COLLEGE OF ENGINEERING & MANAGEMENT,

KOLAGHAT

ELECTRONICS DEVICES LAB MANUAL

Subject Code: EC391

Dept Of Electronics & Communication Engineering

VISION

Pursuing Excellence in Teaching-Learning Process to Produce High Quality Electronics and Communication Engineering Professionals.

MISSION

To enhance the employability of our students by strengthening their creativity with different innovative ideas by imparting high quality technical and professional education with continuous performance improvement monitoring systems.

To carry out research through constant interaction with research organizations and industry.

Course objective: This course provides the student with the fundamental skills to understand the basic of semiconductor and components like diode, transistor, FET. It will build mathematical and numerical background for design of electronics circuit & component value. Students equipped with the knowledge and training provided in the course will be able to participate in design, development and operation in the different area of electronics system.

Program Educational Objectives (PEOs)

1	Attain a solid foundation in electronics & communication engineering fundamentals with an attitude to pursue continuing education and to succeed in industry / technical profession through global education.
2	Ability to function professionally in an increasingly international and rapidly changing world due to the advances in emerging technologies and concepts.
3	Exercise excellent leadership qualities on multi-disciplinary and multi-cultural teams, at levels appropriate to their experience, which addresses issues in a responsive, ethical, and innovative manner.
4	Contribute to the needs of the society in solving technical problems using electronics & communication engineering principles, tools, and practices.

Program Specific Outcomes (PSOs)

PSO-1 An ability to design and conduct the experiments, analyse and interpret the data using modern software or hardware tools with proper understanding (basic conceptions) of Electronics and Communication Engineering.

PSO-2 Ability to identify, formulate & solve problems and to apply the knowledge of electronics and communication to develop techno-commercial applications

PROGRAM OUTCOMES

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**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.
PO3	**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.
PO4	**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.
PO5	**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.
PO6	**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.
PO7	**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.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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 and in multidisciplinary environments.
PO12	**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.

COURSE OUTCOMES (COs)

Program Name: B. Tech in Electronics and Communication Engineering

SECOND YEAR: 3RD SEMESTER		
Course Name (Code)	**Course Outcomes (COs)** **On completion of the course, the students will be able to:**	
Electronics Devices Lab (EC391)	CO1	An ability to verify the working of different diodes, transistors, CRO probes and measuring instruments. Identifying the procedure of doing the experiment.
	CO2	Ability to understand the characteristics of BJT and FET and how to Determine different parameters for designing purpose.
	CO3	Ability to understand properties of photoelectric devices
	CO4	Ability to measure and record the experimental data, analyze the results, and prepare a formal laboratory report.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
CO1	3	2	1	2	2	1	2	1	2	1	2	3
CO2	3	2	1	2	2	1	2	1	2	1	2	3
CO3	3	2	1	2	2	1	2	1	2	1	2	3
CO4	3	2	1	2	2	1	2	1	2	1	2	3
AVG.	3	2	1	2	2	1	2	1	2	1	2	3

CO – PSO Mapping

	PSO-1	PSO-2
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3

SYLLABUS

Electronics Devices Lab

EC391

- Identifying and study of different components like resistor, capacitors, diodes, LED, Transistors, FET (JFET & MOSFET) etc.

- Study of different instruments used in the laboratories like, power supply, Oscilloscope, Multimeter etc.

- CHARACTERISTICS OF PN JUNCTION DIODE
  a) To Plot the Volt Ampere Characteristics of PN Junction Diode under Forward and Reverse Bias Conditions.
  b) To find the Cut-in voltage, Static Resistance, Dynamic Resistance for Forward Bias & Reverse Bias
- CHARACTERISTICS OF ZENER DIODE & LOAD REGULATION
  a) To Obtain the Forward Bias and Reverse Bias characteristics of a Zener diode.
  b) Find out the Zener Break down Voltage from the Characteristics.
  c) To Obtain the Load Regulation Characteristics.

- COMMON BASE BIPOLAR TRANSISTOR CHARACTERISTICS
  a) To plot the Input and Output characteristics of a transistor connected in Common Base Configuration and to find the h – parameters from the characteristics.

- COMMON EMITTER BIPOLAR TRANSISTOR CHARACTERISTICS
  a) To plot the Input and Output characteristics of a transistor connected in Common Emitter Configuration and to find the h – parameters from the characteristics.

- DESIGN SELF BIAS BJT CIRCUIT.

- JFET DRAIN & TRANSFER CHARACTERISTICS (COMMON SOURCE)
  a) Drain characteristics b) Transfer Characteristics. c) To find rd, gm, and μ from the characteristics.

- Study Characteristics of Photo transistor.

- Study Characteristics of LED & LDR.

OBJECTIVE (S):

1.1.
1.2.

1. THEORY:

2. CIRCUIT DIAGRAM:

3. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.

4.2 Components:

Sl. No.	Components	Specifications	Qty.

4. PROCEDURES:

6. EXPERIMENTAL DATA:

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

CONTENTS

Experiment no. 1

Title: Identifying and study of different components like resistor, capacitors, diodes, LED, Transistors, FET (JFET & MOSFET) etc.

1. OBJECTIVE (S):

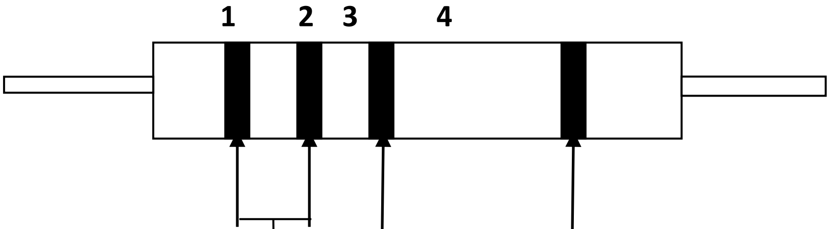
Familiarization with electronic components like Resistors, Capacitors, Diodes, LED, Transistors, FET (JFET & MOSFET) etc.

2. THEORY:

2.1 Resistance Codes:

Colour code is the main type of resistance code. Colour code is a means of identifying the value of the given resistor. There are two methods of colour coding in use.

(a) Four Colour Band.
(b) Five Colour Band.



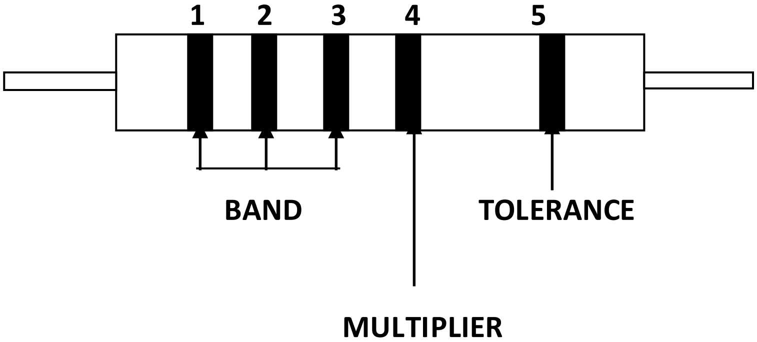
(a)

1st , 2nd .... Significant Figure.
3rd .... Multiplier.
4th .... Tolerance.

Colour	Band	Colour	Multiplier	Colour	Tolerance
Black	0	Silver	10^{-2}	Red	± 2%
Brown	1	Gold	10^{-1}	Gold	± 5%
Red	2	Black	10^{0}	Silver	± 10%
Orange	3	Brown	10^{1}	No Colour	± 20%
Yellow	4	Red	10^{2}	Brown	± 1%
Green	5	Orange	10^{3}		
Blue	6	Yellow	10^{4}		
Violet	7	Green	10^{5}		
Grey	8	Blue	10^{6}		
White	9				

e.g. (a) Colour :	Brown	Black	Red	Gold
	1	0	10^2	± 5%

Actual Value: 1000 ± 5%



(b)

1st , 2nd , 3rd Significant Figure .
4th. Multiplier.
5th. Tolerance.

e.g. (b) Colour :	Red	Yellow	Black	Black	Red
	2	4	0	10^0	± 2%

Actual Value: 240 ± 5%

The following three factors are to be connected, while choosing a resistor:

1. TOLERANCE
   Exact value cannot be guaranteed by mass production methods, but this is not a disadvantage because in most electronic circuits the values of resistors are not critical. A resistor with a stated, called nominal, value of 100 and a tolerance of ±10% could have any value between 90 ohm and 110 ohm.

2. POWER RATING
   This is the maximum power which can be developed in a resistor without damage occurring by overheating. For most electronic circuits 0.25 W or 0.5 W rating are adequate. The greater the physical size of a resistor the greater is its rating.

3. STABILITY
   This is the ability to keep the same value with changes of temperature and age.

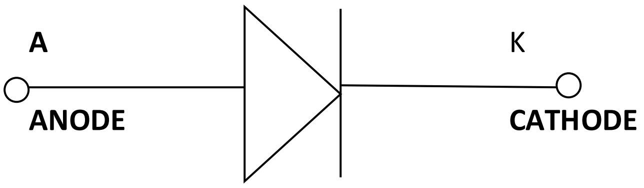
2.2 Capacitors:

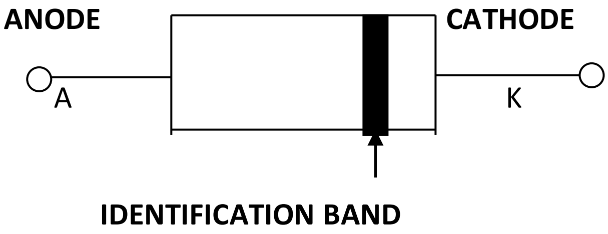
For electrolyte capacitor the capacitance value, rated voltage and polarity are marked on the surface of the capacitor.
For non-electrolyte capacitors two- or three-digit codes are there on the capacitor.
If two digits are there then both are significant value and unit is pF.
If three digits are there then first two are significant and third is multiplier and unit is in pF.

2.3 DIODE

(A) P-N JUNCTION DIODE:

A junction diode consists of a p-n junction with one connection to the p– side, the anode A, and another to the n– side, the cathode C as shown in adjacent figure.





Following are some important characteristics of p–n junction diode:

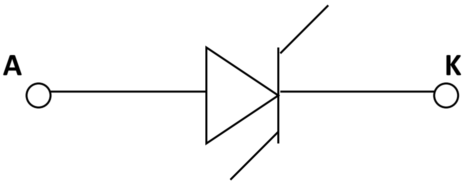
Peak Reverse Voltage (PRV):
Maximum allowable instantaneous reverse voltage that may be applied across the diode.

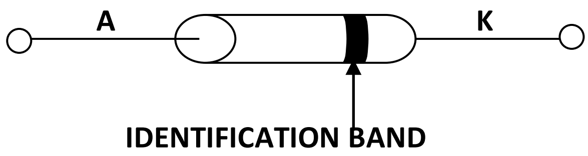
Maximum reverse dc voltage (V_{rdc}) :
It is the maximum allowable dc reverse voltage which is usually less than PRV.

Maximum dc current (I_r max) :
It is the maximum allowable dc forward current flow at a stated temperature.

(B) ZENER DIODE:

A Zener diode is a silicon junction diode designed for stabilizing i.e. keeping steady the output voltage of power supply. It is made such that it can be used in the break down region.





TESTING OF ELETRONIC COMPONENTS

DIODE:

- Connect a multimeter (in resistance mode) across the diode.
- Observe the resistance of the diode in that position. If it shows a lower resistance value the diode is in forward bias. Then the terminal connected to the positive terminal of the multimeter is p – junction and the other terminal is n – junction.
- Now, reverse the multimeter position and observe the resistance value. If it is high resistance then the given diode is good.

2.4 TRANSISTOR:

- Transistor follows the same rules as that of a diode.
- For a npn transistor, connect the positive terminal of the multimeter to the base terminal of the transistor and the negative terminal to the emitter terminal of the transistor.
- Follow the procedure given for diode. If it is successful, then the base emitter junction of the transistor is good.
- Now shift the negative terminal of the multimeter to the collector terminal of the transistor by maintaining the positive terminal same.
- Follow the procedure given for diode. If it is successful, then the base collector junction of the transistor is good.
- Observe the collector to emitter resistance of the given transistor in both directions.
- The above procedure can be executed for pnp terminal. Here, the multimeter position should be interchanged, the rest of the procedure remaining same.

UNI–JUNCTION TRANSISTOR (UJT) :

- In case of UJT emitter-to-base1 and emitter-to-base2 should exhibit typical diode characteristics except that the diode resistance in forward and reverse case is different for the two configurations.
- The resistance across base1 to base2 should be a fixed resistance in emitter direction.

FIELD EFFECT TRANSISTOR (FET):

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

Experiment no. 2

Title: Study of different instruments used in the laboratories like, power supply, Oscilloscope, Multimeter etc.

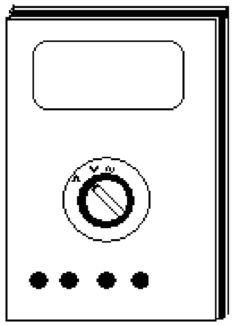
1. **OBJECTIVE (S):**

Familiarization with power supply, oscilloscope, multimeter etc.

2. **THEORY:**

2.1 Multimeter:

Multimeter is an advanced electronics instrument which can measure resistances, voltages, capacitances, P-N-P, N-P-N, junction etc. It is used for identifying the emitter, base, collector of transistor and to find whether it is a N-P-N or P-N-P one. It is used for measuring the value of DC and AC currents. It is highly expensive instrument which is well understood by its use in various fields of electrical measurement.



Construction:

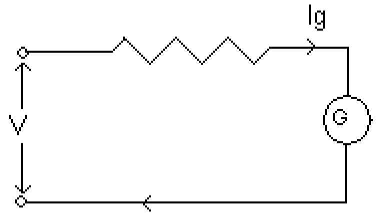
A multimeter consists of an ordinary pivoted type of moving coil galvanometer. This galvanometer consists of a coil pivoted or jeweled bearing between the poles of a permanent magnet. The indicating needle is fastened to the coil. When electric current is passed through the coil, mechanical force acts and the pointer moves over the scale.

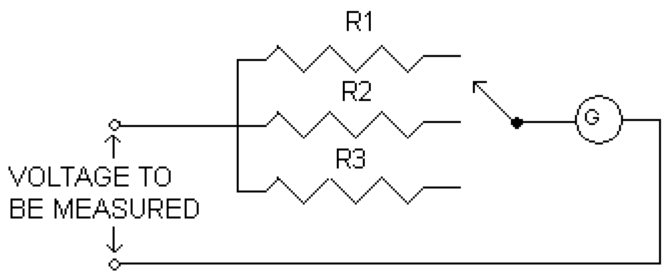
Function:

A multimeter can measure voltages, current and resistances. To achieve this objective, proper circuits are incorporated with galvanometer. The galvanometer in a multimeter is always of left type i.e., normally its needle rests in extreme left position as compared to center (zero position) of ordinary galvanometer.

(1) Multimeter As Voltmeter: When a high resistance is connected in series with a galvanometer, it becomes a voltmeter. Like fig. when a high resistance R connected in series with the galvanometer of resistance G. If Ig is the full-scale deflection current, then the galvanometer becomes a voltmeter of range 0-V volts.

$V=IgR+IgG$ or $V/Ig=R+G$ or $R=V/Ig-G$

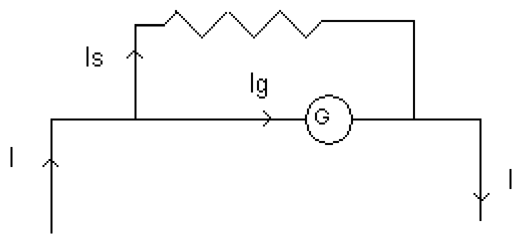


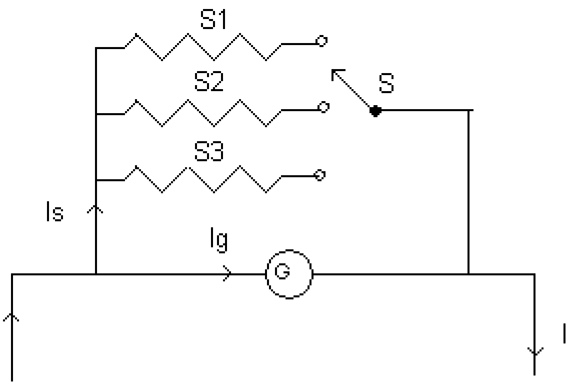


(2) Multimeter As Ammeter:

When low resistance is connected in parallel with a galvanometer, it becomes an ammeter. Like fig. when a low resistance S (shunt) connected in parallel with the galvanometer of resistance G. If Ig is the full-scale deflection current then the galvanometer becomes an ammeter of range: 0-1 amp.

$IsS=IgG$ or $(Is+Ig)/Ig=(G+S)/S$ or $I/Ig=(G+S)/S$ or $I=(G+S)Ig/S$





(3) Multimeter As Ohmmeter:

The multimeter can be used as ohmmeter.Fig.8 shows the circuit of ohmmeter. The resistance to be measured is connected between A and B terminal.

Merits Of Multimeter:

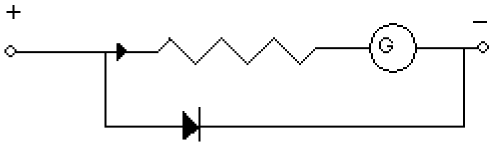
1.It is a single instrument that performs several measuring functions.
2.It has small size and is easily portable.
3.It can make measurements with reasonable accuracy.

Demerits Of Multimeter:

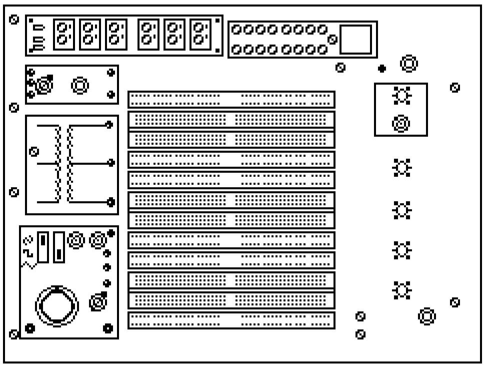
1.It is costly instrument.
2.It cannot make precise and accurate measurement due to the loading effect.
3.Technical skill is required to handle it.

Discussions:

It is important that the multimeter should be protected in the event of accidental over load by connecting a diode as shown in the fig.



2.2 TRAINER KIT:



Block diagram of trainer kit

Function Of a Trainer Kit:

A> A trainer kit is primarily for the purpose of training of how to make circuits using electronic parts such as diode, resistance, capacitance etc. The major part of trainer kit consists of circuit beds which are arranged horizontally in plates.

There are two types of plates:

1. A plate in which 2 lines of punched holes are present which are internally connected horizontally i.e., in rows.
2. A plate in which 4 lines of punched holes are present which are internally connected vertically i.e., in columns.

The electronic parts, which are required for the completion of the circuit, are placed on this circuit bed and the required objective is served.

B> At the left side of the circuit bed, we have voltage poles with help of which suitable potential difference can be applied by choosing the correct voltages poles.

C> A voltage varying point or facility is available which enable to vary the voltage applied within the range 0-30V.

D> A center tap transformer is present which helps to vary the voltage supplied either by stepping it upon down.

E> A function is present which helps to supply signals of different ranges of frequency. The frequency can be varied with the frequency-varying knob. There is waveform-varying knob with help of which we can transfer a signal from sinusoidal wave form to square wave form to triangular waveform.

2.3 Cathode Ray Oscilloscope:

The Cathode ray oscilloscope is probably the most versatile tool for the development of electronic circuits & systems, and has been one of the most important tools in the development of modern electronics. It is the device that allows the amplitude of electrical signals, whether they be voltage, current or power, etc., to be displayed primarily as a function of time. The oscilloscope depends on the movement of an electron beam, which is then made visible by allowing the beam to impinge on a phosphor surface, which produces a visible spot. If the electron beam is deflected in either of two orthogonal axes, such as the familiar X & Y axes used in conventional graph construction, the luminous spot can be used to create two dimensional displays.

The heart of the oscilloscope is cathode ray tube, which generates the electron beam, accelerates the beam to a high velocity, deflects the beam to create the image, and contains the phosphor screen where the electron beam eventually becomes visible. To accomplish these tasks, various electrical signal and voltages are required and these requirements dictate the remainder of the blocks of the oscilloscope as shown in fig1. The power supply block provides the voltages required by the CRT to generate and accelerate the electron beam, as well as to supply the required operating voltages for the other circuits of the oscilloscope. The laboratory oscilloscope has a time base which generates the correct voltage to supply the CRT to deflect the spot at a constant time dependent rate. The signal to be viewed is fed to a vertical amplifier, which increases the potential of the input signal to a level that will provide a usable defection of the electron beam. To synchronize the horizontal deflection starts at the same point of the input vertical signal each time it sweeps, a synchronizing or triggering circuit is used. This circuit is the link between the vertical input and horizontal time base.

Electron Gun

The ELECTRON GUN consists of a HEATER and a CATHODE to generate electrons, a CONTROL GRID to control brightness by controlling electron flow, and two ANODES (FIRST and SECOND). The main purpose of the first (FOCUSING) anode is to focus the electrons into a narrow beam on the screen. The second (ACCELERATING) anode accelerates the electrons as they pass. The control grid is cylindrical and has a small opening in a baffle at one end. The anodes consist of two cylinders that contain baffles (or plates) with small holes in their centers.

3. SCHEMATIC/BLOCK DIAGRAM:

Figure1. - Construction of a CRT.

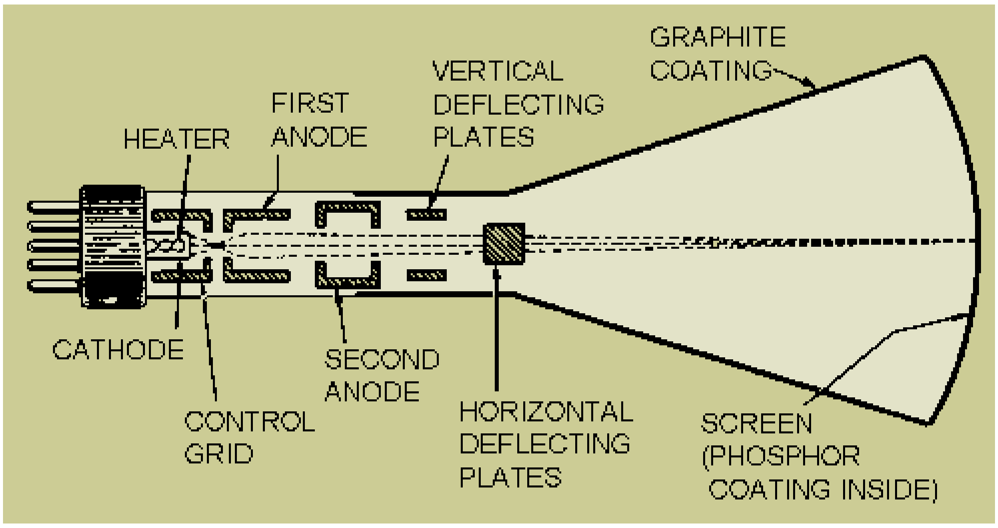
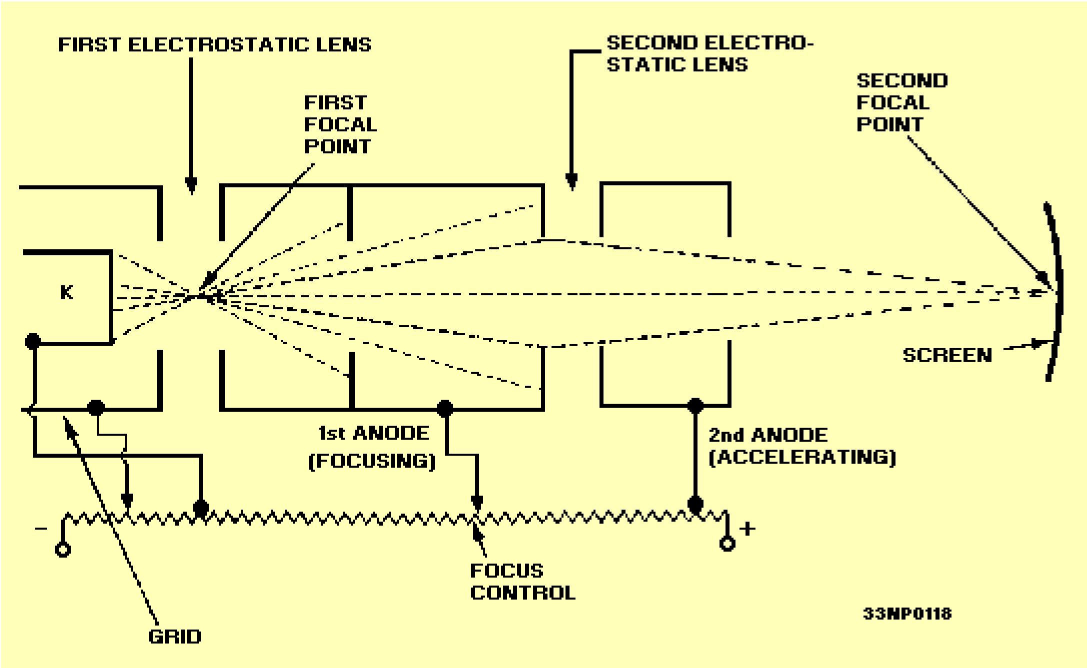


Figure2. - Formation of an electron beam.



4. APPARATUS USED:

Trainer kit for function generator.

5. PROCEDURE:

Step-1: Follow the supplier's manual for front panel operations.
Step-2: Set the input supply of (say 5V P-P, 2kHz) sinusoidal signal from trainer kit.
Step-3: Measure exact value of voltage source by CRO using at least two other different scales of both the voltage and time scale.
Step-4: Trace the wave pattern.
Step-5: Repeat the steps for other types of wave patterns of available in your source.

6. EXPERIMENTAL DATA:

Table-1

Data for measured voltage with CRO

Type and value of signal used from source (say 4V P-P 2kHz)	Signal value measured by CRO using Scale 1(say time scale: 1ms & voltage scale: 2V	Signal value measured by CRO using Scale 2	Remarks

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Properly ground both the common terminals of CRO and function generator.
2) Select proper mode of the CRO.

9. SOME SAMPLE QUESTIONS:

i) What element controls the number of electrons striking the screen?
ii) What element is controlled to focus the beam?
iii) Why are the electrostatic fields between the electron gun elements called lenses?
iv) What is the function of the electron gun?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 3

Title: Characteristics Of PN Junction Diode.

1. OBJECTIVE:

1.1. To plot the V_D- I_D characteristic of Diode.
1.2. To compute static resistance ($r_{dc} = V_D / I_D$) & dynamic resistance ($r_{ac} = dV_D/dI_D$)
1.3. Static characteristic of a semiconductor Diode
1.4. Dynamic characteristic of a semiconductor Diode

2. THEORY:

i) Static characteristic of a semiconductor Diode

When a positive potential is applied to the p-side of a p-n junction diode with respect to its n-side, the diode is said to be forward biased. The graph showing the variation of the diode current with the voltage across the diode is known as the forward static characteristic of the diode.

If V is the voltage across the junction, the diode current I is given by I= I_s[exp(ev/ηkT)-1] ………………….(1)

Where I_s is the reverse saturation current, k, Boltzman constant, T absolute temperature, η is a numerical constant depending on the material of the diode. For Ge, η=1, & for Si, η=2.

The d.c resistance of the diode for a current I is given by

$r_{dc}= V_D/ I_D$ ……………………….(2)

V, Voltage across the diode. The a.c or the dynamic resistance

$r_{ac}=\Delta V_D/\Delta I_D$…………………………(3)

i.e, r_{ac} is the reciprocal of the slope of the static characteristic at the given current I. When diode is sufficiently forward biased, the value of exp(ev/ηkT) is much greater than 1, so from equation (1) we obtain forward dynamic resistance at room temperature

r_{ac}= η 26/I for Ge diode & for Si diode r_{ac}= η 52/I,

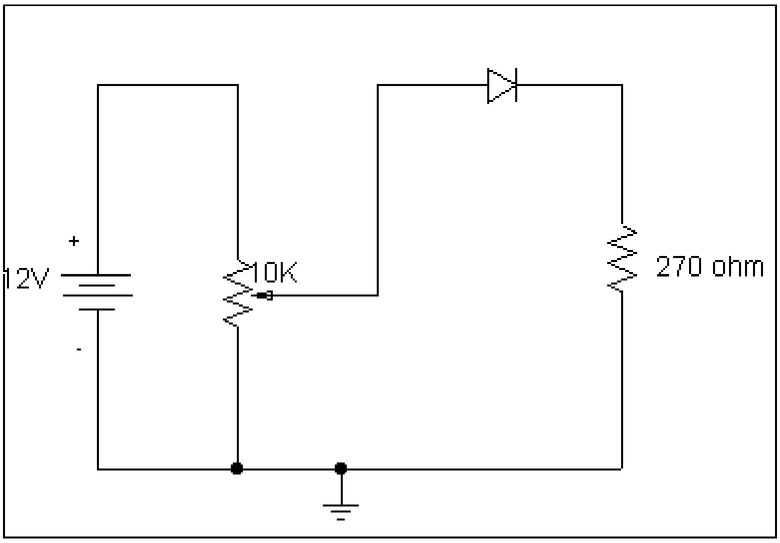
I in mA & r_{ac} in Ohm.

ii) Dynamic characteristic of a semiconductor Diode

Consider the diode is in series with a load resistance R_L. When the diode current, I flows, the output voltage across the load resistance R_L is $V_O=IR_L$. So Supply voltage $V_S= V_D+ V_O$

The curve showing the variation of the diode current I_D with the input supply voltage V_S is termed the dynamic characteristic of the diode for the given load resistance R_L.

3. CIRCUIT DIAGRAM:



Circuit diagram for diode characteristics

4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Resistors	330Ω,1/4 Watt	1
2	Diode	1N4007	1
3	Pot	10KΩ	1

5. PROCEDURES:

(i) To draw Static characteristic of a semiconductor Diode

Step-1: Construct the circuit as shown schematically in Fig.. The p-side that is the anode of the diode must be connected to the positive terminal of the voltage supply. Power on the supply keeping the voltage set at zero.

Step-2: Slowly increase the input voltage from zero in convenient steps of 0.1V. In each case measure the voltage drop across the diode.
Step-3: Measure the drop across the resistance also in order to calculate current through the diode.
Step-4: Repeat steps 2 & 3 for each applied voltage as per table-1.

(ii)To draw Dynamic characteristic of a semiconductor Diode
Step-1: Connect the circuit as shown in fig.
Step-2: Gradually increase the input voltage from zero in suitable steps. At each step, measure the input voltage and diode current.
Step-3: Repeat step 2 for other resistances given.

6. EXPERIMENTAL DATA:

(a) Maximum forward current Rating:
(b) Maximum PIV:

Table1
Data for static characteristic

Sl. No.	Supply voltage(V_S)	Diode Voltage(V_D)(V)	Vol. across resist.(V_R) (V)	Diode Current(I_D)(mA)

Table2
Determination of diode dc and ac resistances

Given diode current(mA)	Corresponding diode voltage (from graph)	Change in V from graph ΔV(volt)	Change in I from graph ΔI(mA)	r_{dc} =V/I ohm	r_{ac}=ΔV/ΔI ohm	Theoretical r_{ac}=52/I ohm

Table3

Data for dynamic characteristic

Sl. No.	Supply voltage(V_S)	Vol. across resist.(V_R) (V)	Diode Current(I_D)= V_R/R (mA)

7. DATA ANALYSIS:

I. Draw the static characteristic by plotting the diode voltage along the X-Axis and Diode current along Y-Axis.
II. For a given value of diode current determine the dc and ac resistances as per equation given.
III. Compare the value of r_{ac} with the theoretical value which is 52/I for Si diode.

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Connect circuit properly & then only power on the circuit.
2) If any change of the circuit requires then power off first and then disassemble the circuit.

9. SOME SAMPLE QUESTIONS:

i) How can a semiconductor be distinguished from a conductor & an insulator?
ii) Give names of two commonly used semiconductors & the order of their conductivities.
iii) What is a junction diode?
iv) What do you mean by forward bias arrangement?
v) What is meant by static and dynamic characteristic of diode?
vi) What is meant by PIV?
vii) What will happen if reverse bias of p-n junction diode is gradually increased?
viii) What is reverse saturation current? Why does it vary with temperature?
ix) What is the necessity for studying dynamic characteristic of diode?
x) On which factors does the forward resistance of a semiconductor diode depend?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 4

Title: Characteristics Of Zener Diode & Load Regulation.

1. OBJECTIVE (S):

1.1. To plot the V_Z- I_Z characteristic of Diode.
1.2. To compute static resistance (r_{dc} =V_Z/ I_Z) & dynamic resistance (r_{ac} =dV_Z/dI_z)
1.3. Load regulation at a fixed input voltage
1.4. Line regulation at a fixed load

2. THEORY:

(i) Volt-ampere characteristic of a zener Diode

Rectifier diodes or small signal diodes are not normally operated in the breakdown region because of possible damages. Zener diodes are optimized for reverse breakdown operation. Zener breakdown is the result of ionization of covalent bonds due to high-density electric field. This mechanism is possible if the depletion layer is very thin and the electric field is high. Valence electrons liberate out of covalent bonds and thereby produce extra conduction electrons and holes. These additional carriers drift across the junction under the influence of reverse bias causing current to increase rapidly and bringing about *Zener reverse breakdown*. However, above a certain threshold value of the reverse voltage, the current through the diode increases rapidly although the voltage across it tends to remain constant.
Let V_z be the voltage drop across the zener diode when current I_z flows through it.
The d.c or static resistance of zener diode for current I_z is
$r_{dc}= V_z/I_z$ …………. (1)
The a.c or static resistance of zener diode for current I_z is
$r_{ac}= \Delta V_z/\Delta I_z$ …………. (1)
Where ΔV_z &ΔI_z are chage in voltage and current from graph.

(ii) Load regulation at a fixed input voltage
(iii) Line regulation at a fixed load

The function of the regulator is to provide an output voltage V_O that is as constant as possible in spite of the variation in load current I_L and the ripple in source voltage V_S . Two parameters –*Load regulation & Line Regulation* –can be used to measure how well the regulator is performing its function.

The load regulation is defined as the change in load voltage corresponding to change in load current. If V_{NL} is the no load voltage and V_L be the load voltage at rated load current then
% Regulation = V_{NL}-V_L/V_L x 100%.

The line regulation is defined as the change in output voltage corresponding to change in supply voltage.

3. CIRCUIT DIAGRAM:

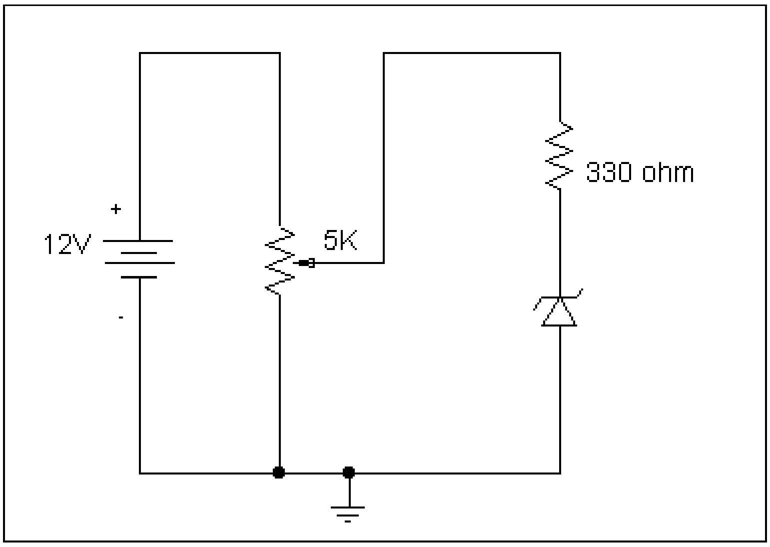


Fig.1 Circuit for Zener diode characteristic

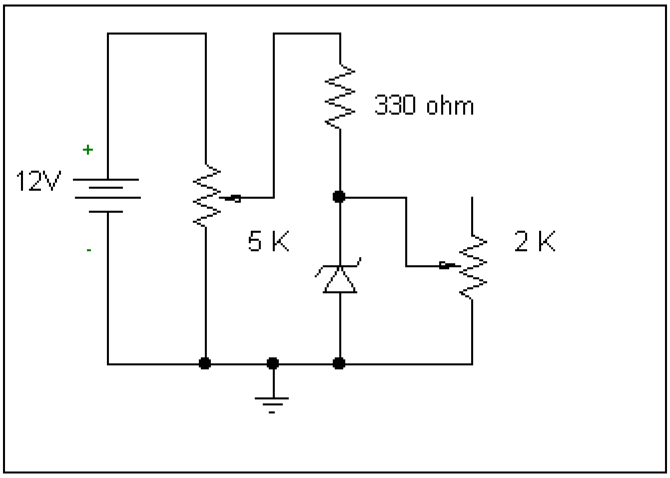


Fig.2 Circuit for load regulation

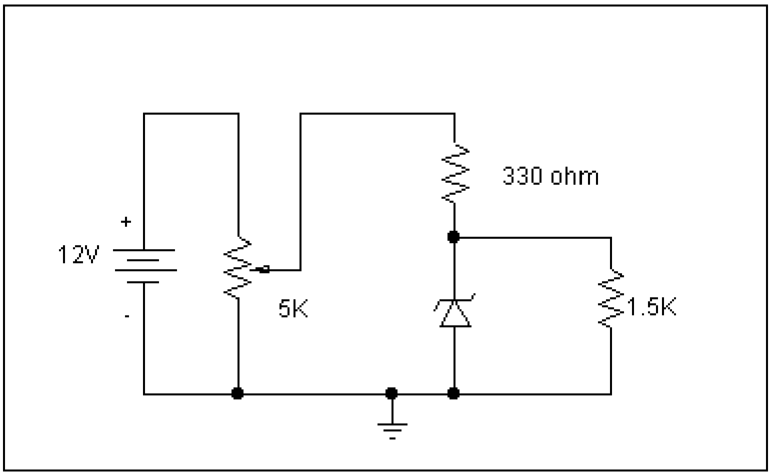


Fig. 3 Circuit for line regulation

4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Resistors	330Ω,1.5KΩ,1/4 Watt	1
2	Zener Diode	6.2V	1
3	Pot	2KΩ,5KΩ	1

5.PROCEDURES:

(i) To draw Volt-ampere characteristic of a zener Diode

1. Construct the circuit as shown schematically in Fig. The p-side that is the anode of the diode must be connected to the negative terminal of the voltage supply, i.e ,in reverse mode. Power on the supply keeping the voltage set at zero.
2. Slowly increase the input voltage from zero in convenient steps of 0.5V. In each case measure the voltage drop across the diode.
3. Measure the drop across the resistance also in order to calculate current through the diode.
4. Repeat steps 2 & 3 for each applied voltage as per table-1.

(ii) Load regulation at a fixed input voltage

1. Connect the circuit as shown in fig.2.
2. Keep the input dc voltage V_S fixed at a value sufficiently higher than the zener breakdown voltage say at 10V.
3. Connect different values of R_L . For each R_L note the load current I_L and load voltage V_L.
4. Measure no load voltage for I_L= 0.

(iii) Line regulation at a fixed load

1. Connect the circuit as shown in fig.3.
2. Take R_L about 5 times R_S, and keep it fixed.
3. Increase V_S from Zener break down voltage in suitable steps and at each step measure the voltages V_S & V_L.

6. EXPERIMENTAL DATA:

Zener breakdown voltage :

Table1

Data for volt-ampere characteristic

Sl. No.	Supply voltage V_s (V)	Diode Voltage(V_Z) (V)	Vol. across resist.(V_R) (V)	Diode Current(I_Z) = V_R/R (mA)

Table2

Determination of diode dc and ac resistances

Given diode current I_Z(mA)	Corresponding diode voltage V_Z(from graph)	Change in V from graph ΔV_Z(volt)	Change in I from graph ΔI_Z(mA)	r_{dc} $=V_Z/I_Z$ ohm	r_{ac}= $\mathbf{\Delta V_Z/\Delta I_Z}$ ohm

Table3

Data for load regulation characteristic

Sl. No.	Load Resistance R_L(Ohm)	Load Voltage V_L (V)	Load Current(I_L)= V_L/R_L (mA)

Table 4

Determination of % regulation

No-load voltage V_{NL}(V)	Rated load current I_L (mA)	Corresponding Load voltage V_L(V)	% Regulation = $(V_{NL} - V_L) / V_L \times 100\%$

Table5

Data for line regulation characteristic

Load Resistance R_L= 1.5KΩ

Sl. No.	Supply Vol. V_S (V)	Load Voltage V_L(V)

7. DATA ANALYSIS:

I. Draw the *volt-ampere characteristic* by plotting the diode voltage along the X-Axis and Diode current along Y-Axis.
II. For a given value of diode current determine the dc and ac resistances as per equation given.

III. Plot V_L vs. I_L taking I_L along the X-axis and V_L along the Y-axis. This curve is known as *load regulation characteristic.* Determine the % Regulation at the rated load current from the load regulation characteristic.

IV. Plot V_L vs. V_S taking V_L along Y-axis & V_S along X-axis. This curve is known as *line regulation characteristic.*

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Connect circuit properly & then only power on the circuit.
2) If any change of the circuit requires then power off first and then disassemble the circuit.

9. SOME SAMPLE QUESTIONS:

i) What is the difference between zener diode & rectifier diode?
ii) What are zener breakdown and avalanche breakdown?
iii) What is basic application of zener diode?
iv) Will the zener diode fire for any value of load resistance R_L?
v) What would happen if R_L is taken equal to R_S in studying "line regulation at a fixed load"?
vi) What should be the value of dynamic resistance for zero % of load regulation?
vii) What is the range of available zener voltage?
viii) What is the function of series resistance R_s in the circuit?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 5

Title: Common Base Bipolar Transistor Characteristics.

1. OBJECTIVE (S):

1.1. Input characteristics.
1.2. Output characteristics.
1.3. Determination of R_i, R_o, α_{dc} and α_{ac}.

2. THEORY:

In this theory part, mention the following important terms:

a) Input dynamic resistance, $R_i = \Delta V_{EB}/\Delta I_E$ (V_{CB}=const.)……(1)

b) Output dynamic resistance, $R_o = \Delta V_{CB}/\Delta I_C$ (I_E =const.) …… (2)

c) DC current gain $\alpha_{dc} = I_C/I_E$ ………………………………… (3)

d) AC current gain $\alpha_{ac} = \Delta I_C/\Delta I_E$ (V_{CB}=const.) ………………… (4)

3. CIRCUIT DIAGRAM:

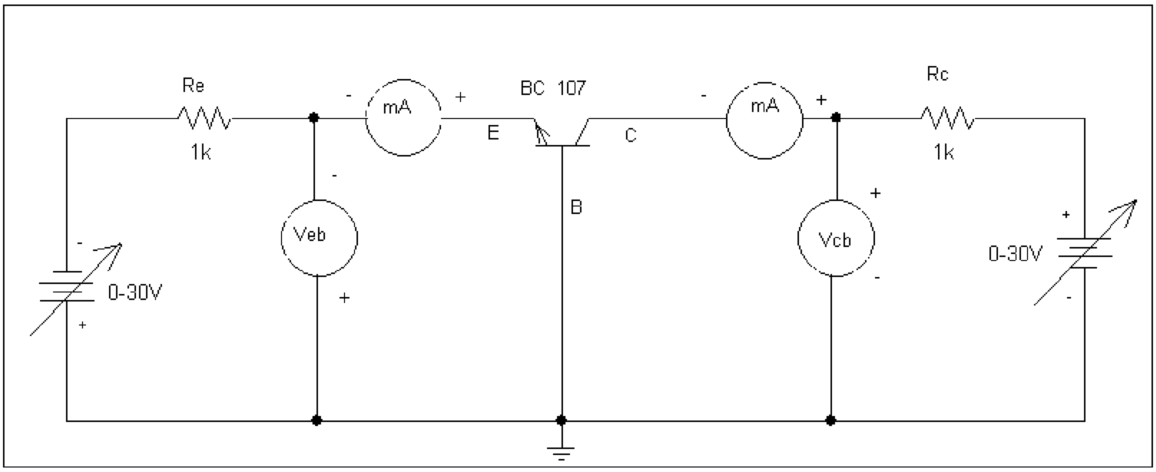


FIG. A

4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Transistor	BC 107	1
2	Resistors	1K ,1/4 Watt	2

5. PROCEDURES:

Input Characteristic:

Step-1: Make the circuit connections as shown in fig A.

Step-2: Set V_{CB} = 2V(say), the voltage V_{EB} in steps of 0.1V and note the corresponding V_{RE} and hence $I_E = V_{RE}/R_E$. Repeat the above procedure for 6V,10V etc

Output Characteristic:

Step-1: Make the circuit connections as shown in fig A.

Step-2: Set I_E = 0 (say), vary V_{CB} insteps of 1V and note down the corresponding V_{RC} and hence $I_C = V_{RC}/R_C$. Repeat the above procedure for 3 mA, 5 mA etc.

6. EXPERIMENTAL DATA:

A) Input characteristics: $R_E = 1\ K\Omega$

Sl. No.	V_{CB}=2V			V_{CB}=6V			V_{CB}=10V		
	V_{EB} (Volt)	V_{RE} (mV)	$I_E = V_{RE}/R_E$ (mA)	V_{EB} (Volt)	V_{RE} (mV)	$I_E = V_{RE}/R_E$ (mA)	V_{EB}	V_{RE}	$I_E = V_{RE}/R_E$ (mA)

B) Output characteristics. $R_C = 1\ K\Omega$.

Sl. No.	I_E =0			I_E =3mA			I_E =5mA		
	V_{CB} (Volt)	V_{RC} (mV)	$I_C = V_{RC}/R_C$ (mA)	V_{CB} (Volt)	V_{RC} (mV)	$I_C = V_{RC}/R_C$ (mA)	V_{CB} (Volt)	V_{RC} (mV)	$I_C = V_{RC}/R_C$ (mA)
1.	-	-	-	-	-	-	-	-	-
2.	-	-	-						

7. DATA ANALYSIS:

I. Plot the graph: V_{EB} vs. I_E for a constant V_{CB} .
II. Plot the graph: V_{CB} vs. I_C for a constant I_E.

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Check the power supply terminals of the trainer kit.
2) Check the components to be used in the experiment.

3) Select proper mode of multimeter.
4) Connect the circuit carefully as per circuit diagram.
5) Don't give the power Supply without verifying the circuit by the class teacher.

9. SOME SAMPLE QUESTIONS:

i) Define input characteristics and output characteristics for a common base Transistor.
ii) What is Cut-in voltage?
iii) What do you mean by base-width modulation?
iv) Define $\propto$.

10. REFERENCE :

A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
B) Linear Integrated Circuit by R.P. Jain & D. Roychowdhury.
C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 6

Title: Common Emitter Bipolar Transistor Characteristics.

1. OBJECTIVE (S):

1.1. Input characteristics.
1.2. Output characteristics.
1.3. Determination of different h-parameters.

2. THEORY:

When a transistor is operated in such a way that the emitter terminal is common to both the input and output circuit, the mode of operation is called the common emitter (CE) mode or the grounded emitter configuration of the transistor.
The plot of the base current I_B against the base to emitter voltage V_{BE} with V_{CE} as parameter is known as the CE mode Input characteristic of transistor.
The plot of the collector current I_C against the collector to emitter voltage V_{CE} with the base current I_B as a parameter is known as the CE mode Output characteristic of transistor.
The portion of the output characteristic when both the junctions are reversed biased is called cut-off region.
The portion of the output characteristic when both the junctions are forward biased is called saturation region.
The portion of the output characteristic when emitter junction is forward biased and collector junction is reversed biased is called active region of characteristics.

The ac input impedance h_{ie} for CE mode is

$h_{ie} = \delta V_{BE}/\delta I_B = V_{BE3}-V_{BE1}/I_{B3}-I_{B1}$ where V_{CE} is constant
The ac reverse voltage gain h_{re} for CE mode is
$h_{re} = \delta V_{BE}/\delta_{CE}$ where I_B const.
The a.c current gain h_{fe} for CE mode
$h_{fe} = \delta I_C/\delta I_B$ where V_{CE} const.
The output admittance h_{oe} for CE mode
$h_{oe} = \delta I_C/\delta V_{CE}$ where I_B const.

3. CIRCUIT DIAGRAM:

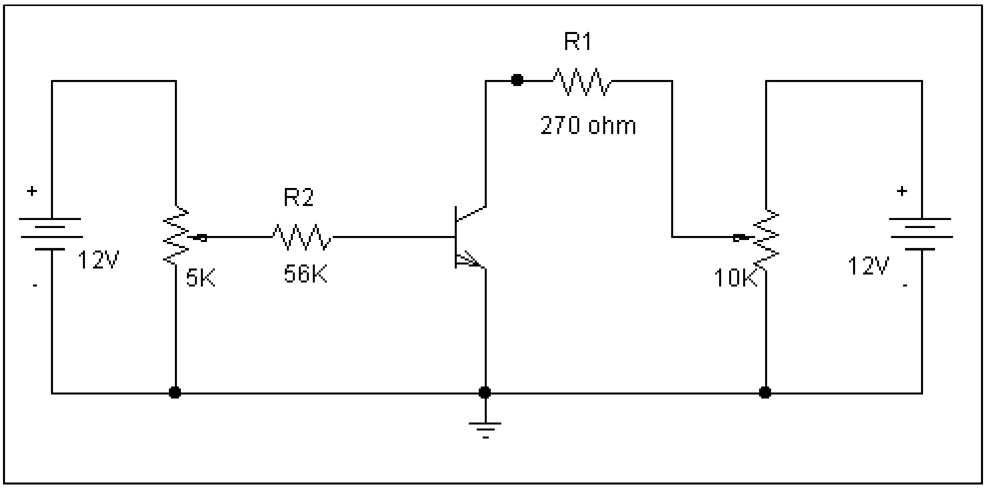


Fig.1. Circuit for Transistor characteristic (CE mode)

4. APPARATUS & COMPONENTS USED:

4.1. Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2. Components:

Sl. No.	Components	Specifications	Qty.
1	Resistors	270Ω,56KΩ,1/4 Watt	1
2	Transistor	CL100	1
3	Pot	5KΩ,10KΩ	1

5. PROCEDURES:

For output characteristics:

1. Set up the circuit as shown schematically and note the specifications of the meter.

2. Turn the potentiometers to their minimum position and switch on the power supply.
3. Adjust the 5KΩ Pot. (connected at base side) till convenient base current I_B (say 10uA) flows.
4. Slowly increase the collector voltage, as recorded by the voltmeter from its minimum value in convenient steps by adjusting the 10KΩ pot.(connected at collector side) up to about 8V. For each collector voltage (V_{CE}) note drop across collector resistance so that collector current can be calculated. Take care that base current I_B remains constant.
5. Change I_B to a new value (say 20 μA) by adjusting the pot. And repeat step 4.
6. Repeat step 4 for another 2 or 3 I_B values.
7. Plot output characteristics for each I_B on same graph sheet.
8. Choose at least two different operating points on the active region of the characteristic and determine β and h_{oe}.

For Input characteristics:

Similar to Output characteristic except V_{CE} remains fixed and plot I_B against V_{BE} at least for three sets of data.

From input characteristics calculate h_{ie} and h_{re} .

6. EXPERIMENTAL DATA:

Table1

Data for output characteristics

I_B=10μA			I_B=20μA			I_B=30μA			I_B=40μA		
V_{CE} (V)	V_{R1} (V)	I_C (mA)	V_{CE} (V)	V_{R1} (V)	I_C (mA)	V_{CE} (V)	V_{R1} (V)	I_C (mA)	V_{CE} (V)	V_{R1} (V)	I_C (mA)

Table2

Data for Input characteristics

V_{CE} =			V_{CE} =			V_{CE} =		
V_{BE}(V)	V_{R2}(V)	I_B(mA)	V_{BE}(V)	V_{R2}(V)	I_B(mA)	V_{BE}(V)	V_{R2}(V)	I_B(mA)

Table 3

Calculation of h parameters
Q-point is at ______________

Parameters	Calculated values
h_{fe}	
h_{re}	
h_{ie}	
h_{oe}	

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Connect circuit properly & then only power on the circuit.
2) If any change of the circuit requires then power off first and then disassemble the circuit.

9. SOME SAMPLE QUESTIONS:

i) Why an ordinary junction transistor is called bipolar?
ii) What are the three terminals of a transistor?
iii) Why base region is made thin and lightly doped?
iv) Define ac current gain of a transistor when operated in common emitter configuration.
v) Define α of a transistor.
vi) Why the value of β is always greater than unity?
vii) What do you mean by the input characteristics of a transistor?
viii) What are the regions in output characteristics of a transistor?
ix) Define ac current gain of a transistor when operated in common base configuration.
x) Define output admittance of a transistor for CE mode?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 7

Title: DESIGN SELF BIAS BJT CIRCUIT.

1. OBJECTIVE (S):

1.1. To design a self-bias circuit.
1.2. To determine the stability factor experimentally.

2. THEORY:

A transistor acts as an amplifier in active region. Biasing circuit is used in a transistor to keep in the activeregion. Following are the three common biasing circuits used in transistors.

Self-bias circuit: In this circuit the base bias is obtained by using a voltage divider network. Anemitter resistor is used to limit the collector current and hence the Q-point is stable.

Also, the reverse saturation current doubles for every 10^0C rise in temperature, hence Q-point should be stable.

Stability factor is defined as the rate of change of collector current with reverse saturation current. For a stable Q-point stability factor should be as small as possible. A self-bias circuit provides the least stability factor out of all the configurations and hence it is commonly preferred over other biasing circuits.

Stability factor is mathematically given by the following equation.

$$S = \frac{\partial I_C}{\partial I_{CO}} = \frac{1+\beta}{1-\beta \times \frac{\partial IB}{\partial IC}}$$

For Self-Bias

$$S = \frac{1+\beta}{1+\beta \times \frac{R_E}{R_b+R_E}}$$

Design:

Given V_{CC} = 12V, V_{BE} = 0.65V, V_{CE} = 6V, I_C = 1mA, β = 200, S=10

Design a self-bias circuit for which the biasing conditions are as follows.
V_{CC} = 12V, I_C = 1mA, V_{CE} = 6V and Stability factor is S = 10. Use R_C = 4.7KΩ. Use A transistor with β = 200 and V_{BE} = 0.65V.

Use, $I_C = \beta \times I_B$
So, I_B = 5µA

Apply KVL to the output loop:
$-V_{CC} + I_C \times R_C + V_{CE} + I_C \times R_E = 0$
So, R_E = 1.3KΩ

Apply Thevenin's theorem to the base circuit, then

$V_B = \frac{V_{cc} \times R_2}{R_1 + R_2}$ And $R_B = \frac{R_1 \times R_2}{R_1 + R_2}$

We know that the stability factor for a self-bias circuit is given by,

$$S = \frac{1+\beta}{1+\beta \times \frac{R_E}{R_b + R_E}}$$

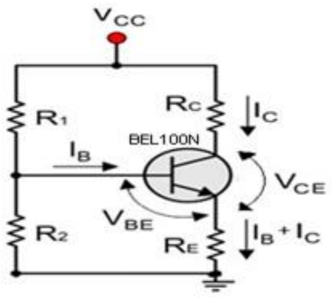
so, R_B = 12.31KΩ

Apply KVL to the input loop, then

$-V_B + I_B \times R_B + V_{BE} - I_E \times R_E = 0$
So, V_B = 2.01V

Divide R_B with V_B:
$R_1 = \frac{V_{CC} \times R_B}{V_B}$ = 73.5KΩ
Also, $R_B = \frac{R_1 \times R_2}{R_1 + R_2}$ so, R_2 = 14.8KΩ

3. CIRCUIT DIAGRAM:



4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Transistor	BEL100N/SL100	1
2	Resistors	As per design	

5. PROCEDURES:

Step-1: Connect the circuit diagram as shown in figure.
Step-2: Note the DC conditions i.e, the values of V_{BE}, I_B and V_{CE}, I_C.
Step-3: Heat the transistor by placing a soldering iron in its vicinity for a minute. Note the values of I_C and I_B.
Step-4: Calculate the stability factors theoretically and compare them with the practical values.

6. EXPERIMENTAL DATA:

	I_{B1}	I_{B2}	I_{C1}	I_{C2}	$\frac{\Delta I_B}{\Delta I_C}$	$S = \frac{1+\beta}{1-\beta \times \frac{\Delta I_B}{\Delta I_C}}$	S (Theoretical)
Self-bias circuit							

Result:

Stability factors are calculated for each circuit. Theoretical and practical values of the stability factors are verified.

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) While performing the experiment do not exceed the ratings of the transistor. This maylead to damage the transistor.
2) Make sure while selecting the emitter, base and collector terminals of the transistor.
3) Do not switch ON the power supply unless you have checked the circuit connections asper the circuit diagram.

9. SOME SAMPLE QUESTIONS:

i) What should be the value of stability factor (high/Low)?

ii) What is the effect of temperature upon reverse saturation current?

iii) What is thermal run away?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 8

Title: JFET Drain & Transfer Characteristics (Common Source).

1. OBJECTIVE (S):

1.1. Drain characteristics.
1.2. Transfer characteristics.
1.3. To find rd, gm, and μ from the characteristics.

2. THEORY:

Field effect Transistor is a unipolar junction transistor. It is voltage-controlled device. The three terminals of FET are Source, Drain and Gate. In this circuit arrangement input is applied between gate and source and output is taken from the drain and source. Here source of the transistor is common to both input and output.

Drain Characteristics:

The plot of Drain current (I_D) vs. drain to source voltage (V_{DS}) when V_{GS} const. is known as Drain characteristic.

Transfer Characteristics:

The plot of Drain current (I_D) vs. gate to source voltage (V_{GS}) when V_{DS} constant is known as transfer characteristic.

Drain Resistance:

Drain resistance r_D is $\Delta V_{DS}/\Delta I_D$ for constant V_{GS} that can be calculated from Drain characteristic.

Transconductance:

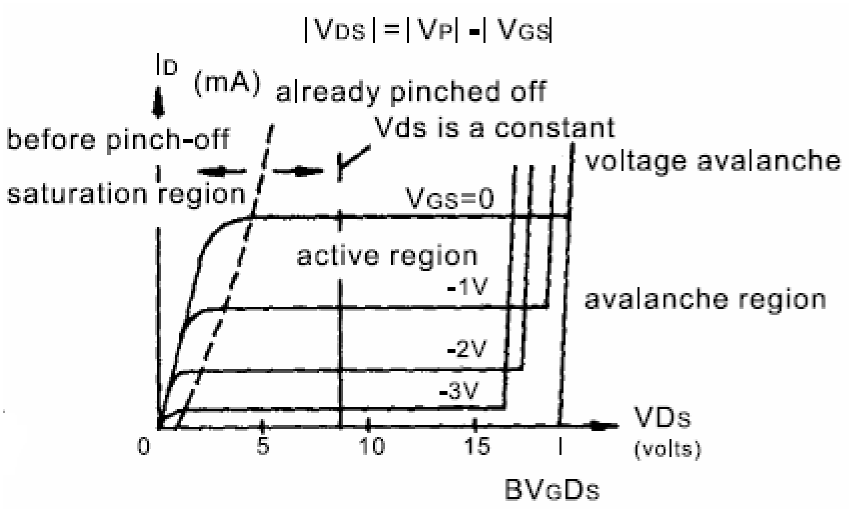
Transconductance g_m is $\Delta I_D/\Delta V_{GS}$ for constant V_{DS} that can be calculated from Transfer characteristic.

Amplification factor:

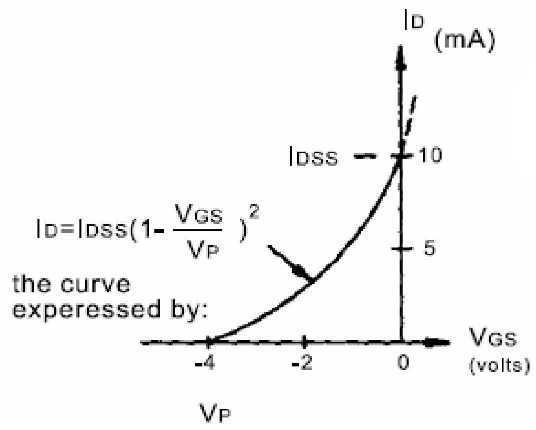
Amplification factor μ is $\Delta V_{DS}/\Delta V_{GS}$ for constant drain current.

Model Graph:

Drain Characteristics:



Transfer Characteristics:



3. CIRCUIT DIAGRAM:

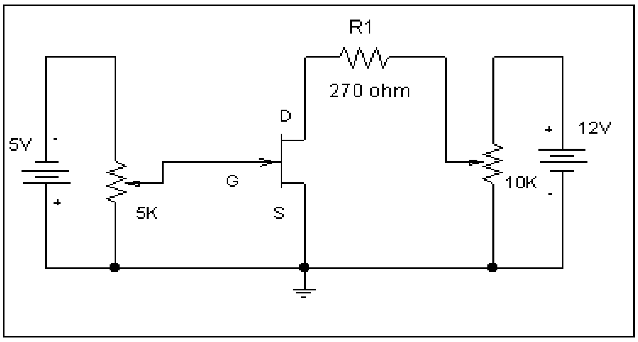


Fig.1. Circuit for the characteristic of FET (CS mode)

4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Resistors	270Ω,1/4 Watt	1
2	FET	PN4393	1
3	Pot	5KΩ,10KΩ	1

5. PROCEDURES:

Drain characteristic:

Step-1: Connect the circuit diagram as shown in figure.

Step-2: Set gate voltage V_{GS}=0v, vary drain voltage V_{DS} in steps of 0.5V and note down the corresponding drain current I_D.

Step-3: Repeat the above procedure for V_{GS} = -0.5v, -1v, -1.5v,-2v.

Transfer characteristic:

Step-4: Set Drain voltage V_{DS} =10V so that FET operates at saturation region, vary Gate voltage V_{GS} in steps of 0.5V and note down the corresponding Drain current I_D.

6. EXPERIMENTAL DATA:

Table1

Data for Drain characteristics

V_{GS}=0V		V_{GS}= -0.5V		V_{GS}=-1V		V_{GS}=		V_{GS}	
V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)

Table2

Data for Transfer characteristics

V_{DS}=10 V	
V_{GS}(V)	I_D(mA)

Table-3

Calculation of FET parameters

Parameters	Calculated Values
$r_D=\Delta V_{DS}/\Delta I_D$	
$g_m=\Delta I_D/\Delta V_{GS}$	
$\mu= r_D x g_m$	

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Connect circuit properly & then only power on the circuit.
2) If any change of the circuit requires then power off first and then disassemble the circuit.

9. SOME SAMPLE QUESTIONS:

i) What Is FET? Differentiate between JFET and MOSFET.
ii) How many terminals a JFET have? What is the function of Substrate?
iii) What is pinch off voltage?
iv) What is N channel or P Channel?
v) What is enhanced or depletion type MOSFET?
vi) What is the composition material of FET?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 9

Title: Study Characteristics of Photo transistor.

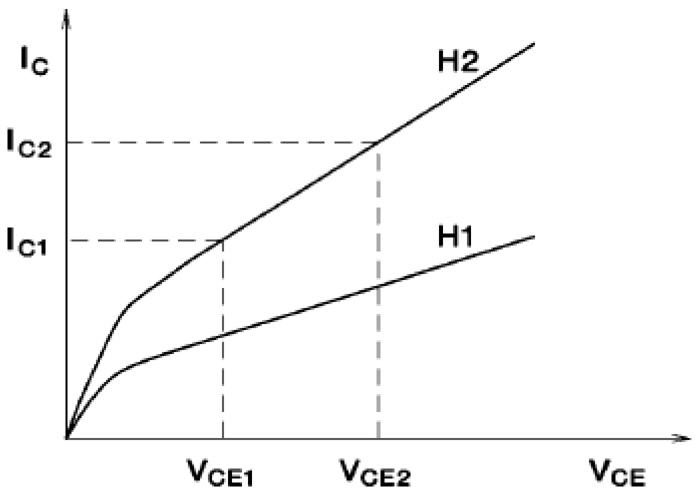
1. OBJECTIVE (S):

1.1 To obtain the V-I characteristics of the given photo transistor.

2. THEORY:

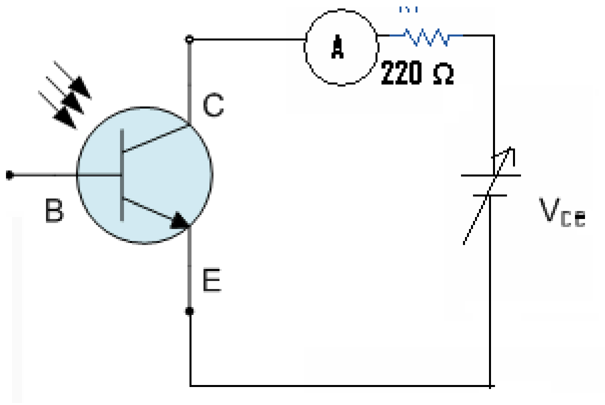
The photo transistor is a 3 terminal device which gives an electrical current as output if an input light excitation is provided. It works in reverse bias. When reverse biased along with the reverse bias current I_{CO}, the light current I_L is also added to the total output current. The amount of current flow depends on the input light intensity given as excitation. Phototransistor is basically a photodiode with amplification and operates by exposing its base region to the light source. Phototransistor light sensors operate the same as photodiodes except that they can provide current gain and are much more sensitive than the photodiode with currents are 50 - 100 times greater than that of the standard photodiode. Phototransistors consist mainly of a bipolar NPN transistor with the collector-base PN-junction reverse-biased. The phototransistor's large base region is left electrically unconnected and uses photons of light to generate a base current which in turn causes a collector to emitter current to flow.

Model graph



Current vs Voltage Curves

3. CIRCUIT DIAGRAM:



4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Photo transistor	IR 3MM 935NM	1
2	Resistor	220Ω,1/4 Watt	1

5 PROCEDURES:

Step-1: Connect the circuit as per the circuit diagram.

Step-2: Keep the input light excitation fixed. Then vary the V_{ce} in steps of 1V till the maximum voltage rating of the transistor is reached and then note down the corresponding valuesof $I_{c.}$

Step-3: Tabulate the readings. For various values of input excitation record, the values of Vce and Ic and plot the characteristics of the photo transistor.

6. EXPERIMENTAL DATA:

V_{ce} (V)	I_c (mA)

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) The photo transistor must be given a proper excitation for a reasonable current flow.
2) Connections must be tight.

9. SOME SAMPLE QUESTIONS:

i) What are the applications of phototransistor?
ii) When does the photo transistor conduct?
iii) What is the input excitation in a photo transistor?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

Experiment no. 10

Title: Study Characteristics of LED & LDR.

1.A: Study Characteristics of LED

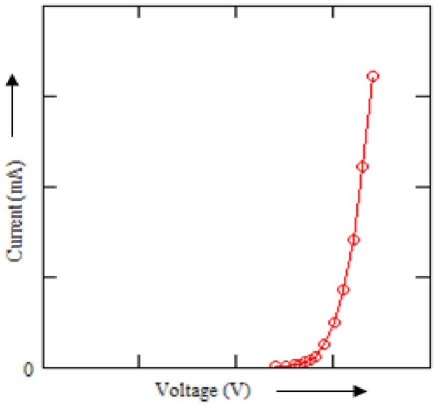
1. OBJECTIVE (S):

1.1 To study the V-I characteristics of light emitting diode.
1.2 To find the threshold voltage and forward resistance of LED.

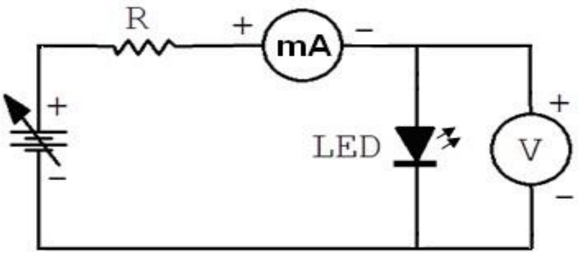
2. THEORY:

In a PN junction charge carrier recombination takes place when the electrons cross from the N- layer to the P-layer. The electrons are in the conduction band on the P-side while holes are in the valence band on the N-side. The conduction band has a higher energy level compared to the valence band and so when the electrons recombine with a hole the difference in energy is given out in the form of heat or light. In case of silicon or germanium, the energy dissipation is in the form of heat, whereas in case of gallium-arsenide and gallium phosphide, it is in the form of light. This light is in the visible region. Germanium and silicon, which have E_g about 1ev cannot be used in the manufacture of LED. Hence Gallium arsenide, Gallium phosphide which emits light in the visible region are used to manufacture LED.

Model graph



3. CIRCUIT DIAGRAM:



4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1
3	D.C Ammeter	0-50mA	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Resistor	220Ω,1/4 Watt	1
2	LED	-	1

5. PROCEDURES:

Step-1: Connect the Light emitting diode as shown in figure.
Step-2: Slowly increase forward bias voltage in steps of 0.1 volt.
Step-3: Note the current passing through the LED.
Step-4: Do not exceed 30mA current.
Step-5: Plot a graph of light emitting diode
Step-6: Voltage vs light emitting diode current.

6. EXPERIMENTAL DATA:

S. No.	Voltage (Volts)	Current (mA)

7. DATA ANALYSIS:

Calculated Threshold Voltage V_{th} =__________V.

Forward Resistance R_f =_________Ω.

8. PRECAUTIONARY MEASURE TO BE TAKEN:

1) Connect voltmeter and Ammeter in correct polarities as shown in the circuitdiagram.
2) Do not switch **ON** the power supply unless you have checked the circuitconnections as per the circuit diagram.

9. SOME SAMPLE QUESTIONS

i) What is forward biased diode?
ii) What are p-type and n-type semiconductors?
iii) Define threshold voltage.
iv) What is depletion layer?

10. REFERENCE:

(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.

1.B: Study Characteristics of LDR

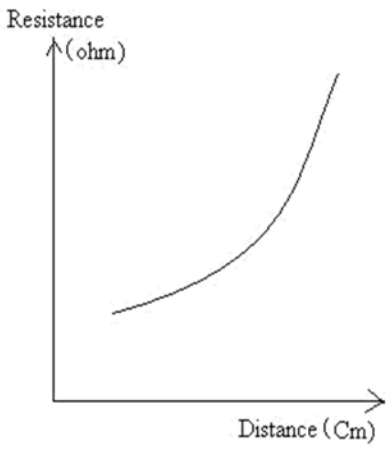
1. OBJECTIVE (S):

1.1 To study and verify the characteristics of LDR.

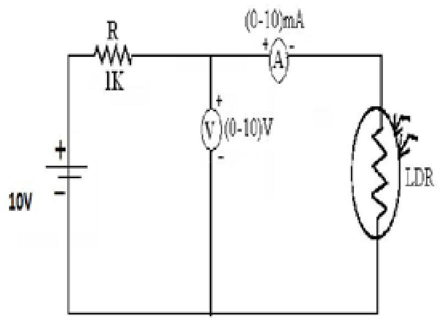
2. THEORY:

A photoresistor or light dependent resistor or cadmium sulfide (CdS) cell is a resistor hose resistance decreases with increasing incident light intensity. It can also bereferred to as a photoconductor.
A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

Model graph



3. CIRCUIT DIAGRAM



4. APPARATUS & COMPONENTS USED:

4.1 Apparatus:

Sl. No.	Apparatus	Range	Qty.
1	Trainer Kit	-	1
2	Multimeter	-	1
3	D.C Ammeter	0-10mA	1

4.2 Components:

Sl. No.	Components	Specifications	Qty.
1	Resistor	1KΩ,1/4 Watt	1
2	LDR	1KΩ	1

5. PROCEDURES:

Step-1: Connect circuit as shown in figure.
Step-2: Keep light source at a distance and switch it ON, so that it falls on the LDR
Step-3: Note down current and voltage in ammeter and voltmeter.
Step-4: Vary the distance of the light source and note the V & I.
Step-5: Sketch graph between R as calculated from observed V and I and distance oflight source

6. EXPERIMENTAL DATA:

Distance (cm)	Voltage (V)	Current (mA)	Resistance(KΩ)

7. DATA ANALYSIS:

8. PRECAUTIONARY MEASURE TO BE TAKEN:

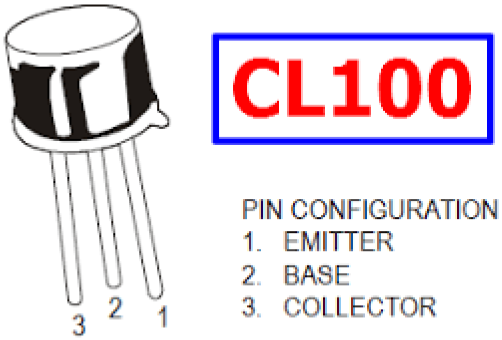
1) Connect voltmeter and Ammeter in correct polarities as shown in the circuitdiagram.
2) Do not switch **ON** the power supply unless you have checked the circuitconnections as per the circuit diagram.

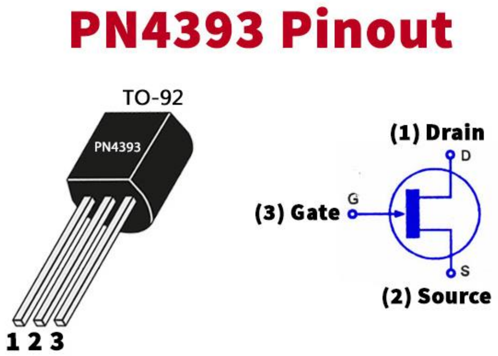
9. SOME SAMPLE QUESTIONS:

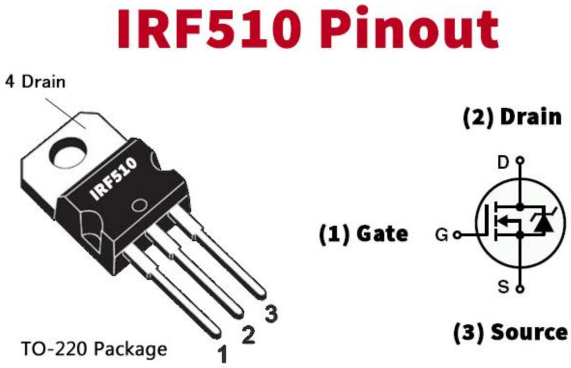
i) Give the principle of operation of LDR.
ii) Give the applications of LDR.

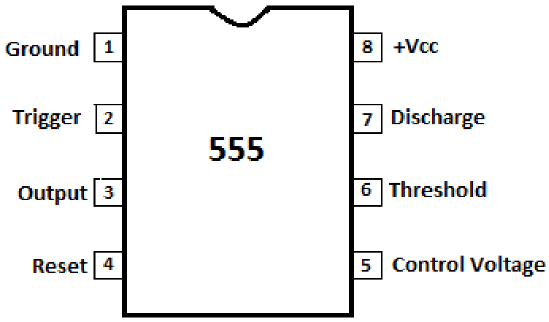
10. REFERENCE:

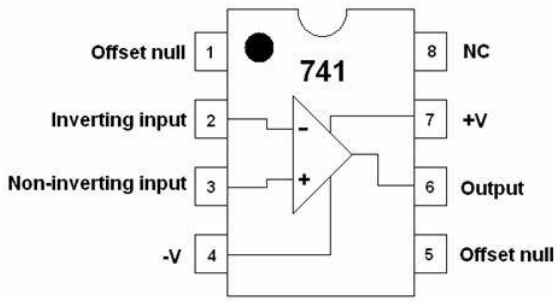
(A) Electronics Laboratory Primer – A Design approach by S. Poorna Chandra & B Sasikala.
(B) Linear Integrated Circuit by R.P. Jain & D. Roy Chowdhury.
(C) Operational Amplifier and Linear Integrated Circuit by Ramakant A. Gayakwad.


CL100
PIN CONFIGURATION
1. EMITTER
2. BASE
3. COLLECTOR
3 2 1


PN4393 Pinout
TO-92
PN4393
1 2 3
(1) Drain
D
(3) Gate
G
S
(2) Source


IRF510 Pinout
4 Drain
IRF510
TO-220 Package
1 2 3
(2) Drain
D
(1) Gate
G
S
(3) Source


555
Ground 1
Trigger 2
Output 3
Reset 4
8 +Vcc
7 Discharge
6 Threshold
5 Control Voltage


741
Offset null 1
Inverting input 2
Non-inverting input 3
-V 4
8 NC
7 +V
6 Output
5 Offset null
-
+