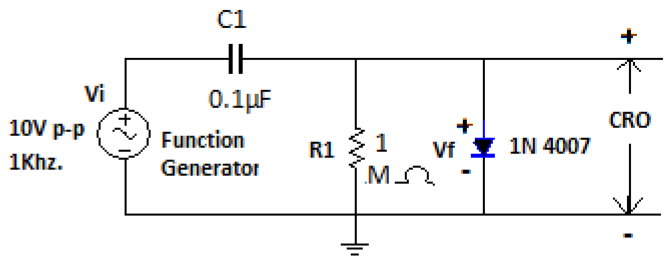


Fig (h) : Negative Clamper

PROCEDURE :

1). Connected the circuit as shown in the circuit diagram of figure (a)
2). Switched ON the Function generator and CRO.
3). Set the sine wave as $10V_{p\text{-}p}$ in the function generator.
4). Observed the wave forms in the CRO and draw in the graph sheets.
5). Repeated the same procedure for circuit diagrams of figures from b to h.
6). Repeated the same procedure using Multisim software.

EXPECTED WAVEFORMS :

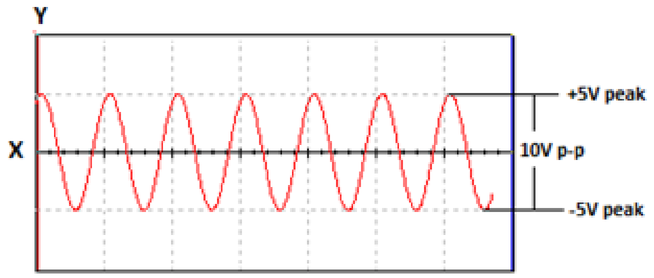


Fig (a) : Input wave form

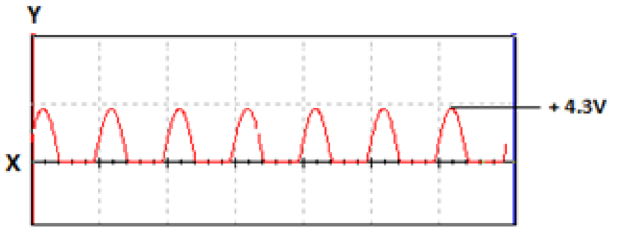


Fig (b) : Negative Series Clipper (CRO in DC mode)

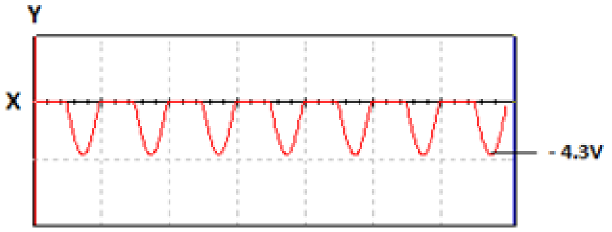


Fig (c) : Positive Series Clipper (CRO in DC mode)

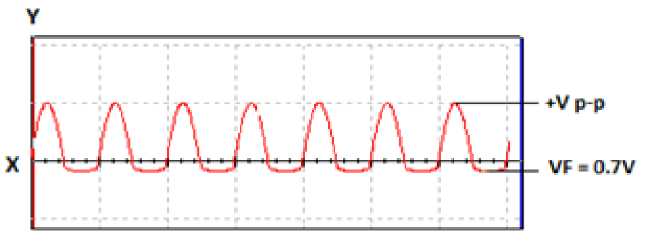


Fig (d) : Negative Shunt Clipper (CRO in DC mode)

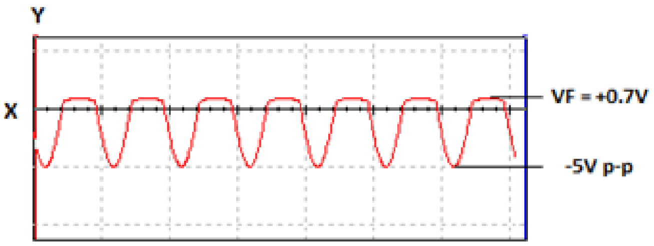


Fig (e) : Positive Shunt Clipper (CRO in DC mode)

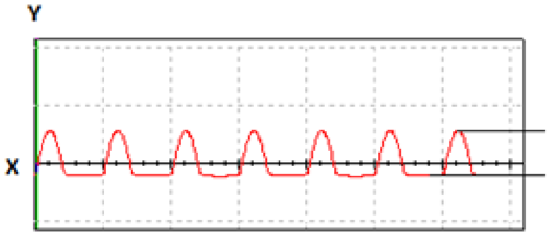


Fig (f) : Biased Clipper (CRO in AC mode)

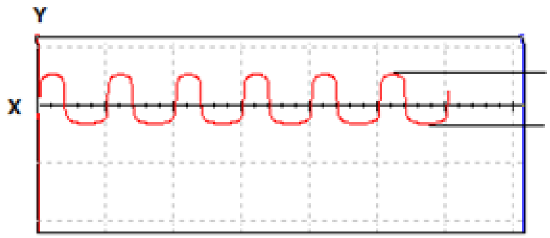


Fig (g) : Two level clipper (CRO in AC mode)

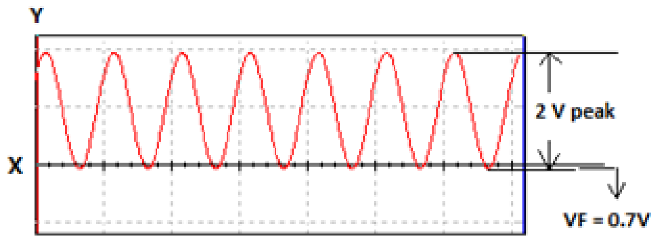


Fig (h) : Positive Clamper (CRO in DC mode)

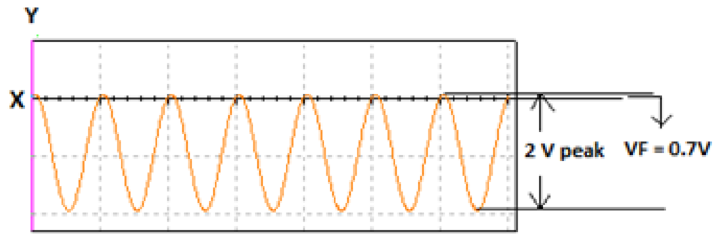


Fig (i) : Negative Clamper (CRO in DC mode)

For Figures b to e and h & i : Scale on X-axis : 1 Unit = 1mS
Y-axis : 1 Unit = 5V

For Figures f&g Scale on X-axis : 1 Unit = 1mS
Y-axis : 1 Unit = 2V

RESULT : We have observed and drawn the output and input wave forms of different types of Clippers and Clampers

VIVA VOICE Questions:

1. What is Clipper?
2. What is Clamper?
3. What is negative series clipper?
4. What is positive series clipper?
5. What is negative shunt clipper?
6. What is positive shunt clipper?
7. What is positive clamper?
8. What is negative clamper?
9. What is two- level clipper?
10. Importance of clippers and clampers.

APPENDIX – A - DATA SHEETS

PN JUNCTION DIODE :

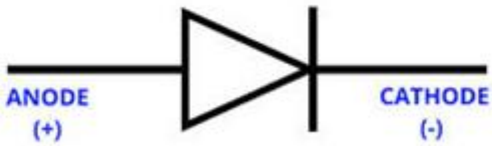
1N4001 - 1N4007 1.0A

Features

- Diffused Junction
- High Current Capability and Low Forward Voltage Drop
- Surge Overload Rating to 30A Peak
- Low Reverse Leakage Current
- Lead Free Finish, RoHS Compliant (Note 3)

Mechanical Data

- Case: DO-41
- Case Material: Molded Plastic. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020D
- Terminals: Finish - Bright Tin. Plated Leads Solderable per MIL-STD-202, Method 208
- Polarity: Cathode Band
- Ordering Information: See Page 2
- Marking: Type Number
- Weight: 0.30 grams (Approximate)



Maximum Ratings and Electrical Characteristics (@T_A = +25°C unless otherwise specified.) Single phase, half wave,

60Hz, resistive or inductive load.

For capacitive load, derate current by 20%.

Characteristic	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	V
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	V
Average Rectified Output Current (Note 1) @ T_A =+75°C	I_O	1.0							A
Non-Repetitive Peak Forward Surge Current 8.3ms Single Half Sine-Wave Superimposed on Rated Load	I_{FSM}	30							A
Forward Voltage @ I_F = 1.0A	V_{FM}	1.0							V
Peak Reverse Current @T_A = +25°C at Rated DC Blocking Voltage @ T_A = +100°C	I_{RM}	5.0 50							µA
Typical Junction Capacitance (Note 2)	C_j	15				8			pF
Typical Thermal Resistance Junction to Ambient	$R_{\theta JA}$	100							K/W
Maximum DC Blocking Voltage Temperature	T_A	+150							°C
Operating and Storage Temperature Range	T_J, T_{STG}	-65 to +150							°C

ZENER DIODE :

TOSHIBA 1Z6.2~1Z390,1Z6.8A~1Z30A

TOSHIBA ZENER DIODE SILICON DIFFUSED JUNCTION TYPE

1Z6.2~1Z390,1Z6.8A~1Z30A

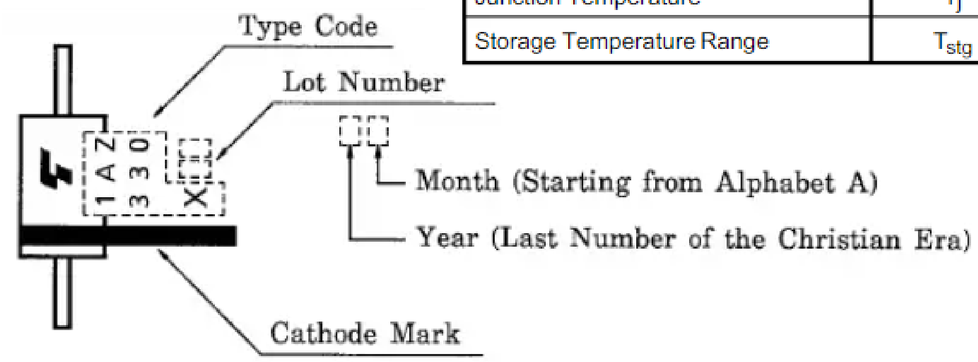
CONSTANT VOLTAGE REGULATION
TRANSIENT SUPPRESSORS

- Average Power Dissipation : P = 1W
- Peak Reverse Power Dissipation : P_{RSM} = 200W at t_W = 200μs
- Zener Voltage : V_Z = 6.2 ~ 390V
- Tolerance of Zener Voltage
  1Z6.2 Series : ±10%
  1Z6.8A Series : ±5%
- Plastic Mold Package

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Dissipation	P	1	W
Junction Temperature	T_j	−40~150	°C
Storage Temperature Range	T_{stg}	−40~150	°C

MARK



Color : Silver

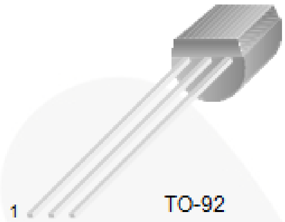
BJT:

FAIRCHILD

BC546 / BC547 / BC548 / BC549 / BC550
NPN Epitaxial Silicon Transistor

Features

- Switching and Amplifier
- High-Voltage: BC546, V_{CEO} = 65 V
- Low-Noise: BC549, BC550
- Complement to BC556, BC557, BC558, BC559, and BC560



TO-92

1. Collector 2. Base 3. Emitter

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Value	Unit
V_{CBO}	Collector-Base Voltage	BC546	80	V
		BC547 / BC550	50	
		BC548 / BC549	30	
V_{CEO}	Collector-Emitter Voltage	BC546	65	V
		BC547 / BC550	45	
		BC548 / BC549	30	
V_{EBO}	Emitter-Base Voltage	BC546 / BC547	6	V
		BC548 / BC549 / BC550	5	
I_C	Collector Current (DC)		100	mA
P_C	Collector Power Dissipation		500	mW
T_J	Junction Temperature		150	°C
T_{STG}	Storage Temperature Range		-65 to +150	°C

Electrical Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-Off Current		V_{CB} = 30 V, I_E = 0			15	nA
h_{FE}	DC Current Gain		V_{CE} = 5 V, I_C = 2 mA	110		800	
V_{CE}(sat)	Collector-Emitter Saturation Voltage		I_C = 10 mA, I_B = 0.5 mA		90	250	mV
			I_C = 100 mA, I_B = 5 mA		250	600	
V_{BE}(sat)	Base-Emitter Saturation Voltage		I_C = 10 mA, I_B = 0.5 mA		700		mV
			I_C = 100 mA, I_B = 5 mA		900		
V_{BE}(on)	Base-Emitter On Voltage		V_{CE} = 5 V, I_C = 2 mA	580	660	700	mV
			V_{CE} = 5 V, I_C = 10 mA			720	
f_T	Current Gain Bandwidth Product		V_{CE} = 5 V, I_C = 10 mA, f = 100 MHz		300		MHz
C_{ob}	Output Capacitance		V_{CB} = 10 V, I_E = 0, f = 1 MHz		3.5	6.0	pF
C_{ib}	Input Capacitance		V_{EB} = 0.5 V, I_C = 0, f = 1 MHz		9		pF
NF	Noise Figure	BC546 / BC547 / BC548	V_{CE} = 5 V, I_C = 200 μA, f = 1 kHz, R_G = 2 kΛ		2.0	10.0	dB
		BC549 / BC550			1.2	4.0	
		BC549	V_{CE} = 5 V, I_C = 200 μA, R_G = 2 kΛ, f = 30 to 15000 MHz		1.4	4.0	
		BC550			1.4	3.0	

h_{FE} Classification

Classification	A	B	C
h_{FE}	110 ~ 220	200 ~ 450	420 ~ 800

UJT :

2N2646
2N2647

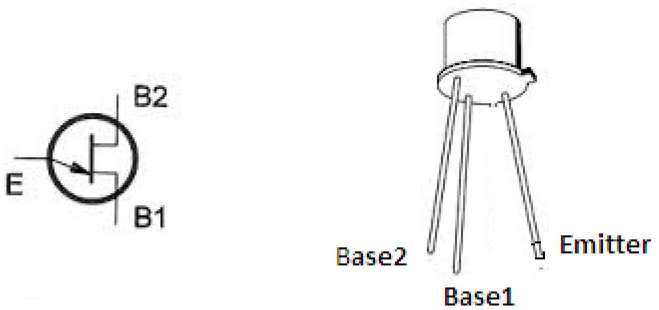
SILICON
PN UNIJUNCTION TRANSISTORS

Central Semiconductor Corp.

www.centralsemi.com

DESCRIPTION:
The CENTRAL SEMICONDUCTOR 2N2646 and 2N2647 devices are silicon PN Unijunction Transistors designed for general purpose industrial applications.

UJT Symbol & Terminal Identification



(a). Symbol (b). Terminal Identification

MAXIMUM RATINGS: (T_A=25°C)	SYMBOL		UNITS
Emitter Reverse Voltage	V_{B2E}	30	V
Interbase Voltage	V_{B2B1}	35	V
RMS Emitter Current	I_e	50	mA
Peak Emitter Current (Duty Cycle ≤1%, PRR≤10pps)	i_e	2.0	A
RMS Power Dissipation	P_D	300	mW
Operating and Storage Junction Temperature	T_J, T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS: (T_A=25°C unless otherwise noted)

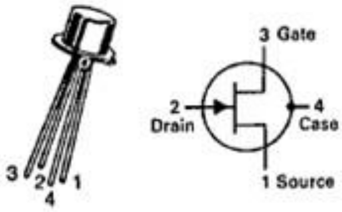
SYMBOL	TEST CONDITIONS	2N2646 MIN	2N2646 MAX	2N2647 MIN	2N2647 MAX	UNITS
η	V_{B2B1}=10V	0.56	0.75	0.68	0.82	
R_{BB}	V_{B2B1}=3.0V	4.7	9.1	4.7	9.1	kΩ
I_{EB2O}	V_{B2E}=30V	-	12	-	0.2	μA
I_V	V_{B2B1}=20V, R_{B2}=100Ω	4.0	-	8.0	18	mA
I_P	V_{B2B1}=25V	-	5.0	-	2.0	μA
V_{OB1}	V_1=20V	3.0	-	6.0	-	V

JFET :

MOTOROLA SC {XSTRS/R F}

BFW10
BFW11

CASE 20-03, STYLE 1
TO-72 (TO-206A)



JFET
VHF/UHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−30	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage ($I_G = 10\ \mu Adc, V_{DS} = 0$)		$V_{(BR)GSS}$	30	—	—	Vdc
Gate-Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $I_D = 0.5$ nAdc)	BFW10 BFW11	$V_{GS(off)}$	—	—	8 6	Vdc
Gate Reverse Current ($V_{GS} = 20$ Vdc, $V_{DS} = 0$)		I_{GSS}	—	—	0.1	nAdc
Gate-Source Voltage ($V_{DS} = 15$ Vdc, $I_D = 400\ \mu Adc$)	BFW10	V_{GS}	2	—	7.5	Vdc
Gate-Source Voltage ($V_{DS} = 15$ Vdc, $I_D = 50\ \mu Adc$)	BFW11	V_{GS}	1.25	—	4	Vdc
ON CHARACTERISTICS						
Zero-Gate Voltage Drain Current ($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	BFW10 BFW11	I_{DSS}	8 4	— —	20 10	mAdc
SMALL-SIGNAL CHARACTERISTICS						
Forward Transadmittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1 kHz)	BFW10 BFW11	Y_{fs}	3.5 3.0	— —	6.5 6.5	mmhos
Output Admittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	BFW10 BFW11	Y_{os}	— —	— —	85 50	µmhos
Input Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$ Vdc, f = 1.0 MHz)		C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$ Vdc, f = 1.0 MHz)		C_{rss}	—	—	0.8	pF
Forward Transadmittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 200 MHz)		Y_{fs}	3.2	—	—	mmhos
Equivalent Noise Voltage ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 25 Hz)		e_n	—	—	75	$nV/\sqrt{Hz}$
Noise Figure ($V_{DS} = 15$ Vdc, $V_{GS} = 0$ V, see Figures 1, 2, 3)		NF	—	—	2.5	dB

BF245A, BF245B, BF245C N-CHANNEL SILICON FIELD-EFFECT TRANSISTOR

NXP Semiconductors Product specification

N-channel silicon field-effect transistors BF245A; BF245B; BF245C

FEATURES

- Interchangeability of drain and source connections
- Frequencies up to 700 MHz.

APPLICATIONS

- LF, HF and DC amplifiers.

DESCRIPTION

General purpose N-channel symmetrical junction field-effect transistors in a plastic TO-92 variant package.

CAUTION
The device is supplied in an antistatic package. The gate-source input must be protected against static discharge during transport or handling.

PINNING

PIN	SYMBOL	DESCRIPTION
1	d	drain
2	s	source
3	g	gate

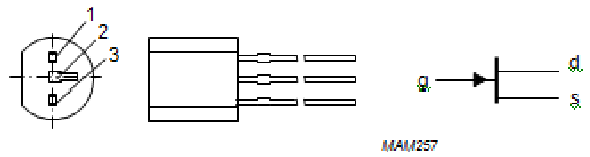


Fig.1 Simplified outline (TO-92 variant) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DS}	drain-source voltage		–	–	±30	V
V_{GSoff}	gate-source cut-off voltage	I_D = 10 nA; V_{DS} = 15 V	−0.25	–	−8	V
V_{GSO}	gate-source voltage	open drain	–	–	−30	V
I_{DSS}	drain current	V_{DS} = 15 V; V_{GS} = 0				
	BF245A		2	–	6.5	mA
	BF245B		6	–	15	mA
	BF245C		12	–	25	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C	–	–	300	mW
$\lvert y_{fs} \rvert$	forward transfer admittance	V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	3	–	6.5	mS
C_{rs}	reverse transfer capacitance	V_{DS} = 20 V; V_{GS} = −1 V; f = 1 MHz; T_{amb} = 25 °C	–	1.1	–	pF

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DS}	drain-source voltage		–	±30	V
V_{GDO}	gate-drain voltage	open source	–	–30	V
V_{GSO}	gate-source voltage	open drain	–	–30	V
I_D	drain current		–	25	mA
I_G	gate current		–	10	mA
P_{tot}	total power dissipation	up to T_{amb} = 75 °C;	–	300	mW
		up to T_{amb} = 90 °C; note 1	–	300	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	150	°C

Note

1. Device mounted on a printed-circuit board, minimum lead length 3 mm, mounting pad for drain lead minimum 10 mm × 10 mm.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	in free air	250	K/W
	thermal resistance from junction to ambient		200	K/W

STATIC CHARACTERISTICS

T_j = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{(BR)GSS}$	gate-source breakdown voltage	I_G = –1 µA; V_{DS} = 0	–30	–	V
V_{GSoff}	gate-source cut-off voltage	I_D = 10 nA; V_{DS} = 15 V	–0.25	–8.0	V
V_{GS}	gate-source voltage	I_D = 200 µA; V_{DS} = 15 V			
	BF245A		–0.4	–2.2	V
	BF245B		–1.6	–3.8	V
	BF245C		–3.2	–7.5	V
I_{DSS}	drain current	V_{DS} = 15 V; V_{GS} = 0; note 1			
	BF245A		2	6.5	mA
	BF245B		6	15	mA
	BF245C		12	25	mA
I_{GSS}	gate cut-off current	V_{GS} = –20 V; V_{DS} = 0	–	–5	nA
		V_{GS} = –20 V; V_{DS} = 0; T_j = 125 °C	–	–0.5	µA

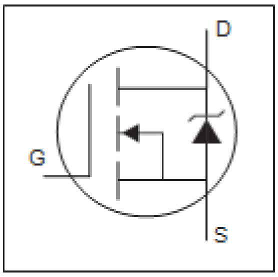
Note

1. Measured under pulse conditions: t_p = 300 µs; $\delta \leq 0.02$.

DATA SHEET OF MOSFET IRFZ 44N

IRFZ44NPbF

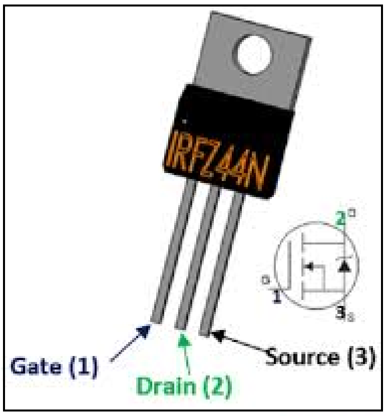
HEXFET® Power MOSFET



V_{DSS} = 55V

$R_{DS(on)}$ = 17.5mΩ

I_D = 49A



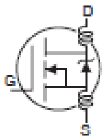
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	49	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	35	
I_{DM}	Pulsed Drain Current ①	160	
P_D @T_C = 25°C	Power Dissipation	94	W
	Linear Derating Factor	0.63	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
I_{AR}	Avalanche Current①	25	A
E_{AR}	Repetitive Avalanche Energy①	9.4	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 srew	10 lbf•in (1.1N•m)	

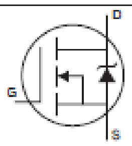
Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	——	1.5	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient	——	62	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	55	——	——	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.058	——	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	——	17.5	mΩ	V_{GS} = 10V, I_D = 25A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	——	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
g_{fs}	Forward Transconductance	19	——	——	S	V_{DS} = 25V, I_D = 25A④
I_{DSS}	Drain-to-Source Leakage Current	——	——	25	μA	V_{DS} = 55V, V_{GS} = 0V
		——	——	250		V_{DS} = 44V, V_{GS} = 0V, T_J = 150°C
I_{GSS}	Gate-to-Source Forward Leakage	——	——	100	nA	V_{GS} = 20V
	Gate-to-Source Reverse Leakage	——	——	-100		V_{GS} = -20V
Q_g	Total Gate Charge	——	——	63	nC	I_D = 25A
Q_{gs}	Gate-to-Source Charge	——	——	14		V_{DS} = 44V
Q_{gd}	Gate-to-Drain ("Miller") Charge	——	——	23		V_{GS} = 10V, See Fig. 6 and 13
$t_{d(on)}$	Turn-On Delay Time	——	12	——	ns	V_{DD} = 28V
t_r	Rise Time	——	60	——		I_D = 25A
$t_{d(off)}$	Turn-Off Delay Time	——	44	——		R_G = 12Ω
t_f	Fall Time	——	45	——		V_{GS} = 10V, See Fig. 10 ④
L_D	Internal Drain Inductance	——	4.5	——	nH	Between lead, 6mm (0.25in.) from package and center of die contact 
L_S	Internal Source Inductance	——	7.5	——		
C_{iss}	Input Capacitance	——	1470	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	360	——		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	——	88	——		f = 1.0MHz, See Fig. 5
E_{AS}	Single Pulse Avalanche Energy②	——	530⑤	150⑥	mJ	I_{AS} = 25A, L = 0.47mH

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	49	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode)①	——	——	160		
V_{SD}	Diode Forward Voltage	——	——	1.3	V	T_J = 25°C, I_S = 25A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	——	63	95	ns	T_J = 25°C, I_F = 25A
Q_{rr}	Reverse Recovery Charge	——	170	260	nC	di/dt = 100A/μs ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Notes:

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)

② Starting T_J = 25°C, L = 0.48mH R_G = 25Ω, I_{AS} = 25A. (See Figure 12)

③ $I_{SD} \le$ 25A, di/dt $\le$ 230A/μs, $V_{DD} \le V_{(BR)DSS}$, $T_J \le$ 175°C

④ Pulse width ≤ 400μs; duty cycle ≤ 2%.

⑤ This is a typical value at device destruction and represents operation outside rated limits.

⑥ This is a calculated value limited to T_J = 175°C .

APPENDIX – B - SYLLABUS

JAWAHARLAL NEHRU TECHN OLOGICAL UNIVERSITY - ANANTAPUR

II. B.Tech (ECE & EEE) – I Sem-R 15

(15A04305) ELECTRONIC DEVICES & CIRCUITS LAB (Common to ECE and EEE)

PART – A : Electronic workshop practice:

1. Identification, Specification and testing of R, L, C components(Colour codes), Pote ntio meters, coils, Gang condensers, Relays and bread board.
2. Identification, Specification and testing of Active devices - Diodes, BJT's, JFET's, LED's, LCD's, SCR and UJT.
3. Soldering practice – Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog & Digital multi meters, Function generator, Regulated power supply and CRO.

PART – B : List of experiments.

(For laboratory Examinatrion – Minimum of ten experiments)

1. PN junction diode characteristics :
   A : Germanium diode (Forward bias & Reverse bias)
   B : Silicon diode (Forward bias only)
2. Zener diode characteristics :
   A : V – I characteristics
   B : Zener diode act as a voltage regulator
3. Rectifiers (Without & with *C* filter)
   A : Half wave rectifier
   B : Full wave rectifier
4. BJT characteristics (CE configuration)
   A : Input characteristics
   B : Output characteristics
5. FET characteristics (CS configuration)
   A : Drain (output) characteristics
   B : Transfer characteristics
6. SCR characteristics
7. UJT characteristics
8. Transistor biasing
9. CRO operation and its measurements.
10. BJT – CE amplifier
11. Emitter follower - CC amplifier
12. FET – CS amplifier

APPENDIX – C

RULES FOR HOW TO WRITE THE OBSERVATION AND RECORDS

The following rules are given for how to write the observation and record.

1. Make the top & right margins in each right side page.
2. In top margin make the headings as Experiment No., date and name of the experiment.
3. Circuit diagrams, tabular columns, expected graphs, wave forms and parameters/calculations should write on left side even if these things avail on the left/right side page in the manual.
4. Aim, apparatus, components, theory, procedure, applications, conclusion and result should write on right side page , even if these things avail on the left/right side page in the manual.
5. Headings should underline with any other ink except red, orange and green.
6. The every new experiment should start with right side page.
7. Write the *theory* in records only.