STUDENTS PROJECT

(PHYSICS)

: Project Work :

Project work is divided in two parts :

(1) : Theoretical essay or educational tour report : 50 marks

(2) : Preparation of Working Model : 50 marks

Project (1): Theoretical essay or educational tour report:

Each student has to prepare one detailed essay based on any topic of Physics which includes the principle of physics or based on any theory of physics or application of physics.

OR

Student should submit detailed report of educational study tour.

Each student should submit this report at the end of the 6th Semester. The Project work would be evaluated by the examiner based on the presentation of the report by students and conducting viva-voce on the topic.

The distribution of marks is as follows:

Essay/ Report writing	: 35
Viva voce	: 15
Total	: 50

Project(2): Preparation of the Working Model:

The project work will be assigned in the team (group) of minimum one and maximum four students.

Students has to prepare one model (preferably working model) based on the principle of Physics. The model, along with a detailed write up (dissertation), explaining the principle, working and applications, should be submitted to the Practical-in-charge at the end of 6th semester.

Each group of the students has to submit a working model in common but each student of the group has to separately submit write up for their common group working model.

Project-in-charge should extend the guidance regarding the selection, preparation and troubleshooting of working model, and there would be one lecture per week per batch of students.

The Project work would be evaluated by the examiner based on the presentation of the report by students and conducting viva-voce and demonstration of the working model.

The distribution of marks is as follows:

Model making	: 20
Model presentation	: 15
Viva voce	: 15
Total	: 50

Total Marks of Project: 50 + 50 = 100.

The Evaluation of the project work will be done at the end of the sixth semester. For the Evaluation of the both types of project works one session of three hours should be allocated during the practical examination.

There would be three sessions of 3 hours each for three experimental practical examination. Fourth session of 3 hours would be for the project work evaluation. (in total a student has to undergo four sessions (3 hours each) of practical +project evaluation examination)

There shall be batch of 15 students for project and viva.

LCR SERIES & PARALLEL RESONANCE CIRCUIT

PROJECT REPORT

SUBMITTED BY

PATEL BINAL D.

ENROLLMENT NO.

(003101165669)

ROLL NO

162

IN FULFILLMENT FOR THE AWARD OF THE DEGREE OF

BACHELOR OF SCIENCE

IN

PHYSICS DEPARTMENT

M.P.SHAH ARTS & SCIENCE COLLEGE, SUREDRANAGAR

Saurashtra University, Rajkot -360005

March 2019

CERTIFICATE

*This is to certify that the dissertation entitled **"LCR"** has been carried out by **PATEL BINAL D. (003101165669)** under my guidance in fulfillment of the degree of Bachelor of Engineering **SCIENCE In PHYSICS DEPARTMENT**(6th semester) during the academic year 2019.*

Guide:

Dr. K. D. PAREKH

M.P.SHAH ARTS & SCIENCE COLLEGE * SURENDRANAGAR *

Head of the Physics Department
M. P. Shah Arts & Science College
Surendranagar.

ACKNOWLEDGEMENT

In the accomplishment of this project successfully, many people have best owned upon me their blessings and the heart pledged support, this time I am utilizing to thank all the people who have been concerned with project.

Primarily I would thank god for being able to complete this project with success. Then I would like to thank my PHYSICS Professor Dr. K.D. Parikh, whose valuable guidance has been the ones that helped me patch this project and make it full proof success his suggestions and his instructions has served as the major contributor towards the completion of the project.

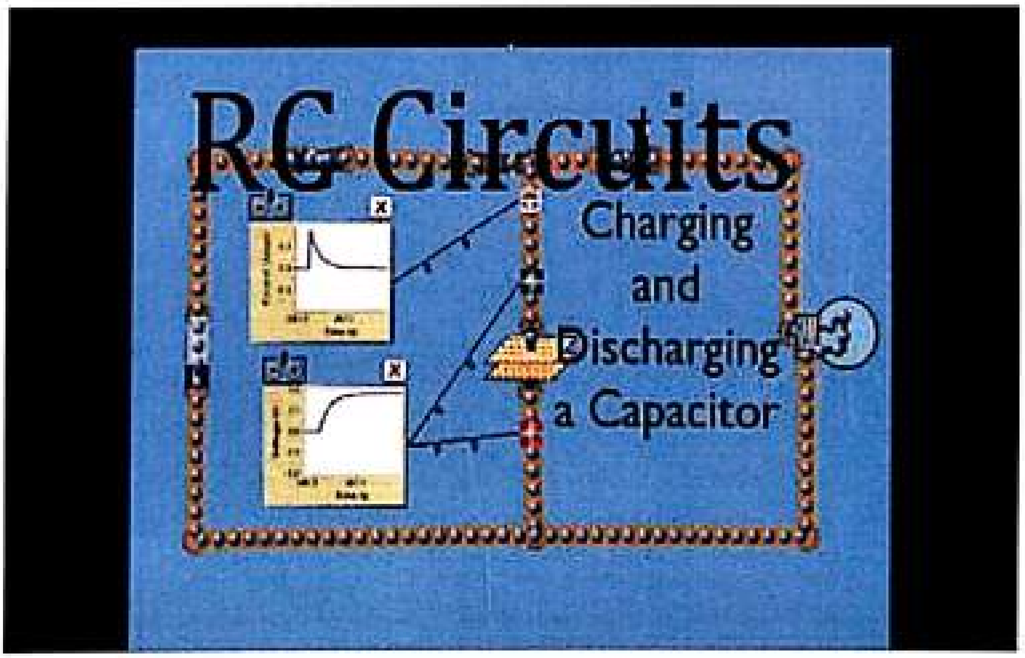
Then I would like to thank my parents and friends who have helped me with their valuable suggestions and guidance has been helpful in various phases of the completion of the project.

Last but not the least I would like to thank my

classmates who have helped me a lot.

PURPOSE

THE GOAL OF THIS PROJECT IS TO verify that 63% charge is stored in a capacitor in an R-C circuit at its time constant and 63% charge remains when capacitor is discharged and hence plot a graph between voltage and time



INTRODUCTION

An R-C circuit is a circuit containing a resistor and capacitor in series to a power source. Such circuits find very important applications in various areas of science and in basic circuits which act as building blocks of modern technological devices. It should be really helpful if we get comfortable with the terminologies charging and discharging of capacitors.

Charging of capacitor
:- A
capacitor
is a passive two-terminal electrical component used to store energy in an electric field. In the hydraulic analogy, charge carriers flowing through a wire are analogous to water flowing through a pipe. A capacitor is like a rubber membrane sealed inside a pipe. Water molecules cannot pass through the membrane, but some water can move by stretching the membrane. The analogy clarifies a few aspects of capacitors:

The flow of current alters the charge on a capacitor
, just as the flow of water changes the position of the membrane. More specifically, the effect of an electric current is to increase the charge of one plate of the capacitor, and decrease

the charge of the other plate by an equal amount. This is just like how, when water flow moves the rubber membrane, it increases the amount of water on one side of the membrane, and decreases the amount of water on the other side.

The more a capacitor is charged, the larger its voltage drop ; i.e., the more it "pushes back" against the charging current. This is analogous to the fact that the more a membrane is stretched, the more it pushes back on the water.

Current can flow "through" a capacitor even though no individual electron can get from one side to the other. This is analogous to the fact that water can flow through the pipe even though no water molecule can pass through the rubber membrane. Of course, the flow cannot continue the same direction forever; the capacitor will experience dielectric breakdown, and analogously the membrane will eventually break.

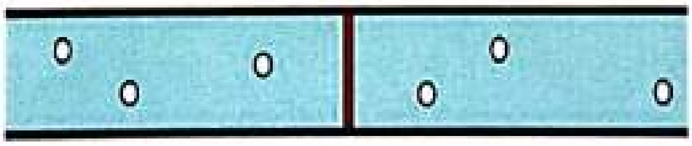
The capacitance describes how much charge can be stored on one plate of a capacitor for a given "push" (voltage drop). A very stretchy, flexible membrane corresponds to a higher capacitance than a stiff membrane.

A charged-up capacitor is storing potential energy, analogously to a stretched membrane. (ii)

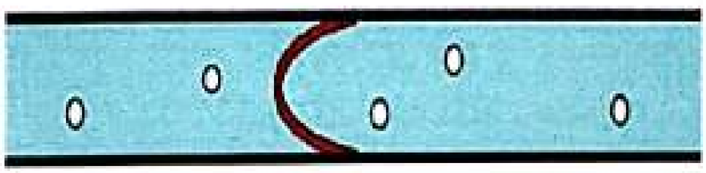
Discharging of capacitor

Using hydraulic analogy only we can understand that when the capacitor is charged the membrane is stretched, but now if you allow the water to come out slowly and let the membrane relax, then it is called discharging of capacitor. In other words when the charge on each of the plates becomes zero and the potential difference across its terminals drops to zero. Below is a graphical description of capacitor as a pipe with a membrane

1. RELAXED MEMBRANE (UNCHARGED)



2. STRETCHED MEMBRANE (CHARGED)



MATERIAL REQUIRED

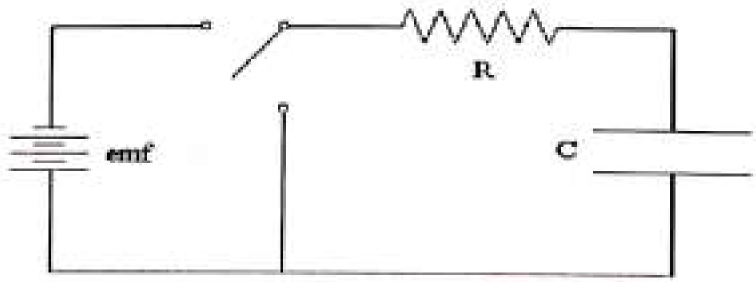
1. BREADBOARD
2. 100μF CAPACITOR
3. MΩ RESISTOR
4. MULTIMETER
5. 9V BATTERY
6. WIRE STRIPPER
7. CONNECTING WIRES
8. BATTERY CONNECTOR
9. STOPWATCH

THEORY

When a capacitor of capacitance C is connected in series with a resistor of resistance R and then connected to a battery of EMF E it gets charged but since some resistance has been introduced, this charging process takes some time and hence the potential difference between the plates of the capacitor varies as an exponential function of time, i.e.

$$V \propto e^{xt}$$

THE CIRCUIT DIAGRAM FOR THIS EXPERIMENT IS GIVEN BELOW:-



APPLYING KIRCHHOFF'S LAW IN THE ABOVE CIRCUIT DURING CHARGING, I.E. CAPACITOR IS CONNECTED TO THE BATTERY

$E - V_C - IR = 0$................. (I)

$V_C = \frac{Q}{C}$

PUTTING ABOVE VALUE IN EQ. (I)

$E - \frac{Q}{C} - IR = 0$

SINCE $I = \frac{dQ}{dt}$

THEREFORE, $E - \frac{Q}{C} - \frac{dQ}{dt}R = 0$

$E - \frac{Q}{C} = \frac{dQ}{dt}R$

$EC - Q = \frac{dQ}{dt}RC$

INTEGRATING BOTH SIDES

$\int_0^t \frac{1}{RC}\, dt = \int_0^Q \frac{1}{EC-Q}\, dQ$

$-\ln\frac{EC-Q}{EC} = \frac{t}{RC}$.............. (II)

$1 - \frac{Q}{EC} = e^{\frac{-t}{RC}}$

HENCE WE GET, $Q = EC\left(1 - e^{\frac{-t}{RC}}\right)$

SINCE $EC = Q_0$ FOR A CAPACITOR

THEREFORE,

$Q = Q_0\left(1 - e^{\frac{-t}{RC}}\right)$..................... (III)

HERE, $Q \rightarrow$ CHARGE AT TIME T

$Q_0 \rightarrow$ MAX CHARGE

ALSO Q=CV AND $Q_0=CV_0$, WHERE V AND V_0 ARE VOLTAGE AT TIME T AND MAX VOLTAGE RESPECTIVELY

THEREFORE FROM EQ (III),

$CV=CV_0\left(1-e^{\frac{-t}{RC}}\right)$

$\boxed{V=V_0\left(1-e^{\frac{-t}{RC}}\right)}$ THIS IS THE REQUIRED EXPRESSION.

[NOTE: - THIS IS THE CHARGING EQUATION ONLY, FOR DISCHARGING EQUATION PROCEED THE SAME WAY BUT ONLY REMOVE E FROM KIRCHHOFF LAW'S EQUATION]

THUS EQUATION FOR DISCHARGING,

$\boxed{V=V_0\left(e^{\frac{-t}{RC}}\right)}$ WHEN RC=T, THEN EQUATION BECOMES,

$V=V_0(1-e^{-1})$

WHICH ON SOLVING GIVES

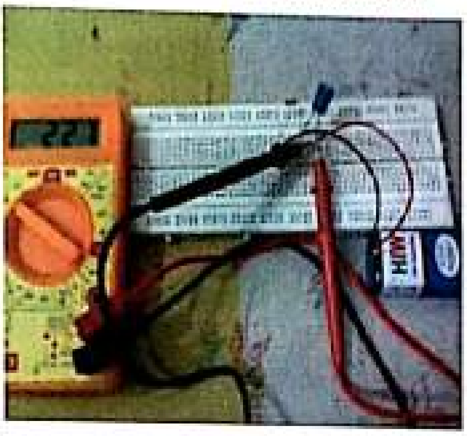
$V=0.63V_0$, I.E. THE VOLTAGE ON CAPACITOR AT TIME T=RC BECOMES 63% OF THE MAX VOLTAGE, WHICH MEANS 63% OF TOTAL CHARGE HAS BEEN STORED IN THE CAPACITOR.

THIS PRODUCT OF R AND C HAS BEEN GIVEN A NEW NAME, I.E. TIME CONSTANT AND IS DENOTED BY τ, WHICH MEANS FOR ANY CAPACITOR IN RC CIRCUIT 63% OF TOTAL CHARGE IS STORED AT TIME CONSTANT.

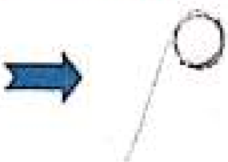
IN MY EXPERIMENT I HAVE USED A 100μF CAPACITOR AND A 1MΩ RESISTOR THUS TIME CONSTANT = 100×10-6×106=100 SEC.

PROCEDURE

1. CONNECT ALL THE COMPONENTS IN THE BREADBOARD AS SHOWN IN THE FOLLOWING PICTURE.

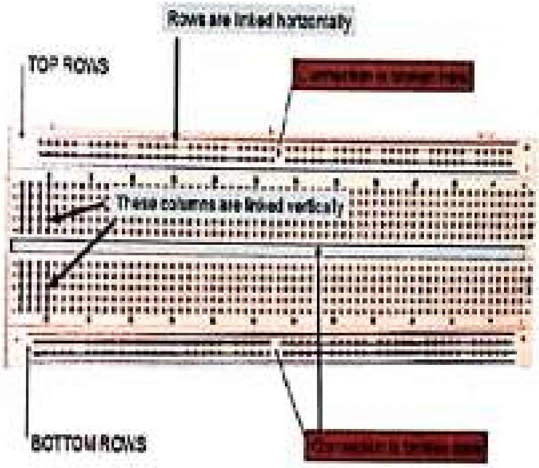


2. NOW TAKE MULTIMETER LEADS AND PLACE THEM IN THE TWO TERMINALS SHAPED LIKE



3. BEFORE PROCEEDING FURTHER WE MUST HAVE A BIT OF KNOWLEDGE ABOUT BREADBOARD. A BREADBOARD IS A SIMPLE CIRCUIT BUILDING DEVICE USED TO BUILD TEMPORARY CIRCUITS JUST TO TEST THEIR WORKING. IT IS VERY SIMPLE TO WORK WITH AS IT DOES NOT REQUIRE ANY SOLDERING OR ATTACHMENT OF COMPONENTS. THE

COMPONENTS COULD BE JUST PUSHED IN THE HOLES AND CONNECTIONS COULD BE MADE EASILY. A STRAIGHT LINE PATTERN OF HOLES RESEMBLES A WIRE AND THE ARRANGEMENT OF THESE HOLES ARE SHOWN BELOW:-



4. NOW TAKE THE BATTERY AND CONNECT ITS TERMINALS ACROSS THE TERMINALS OF THE CAPACITOR AND START THE STOP WATCH. NOTE THE READINGS AT 20SEC INTERVALS AND WRITE THEM DOWN. [NOTE:- READING THE PREVIOUS STATEMENT COULD BE ASTONISHING AS IT SAYS THAT MEASURE VOLTAGE AT 20SEC INTERVAL BUT ONE COULD QUESTION THAT CURRENT MOVE AT VERY HIGH SPEED SO HOW COULD ONE MEASURE THE CHANGING READINGS! BUT BELIEVE ME IT WASN'T AN EASY TASK BUT SINCE THE VOLTAGE DEPENDS ON RECIPROCAL OF EXPONENTIAL FUNCTION AND AS TIME PASSES BY THE CHANGING READINGS WILL GET SLOWED DOWN AND EVEN AFTER INFINITE TIME THE

CAPACITOR COULD NOT BE CHARGED UP TO MAX VOLTAGE. ALSO SINCE ITS TIME CONSTANT IS 100SEC WHICH IS QUITE PRACTICAL TO MEASURE AT AND HENCE THIS EXPERIMENT IS VERY MUCH JUSTIFIED.]. TAKE 10 READINGS AND IF REQUIRED THE 20SEC GAP COULD BE INCREASED BECAUSE AS THE TIME PASSES BY THE CHANGE IN VOLTAGE BECOMES SMALLER AND SMALLER.

5. NOW LET THE CAPACITOR BE CHARGED UP TO 460 SEC BECAUSE THEN IT WILL BECOME 99.99% CHARGED [SINCE WE HAVE A LIMITED TIME AND WE CAN'T WAIT FOR INFINITE TIME FOR IT TO CHARGE COMPLETELY!]. NOW REMOVE THE BATTERY AND NOW ATTACH A WIRE IN PLACE OF THE BATTERY TERMINALS AND AGAIN NOTE THE MULTIMETER READINGS CHANGING AND RECORD THEM.

6. PLOT A GRAPH BETWEEN VOLTAGE AND TIME FOR CHARGING AS WELL AS DISCHARGING.

OBSERVATION:-

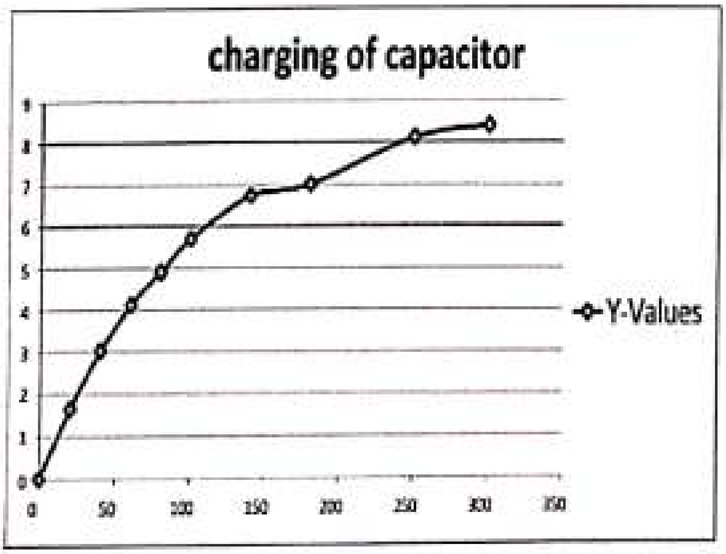
S NO.	MULTIMETER READING WHILE CHARGING(IN VOLT)	MULTIMETER READING WHILE DISCHARGING(IN VOLT)	TIME (IN SECONDS)
1.	0	8.95	0
2.	1.65	7.34	20
3.	3.02	6.00	40
4.	4.11	4.91	60
5.	4.90	4.03	80
6.	5.69	3.30	100
7.	6.72	2.21	140
8.	7.00	1.54	180
9.	8.12	0.74	250
10.	8.40	0.43	300

GRAPH:-

PLOT OF VOLTAGE V/S TIME

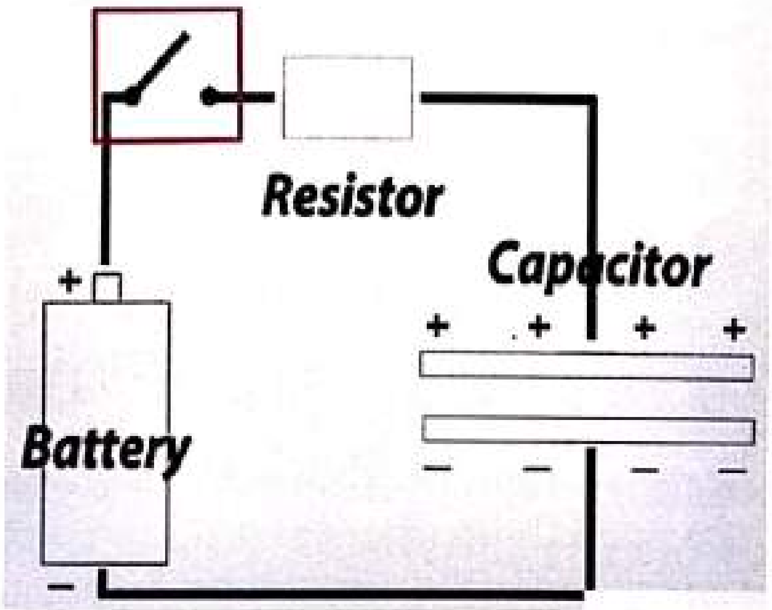
TIME ON X-AXIS AND VOLTAGE ON Y-AXIS

1. FOR CHARGING:-



CONCLUSION:-

HENCE IT IS VERIFIED EXPERIMENTALLY THAT 63% CHARGE IS THERE ON CAPACITOR AFTER TIME CONSTANT DURING CHARGING AND 63% CHARGE IS LOST AT TIME CONSTANT DURING DISCHARGING.



PRECAUTIONS

1.

Follow directions. Come to lab prepared to perform the experiment. Follow all written and verbal instructions. When in doubt, ask. 2.

Absolutely no horseplay. Be alert and attentive at all times. Act like an adult. 3.

Report all accidents, injuries or breakage to the instructor immediately. Also, report any equipment that you suspect is malfunctioning. 4.

Dress appropriately. Avoid wearing overly-bulky or loose-fitting clothing, or dangling jewelry that may become entangled in your experimental apparatus. Pin or tie back long hair and roll up loose sleeves. 5.

Use goggles: 1.

When heating anything. 2.

When using any type of projectile. 3.

When instructed to do so. 6.

Use equipment with care for the purpose for which it is intended. 7.

Do not perform unauthorized experiments. Get the instructor's permission before you try something original. 8.

Be careful when working with apparatus that may be hot. If you must pick it up, use tongs, a wet paper towel, or other appropriate holder. 9.

If a thermometer breaks, inform the instructor immediately. Do not touch either the broken glass or the mercury with your bare skin. 10.

Ask the instructor to check all electrical circuits before you turn on the power. 11.

When working with electrical circuits, be sure that the current is turned off before making adjustments in the circuit. 12.

Do not connect the terminals of a battery or power supply to each other with a wire. Such a wire will become dangerously hot. 13.

Return all equipment, clean and in good condition, to the designated location at the end of the lab period. 14.

Leave your lab area cleaner than you found it.

A

PROJECT REPORT

ON

ANDERSON BRIDGE

Is fulfillment of requirements for the degree of

BACHELOR OF SCIENCE

IN

PHYSICS

BY

VADHER HIRAL R.

003101165750

DEPARTMENT OF PHYSICS

M P SHAH ARTS AND SCIENCE COLLEGE,
SURENDRANAGAR

2018-19

DEPARTMENT OF PHYSICS

Shree M. P. Shah Arts & Science College

Surendranagar-363001 , Gujarat (India)

CERTIFICATE

This is Certify that VADHER HIRAL R. a student of class T.Y.B Sc Physics has successfully completed her physics project on "**ANDERSON BRIDGE**". This Project carried out department of physics M.P. Shah Arts & Science college, Surendranagar, comprises the result of independent & original work for the partial fulfillment of the degree of Bachelor of science in physics.

Teacher In charge

Head of the Department

Seal of college

Head of the Physics Department
M. P. Shah Arts & Science College
Surendranagar.

Date:

Examiner Signature

principal

M.P. SHAH ARTS & SCIENCE COLLEGE * SURENDRANAGAR *

ACKNOWLEDGEMENT

I would like to take this opportunity to express my deep sance of gratitude to all those people whom this project could have never been completed.

First of all i would like to thank Dr. K.D.PARIKH sir , Hod of physics department and principal at M P SHAH ARTS & SCIENCE COLLEGE , SURENDRANAGAR for his constant guidance and providing a very nice platform to learn.

I would like to extend my gratitude to Mr. Alpesh lakhani sir , Mr. Maulesh aachharya sir and Kinjal Mam , lab assistant at M P SHAH ARTS & SCIENCE COLLEGE, SURENDRANAGAR for their constant encouragement and moral support , without which I would have never been able to give in my best.

I would also like to thank Mr. Davershi vyas , Mr.Darshan jadav and Nilam Mam for their keen interest in work and ever useful practical knowledge and for their kind supervision.

Their guidance and supervision was very helpful in bringing this work to conclusion.

INDEX

CHAPTER 1

INTRODUCTION

1.1 What is bridge

The bridge circuits are used to measure various component values like resistance, capacitance, induction, etc.The simple form of a bridge circuit consist of a network of four resistance/impedance arms that forms a closed circuit. A current source is applied to two opposite nodes and a current detector is connected to remaining two nodes. A bridge circuit use the null induction principle and comparison measurement method this is also known as “bridge balance condition at zero voltage”.The bridge circuit compares the value of unknown component with that of an accurately known standard component. Thus the accuracy mostly depends on the bridge circuit, not on the null indicator.

Two types of bridges used to measure the component values. They are D.C. bridge and A.C.bridge.

1.2 ABOUT ANDERSON BRIDGE

Anderson bridge is one type of A.C. bridge. It is the most accurate bridge used for the measurement of self – inductance over a wide range of values, from a few micro-Henries to several Henries. In this method the unknown self-inductance is measured in terms of known capacitance and resistances, by comparison. It is a modification of Maxwell's L - C bridge. In this bridge, double balance is obtained by the variation of resistances only, the value of capacitance being fixed.

1.3 AIM OF ANDERSON BRIDGE

In other ac bridge variable capacitor is used which is very costly while in Anderson bridge fixed capacitor is used. The bridge is used for accurate determination of inductance in the miliameter range. This bridge also gives an accurate result for determination of capacitance in terms of inductance.

CHAPTER 2

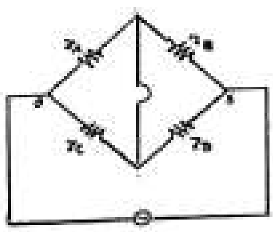
CIRCUIT DESCRIPTION

2.1 WORKING PRINCIPLE

Most of the AC bridges are based on a generalised Wheatstone Bridge circuit. As shown in Fig.1, the four arms of the D.C. Wheatstone Bridge are replaced by impedance (ZA, ZB, ZC and ZD), the battery by an A.C. source and the D.C. galvanometer by an A.C. null detector (usually a pair of headphones). Using Kirchhoff's Laws, it can be easily shown that the balance or null condition (i.e. when no current flows through the detector or the potential at the point P becomes equal to that at point R) is given by.

$$ZA\ ZB = ZC\ ZD. \qquad (1)$$

Eqe. (1) is a complex equation i.e. it represents two real equations obtained by separately equating the real and imaginary parts of the two sides. It follows from the fact that both amplitude and the phase must be balanced. This implies that to reach the unbalance condition two different adjustments



Fig(1) A simple Weinstein bridge

be made. That is, the DC and AC balance conditions have to be obtained one by one. The DC balance is obtained using a D.C. source and moving coil galvanometer by adjusting one of the resistances. After which the battery and the galvanometer are replaced with an AC source and a headphone respectively, without changing the resistances set earlier, the other variable impedance is varied to obtain minimum sound in the headphone.

2.2 CIRCUIT DIAGRAM

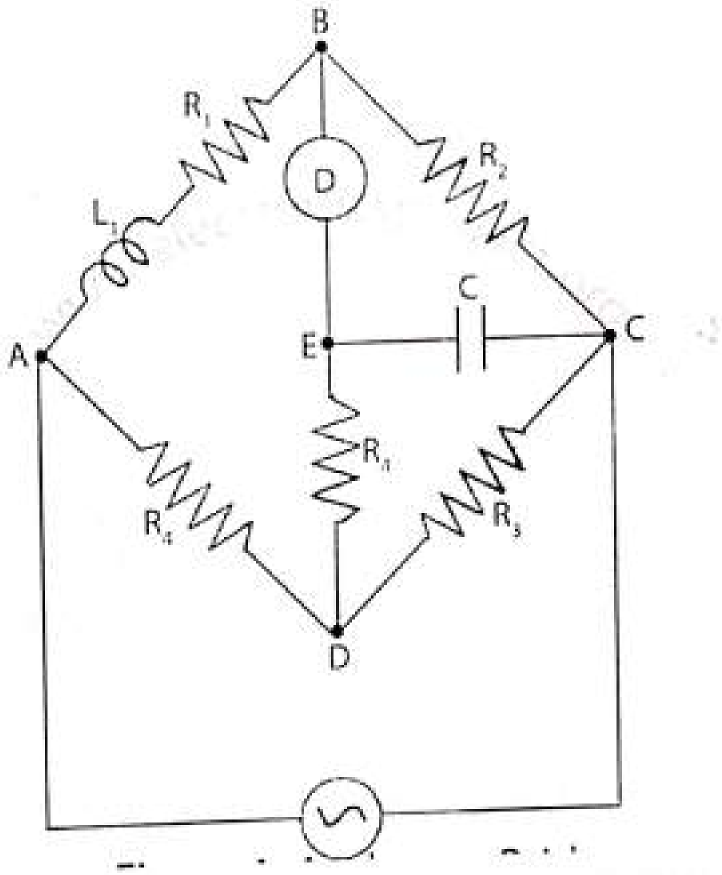


Fig.(2)

2.3 PROCEDURE

The circuit diagram of the bridge is as shown in the figure. The coil whose self-inductance is to be determined , is connected in the arm AB, in series with a variable non-inductive resistor R1. Arms BC, CD and DA contain fixed and non – inductive resistors R2, R3 and R4 respectively. Another non - inductive resistor R5 is connected in series with a standard capacitor C and this combination is put in parallel with the arm CD. The head - phones are connected between B and E. The signal generator is connected between A and C junctions. Select one capacitor and one inductor and connect them in appropriate places using patch chords. The signal generator frequency is adjusted to audible range. A perfect balance is obtained by adjusting R1 and R5 alternatively till the head – phones indicate a minimum sound. The values of R1 and R5 are measured with a multi-meter(While measuring the R1 and R5 values, they should be in open circuit).In the balance condition the self – inductance value of the coil is calculated by using the formula given below

$$L1 = cR2\left[R4 + \frac{R4R5}{R3} + R5\right] \qquad (2)$$

Where C = Capacity of the standard capacitor (μF)

R2,R3,R4 = Known fixed and non–inductive resistances (KΩ)

R1, R5 = Variable resistances (KΩ

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2.4 BALANCE CONDITION

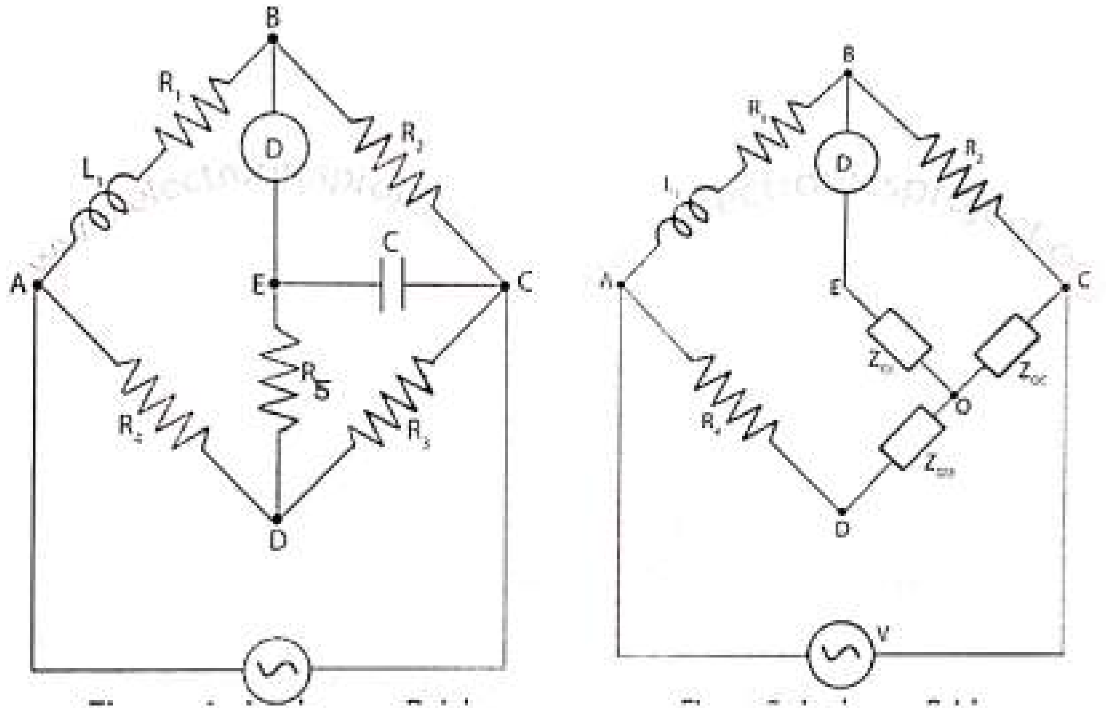


Fig (3)

The balance condition for this bridge can be easily obtained by converting the mesh impedance c, R3 and R5to an equivalent star point ‘o’ as shown in

As per delta to star connection method.

$$Z_{od} = \frac{R3\ R5}{R3 + R5 + \frac{1}{j\omega c}} \quad \text{and} \quad Zoc = \frac{R3}{j\omega c(R3 + R5 + \frac{1}{j\omega c})} \qquad (4)$$

Hence with reference to fig (3)

$$Z_1 = R1+j\omega c \; ; \; Z_2=R2$$

$$Z_3=Z_{oc} \quad ; \quad Z_4=R4+Z_{od}$$

Under the bridge balance condition $Z_1Z_3=Z_2Z_4$

Thus , $(R1+jwL1)z_{oc} = R2(R4+Z_{od})$.

$$(R1+jwL1)\left(\frac{R3}{(R3+R5+\frac{1}{jwc})}\right)=R2\left[R4+\frac{R3R5}{R3+R5+\frac{1}{j\omega c})}\right]$$

$$\frac{(R3+jwc)(\frac{R3}{jwc})}{R3+R5+\frac{1}{j\omega c})}=R2\left[\frac{R4\left(R3+R5+\frac{1}{j\omega c}\right)+R3R5}{R3+R5+\frac{1}{j\omega c}}\right]$$

There for $\frac{(R1+jwL1).R3}{jwc}=R2R4R3+R2R4R5+\frac{R2R4}{jwc}+R3R5R2$

$$\frac{R1R3}{jwc}+\frac{jwL1R3}{jwc}=R2R3R4+R2R4R5+R2R3R5+\frac{R2R4}{jwc}$$

$$\frac{R1R3}{jwc}+\frac{L1R3}{c}=R2R3R4+R2R4R5+R2R3R5+\frac{R2R4}{jwc}$$

Comparing real and imaginary terms ,we have

$$\frac{L1R3}{c} = R2R3R4+R2R4R5+R2R3R5$$

$$L1 = \frac{c}{R3}(R2R3R4+R2R4R5+R2R3R5)$$

And for imaginary term

$$L1 = cR2\left[R4+\frac{R4R5}{R3}+R5\right]$$

$$R_1R_3 = R_2R_4$$

By above equations we get the value of unknown

2.5 COMPONENTS

1. Resistors

2. Capacitor

3. Signal generator

4. Headphones

5. Variable resistors

2.5.1 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

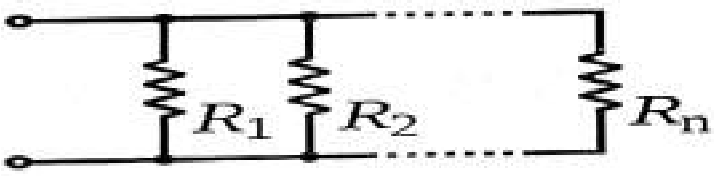
Symbol

Series and parallel resistors,

The total resistance of resistors connected in series is the sum of their individual resistance values.

$$R_{eq} = R_1 + R_2 + \cdots + R_n .$$

The total resistance of resistors connected in parallel is the of the sum of the reciprocals of the individual.



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} .$$

2.5.2 Capacitor

The capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery.

There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge.

In its basic form, a capacitor consists of two or more parallel conductive (metal) plates which are not connected or touching each other, but are electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between a capacitors plates is commonly called the Dielectric.

2.5.3 Headphones

Headphones (or head-phones in the early days of telephony and radio) are a pair of small loudspeaker drivers worn on or around the head over a user's ears. They are electro acoustic transducers, which convert an electrical signal to a corresponding sound. Headphones let a single user listen to an audio source privately, in contrast to a loudspeaker, which emits sound into the open air for anyone nearby to hear. Headphones are also known as ear speakers, earphones.

In this circuit headphones are use as null detector.

2.5.4 Variable resistors

A simple Variable Resistor is a two-terminal electronic component that allows a variable current to be achieved. A Potentiometer is a three-terminal Variable Resistor the allows a variable voltage to be achieved. In reality, all are made as three-terminal Potentiometers, but by using just two of the terminals it becomes a simple Variable Resistor. A very high current version is often called a 'Rheostat'.

They all obey Ohm's law.

Symbol

Potentiometer

Variable resistor

Inside equipment, small 'preset' potentiometers are often used to allow calibration, and are not usually changed once set. Outside equipment potentiometers may be provided for frequently changed settings (eg. a volume control). Low power Potentiometers usually have carbon tracks (below about 1W) and higher power versions will be wirewound. The change in resistance of a potentiometer can have a linear or logarithmic response. The body of the device is usually marked with the value and type. For example 100K Log. Tolerance is normally ± 20%. Controls are also made with built in on/off switches. Rotary potentiometers can also have multiple turns (eg. 10K, 10-turn potentiometer will change resistance by 1k per turn and have resistance from 0-10k Ohm). Some potentiometer are continuous (will turn through 360 degrees) but most normally are stopped.

CHAPTER 3

OBSERVATION

3.1 OBSERVATION TABLE

Sr.no.	C (μf)	R Ω	r Ω	Q (KΩ)	L=CR(Q+2r)

RESULT :

The value of unknown inductor is ____________ μH.

CHAPTER 4

ADVANTAGES , DISADVANTAGES & APPLICATION

4.1 ADVANTAGES OF ANDERSON BRIDGE

1. The bridge is used for accurate determination of inductance in the milliametre range.
2. It is very easy to obtain the balance point in Anderson's bridge as compared to Maxwell bridge in case of low quality factor coils.
3. There is no need of variable standard capacitor is required instead of thin a fixed value capacitor is used.
4. This bridge also gives an accurate result for determination of capacitance in terms of inductance.
5. Due to not required of variable circuit is cheaper

4.2 DISADVANTAGES OF ANDERSON BRIDGE

1. It is very complicated than other bridges in terms of the number of components used.
2. The bridge cannot be easily shielded due to the additional junction point, to avoid the effects of stray capacitances.
3. Balance equations are also complicated to derive.

4.3 APPLICATION OF ANDERSON BRIDGE

1. It is used to measure the self-inductance of the coil (L).
2. To find the value of inductive reactance (XL) of the coil at a specific frequency.

CHAPTER 5

REFERENCES

6.1 REFERENCES

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"COMMON EMITTER TRANSISTOR"

A PROJECT REPORT SUBMITTED

TO

DEPARTMENT OF PHYSICS

M.P. SHAH ARTS AND SCIENCE COLLAGE

SURENDRANAGAR

GUJARAT INDIA

FOR THE PARTIAL FULFILMENT OF DEEGREE OF

BACHELOR OF SCIENCE

IN PHYSICS (SEM-6)

BY

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This Is To Certify That The Work Incorporated In The Project Report "Common Emitter Transistor" by Vadadariya Faizal ikbalbhai Carried Out Department of Physics , M. P. Shah Arts and Science Collage Saurashtra University , Comprise The Result of Independent and The Original Work for The Partially Fulfilment Of The Degree of Bachelor of Science.

DATE :

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M.P. SHAH ARTS & SCIENCE COLLEGE * SURENDRANAGAR *

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Frizu.

INDEX

INTRODUCTION

Transistors find many and varied uses in our daily life ranging from gas lighter and toys to amplifiers, radio sets and televisions. In fact, their use is consistently increasing. In the form of switching device, these can be used to regulate vehicular traffic on the roads. They form key elements in computers, space vehicles, power systems, satellites and communication. In a sense, transistors have brought about a revolution, which has helped upgrade technology and improve efficiency. It is therefore important for you to know how a transistor works.

The practical use of a semiconductor device in electronic circuits depends on the current and voltage (I-V) relationship, as it gives vital information to a circuit designer as well as a technician. Therefore, the first thing of interest is: How does a transistor respond to voltage applied to it? Is the response linear? In your school physics, you have learnt that for a resistor, the characteristic curve (I-V plot) is a straight line passing through the origin. This is manifestation of Ohm's law. For a p-n junction and Zener diode, the characteristic curves are non-linear. In this experiment, you will obtain characteristic curves for a transistor in the common-emitter mode and calculate current gain, input resistance and output admittance.

Objectives

After performing this experiment, you should be able to:

- study variation of base current with potential difference between the base and the emitter (input characteristics) in common-emitter (CE) configuration;
- study variation of collector current with potential difference between the collector and the emitter (output characteristics) in CE-configuration;

• examine the relationship between collector current and base current (transfer characteristics) in CE-configuration; and • calculate current gain, input resistance and output admittance.

1.1 What is transistor?

A transistor is a three-terminal device consisting of alternate regions of p-and n-type semiconductors, as shown in Fig. 1.1 The three segments of the transistor are called emitter (E), base (B) and collector (C). Note that (i) the emitter is sandwiched between the emitter and the collector, (ii) the emitter and collector are of the same type (p or n), and (iii) the base and emitter (or collector) are of different materials.

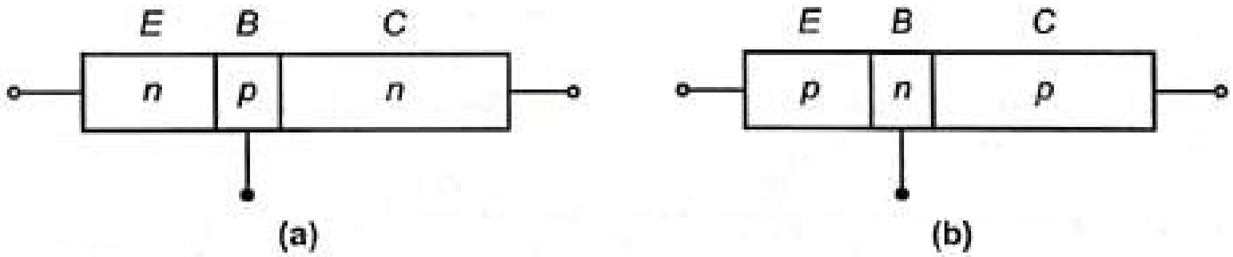


Fig.1.1: a) n-p-n transistor and (b) p-n-p transistor

The names of the terminals of a transistor give clear indication of their functions. In case of a n-p-n transistor, the majority carriers (electrons) from the emitter enter the base region. Since base is a very lightly doped thin layer, it allows most of these electrons (originating in the emitter) to pass into the collector. (The doping level of collector is in-between that of the emitter and the base.) The collector is the largest of the three regions, and it dissipates more heat compared to the other two region.

1.2 Working and principle of transistor

We now discuss the working principle of a transistor and consider an n-p-n transistor because it is more commonly used.

When no voltage is applied across the transistor, diffusion of free electrons across the emitter-base and collector-base junctions produces two desolation layers as shown in fig 1.2) for each depletion layer the barrier potential is about 0.7 V at 25°C for a silicon transistor and 0.3V for a germanium transistor. Do you know that silicon transistors are more widely used than germanium transistors because of higher voltage rating, greater current ratings, and low temperature sensitivity? For our discussion, we will refer to silicon transistors, unless indicated otherwise.

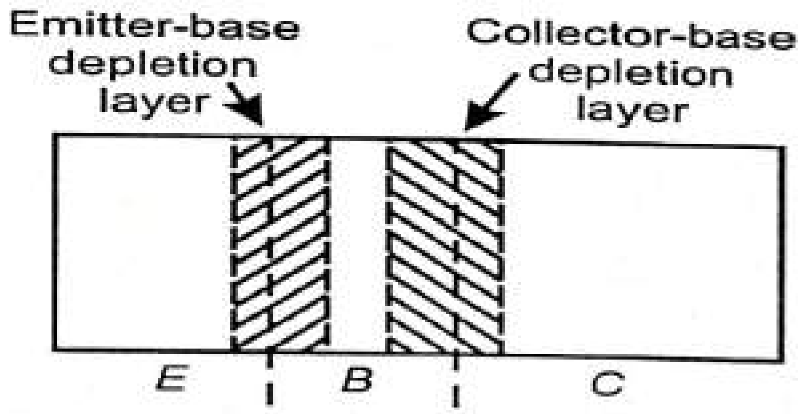


Fig. 1.2) Depletion layers in a transistor when no voltage is applied

Since the three regions of the transistor have different doping levels, the depletion layers have different widths. If a region is heavily doped, the concentration of ions near the junction will be more resulting in thin depletion layer and vice versa. In a transistor, since thé base is lightly doped as compared to emitter and collector, the depletion layers extend well into the base, whereas penetration in emitter/ collector regions is somewhat less (Fig. 10.3). Moreover, the emitter-base depletion layer is narrower compared to collector-base depletion layer.

To make a transistor function properly, it is necessary to apply suitable voltages to its terminals. This is called biasing of the transistor. A typical biasing scheme of an n-p-n transistor is shown in Fig. 1.3a. Note that the emitter-base junction is forward biased while the collector-base junction is reverse biased. We therefore expect a large emitter current and low collector current. But in practice, we observe that the collector current is almost as large as the emitter current. Do you know the reason? Let us discover the answer. When forward bias is applied to the emitter, free electrons in the emitter have to overcome the barrier potential to enter the base region (see

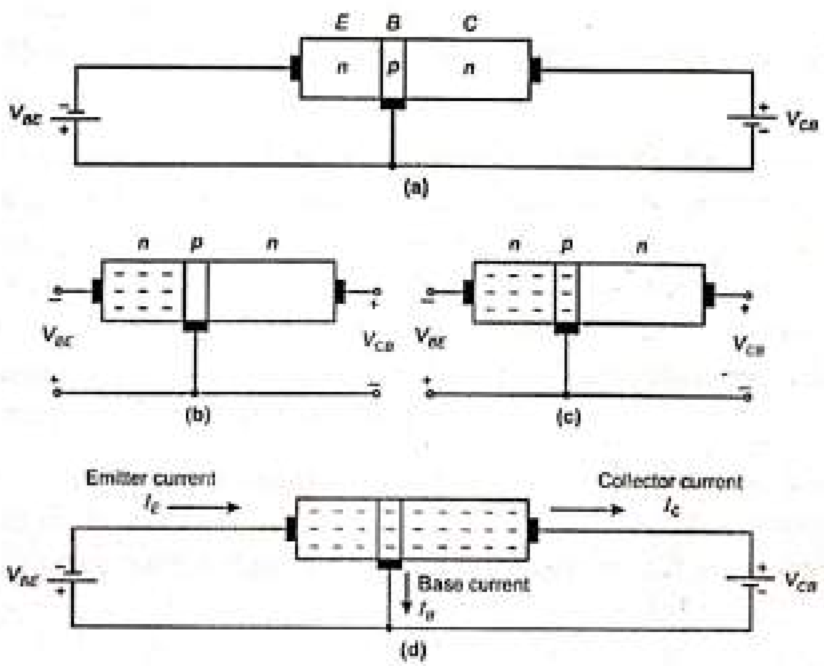


Fig 1.3: An n-p-n transistor when a) emitter is forward-biased and collector is reverse- biased; b) emitter has many free electrons; c) free electrons injected into base; and d) free electrons pass through base to collector

Fig. 1.3b). If V_{BE} is greater than the barrier potential (0.6 V to 0.7 V for silicon transistor), these electrons enter the base region, as shown in Fig. 1.3c). Once inside the base, these electrons can flow either through the thin base into the external base lead, or across the collector junction into the

Collector region. Since the base region is very thin and it receives a large number of electrons for $V_{BE} > 0.7V$, most of these electrons diffuse into the collector depletion layer. The free electrons in this layer are pushed (by the depletion layer field) into the collector region (**Fig. 1.3d**) and flow into the external collector lead.

So, we can say that a steady stream of electrons leaves the negative source terminal and enters the emitter region. The forward bias forces these electrons to enter the base region. Almost all these electrons diffuse into thecollector depletion layer, through the base. The depletion layer field then pushes a steady stream of electrons into the collector region. In most transistors, more then 95 percent emitter-injected electrons flow to the collector; less than 5 percent flow out in the external base lead.

From this you should not conclude that you can connect two discrete diodes back to back to get a transistor. This is because in such a circuit, each diode has two doped regions, and the overall circuit would have four doped regions and the base region is not the same as in a transistor. The key to transistor action therefore is the lightly doped thin base between the heavily doped emitter and the intermediately doped collector. Free electrons passing through the base stay in base for a short time and reach the collector.

The dc alpha of a transistor indicates how close collector current (I_c) aemitter current (I_E) are. It is defined as α_{dc} The dc alpha of a transistor indicates how close collector current (I_c) and emitter current (I_e) are. It is defined as

$$\alpha_{dc} = \frac{I_c}{I_E} \qquad ---(1)$$

The dc alpha is also referred to as large signal current gain. You should note that the value of α_{dc} is nearly equal to but always less than one. Similarly, you can relate the collector current to the base current. It is referred to as dc beta of a trans

Beta signifies the current gain of the transistor in common-emitter

$$\beta_{dc} = \frac{I_c}{I_B} \qquad ---(2)$$

$$I_E = I_C + I_B$$

configuration. Value of β_{dc} is considerably larger than one. Since emitter current is sum of collector current and the base current, we can write

Or

$$\frac{I_E}{I_c} = 1 + \frac{I_B}{I_c} \qquad ----(3)$$

In terms of α_{dc} and β_{dc}, we can rewrite it as

$$\frac{1}{\alpha_{dc}} = 1 + \frac{1}{\beta_{dc}}$$

Or

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}} \qquad - ----(4)$$

Let us now discuss the different ways in which a transistor is configured in a circuit.

1.3) Transistor Configuration

A transistor is a two-port device. It can take an input and deliver an output. For both input and output, two terminals are needed. This can be done in a transistor by making one of the three terminals common. The configurations of a transistor in which one of the terminals is common to both input and in common emitter (CE) configuration (Type equation here.both input and output are shown in Fig. 1.4 :

- when emitter is common to both input and output circuits, we obtain common emitter (CE) configuration (Fig. 1.4a) ;

➢ when base is common to both input and output circuits, we obtain common base (CB) configuration (Fig. 1.4b); and

➢ when collector is common to both input and output circuits, we have common collector (CC) configuration (Fig. 1.4c).

In each of these configurations, the transistor characteristics are unique. The CE configuration is used most widely because it provides voltage, current and power gains. In the CB configuration, the transistor can be used as a constant current source while the CC configuration is frequently used for impedance matching.

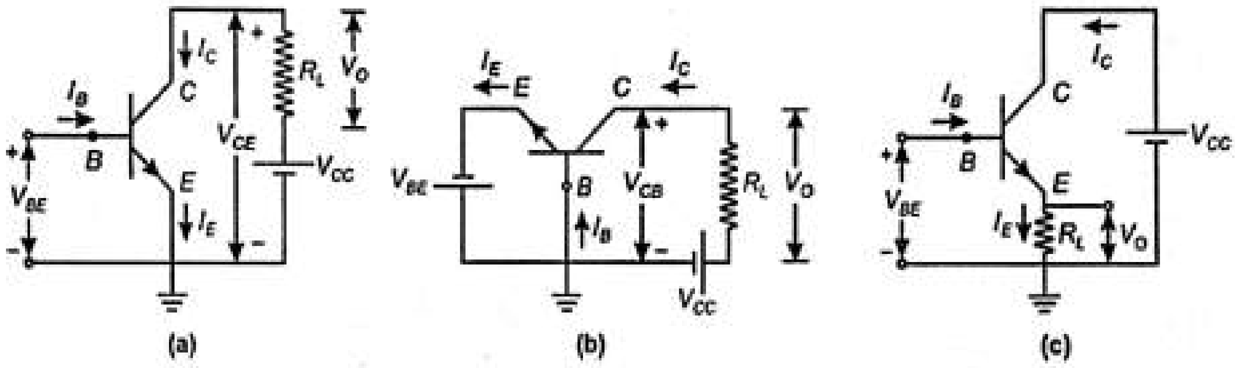


Fig.1.4: Transistor configuration (a) CE; (b) CB; and (c) CC

Table 1.1: Physical quantities of interest in different characteristics of a transistor

Configuration	Input characteristic	Output characteristic	Transfer characteristic	Important transistor constant
CE	V_{BE} and I_B with V_{CE} as parameter	V_{CE} and I_C with I_B as parameter	I_B and I_C	Current gain, β

CB	V_{BE} and I_E with V_{CB} as parameter	V_{CB} and I_C with I_E as parameter	I_E and I_C	Large signal current gain, α
CC	V_{CB} and I_B with V_{CE} as parameter	V_{CE} and I_E with I_B as parameter	I_B and I_E	

1.4) CHARACTERISTICS IN CE CONFIGURATION

There are three types of characteristics they are given below.

1. Input characteristic
2. Output characteristic

All two characteristic are study by doing simple experiment.

2) Experiment

- **Aim** : To study Transistor characteristics in Common Emitter configuration.
- **Apparatus** : NPN Transistor, Power supply ,Connecting wire etc.

2.1) Input characteristic

Procedure :

1.) Make the connections as shown in Fig. 1.6 VBB is a variable dc supply of 0-3V and VCC is a variable dc supply of 0-15V. R1 and R2 are 2.5 kΩ/2W potentiometers, and R is a variable resistor.
2.) Keep collector to emitter voltage (VCE) at zero volt
3.) Change VBE from 0 in steps of 0.1V and observe corresponding base current IB in µA. Record your readings in Observation Table 1.2. We expect that so long as VBE < 0.5V, there will be no measurable base current, i.e., IB = 0.
4.) When VBE is about 0.5V or 0.6V, there may be a small base current of about 2 µA. With a slight increase in voltage (say, by 0.1V), the base current IB may begin to rise steeply, say up to 20µA or more. The voltage should not be increased further. In case of BC107 or BC108 transistor, the base current should not exceed 60µA. In case you are using some other transistor, you should obtain the maximum base current rating from your Counsellor. Otherwise, the transistor can get damaged.
5.) Repeat steps 3 and 4 for a few values of VCE (say) = 2V, 4V, 6V etc. by varying R2. Note that in no case, VCE should exceed 12V.

Circuit diagram

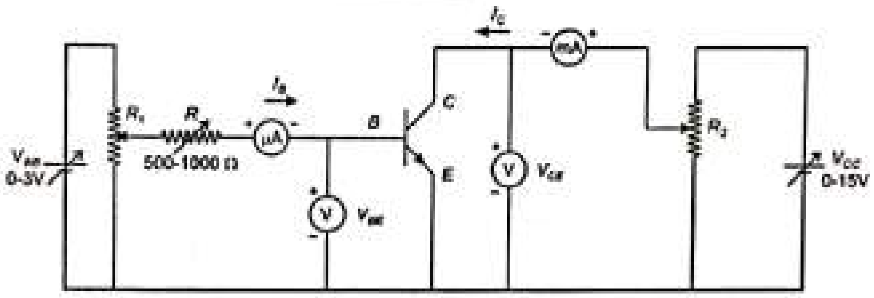
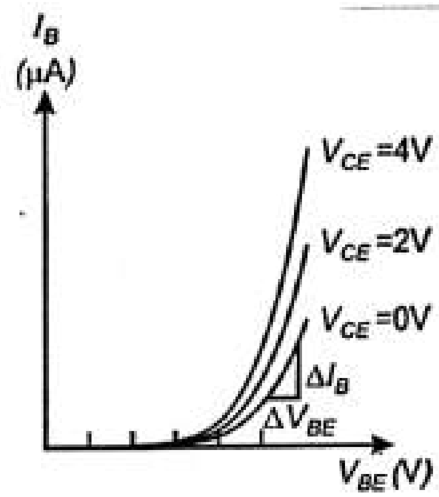


Fig. 1.5) Circuit diagram for determining characteristics of a n-p-n transistor in CE-configuration

Observation Table 1.2: Input characteristics of a transistor in CE-mode

V_{be} (v)	I_b (μA)			
	V_{ce} = 4V	V_{ce} = 6V	V_{ce} = 8V	V_{ce}
0.2	19	28	38	
0.4	51	65	68	
0.6	81	92	108	
0.8	159	200	220	
1	320	360	390	
1.2	488	530	630	

Now plot a graph by taking IB along the y-axis and VBE along the x-axis for each value of VCE and draw best fit curves, as shown in Fig. 1.7 These are referred to as input characteristics. Select a suitable point in the linear portion of the curve and calculate the slope at that point by drawing a tangent. This will give you the value of input resistance.



The slop = $\frac{202 \times 10^{-6}}{0.2}$

Fig.1.7: Typical input characteristics of a transistor in CE mode

- From graph the slop = $\frac{0.2}{202 \times 10^{-6}} = 990\Omega$
or,

Result: The input resistance R_{IN} for the given transistor is ....990.............Ω.

2.2) Output characteristics

Procedure:

1) Fix the base current IB at 20μA by adjusting R1 and R
2) Vary the collector to emitter voltage VCE by varying R2 from 0 to 10V in steps of 0.5V.
3) Note the collector current IC in each case and record it in Observation Table 1.3
4) Repeat steps 2 and 3 for IB = 40 μA, 60μA, and 80μA. Make sure that you do not exceed the maximum base current rating of the transistor.
5) Plot VCE versus IC for different values of IB. Draw smooth curves for each IB. These are the output characteristics. Typical output characteristics of a transistor are shown in Fig. 1.8

We can Calculate output resistance by using equation.

$$R_{out} = \frac{\Delta V_{CE}}{\Delta I_{CE}} \qquad ----(5)$$

Observation Table 1.3: Output characteristics of a Transistor

V_{ce} (V)	Collector current I_C (mA)			
	I_b = 50(μA)	I_b = 100(μA)	I_b = 150(μA)	I_b =
1	10.6	21.4	30.5	
2	10.4	21.4	30.8	
3	10.3	21.4	30.7	
4	10.6	21.4	30.5	
5	10.5	21.5	32.3	
6	10.6	21.6	34	
7	10.5	22.4	35	
8	10.6	22.9	35.9	
9	10.6	22.9	38	

Graph

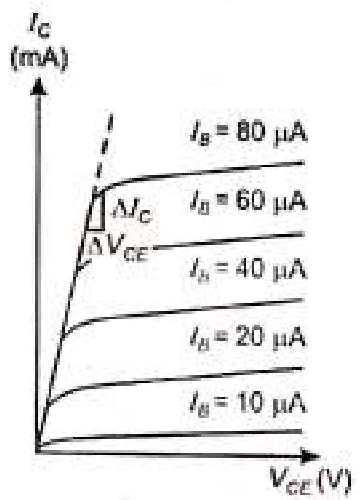


Fig.1.9: Typical output characteristics of a transistor

The slop $= \frac{24.5 \times 10^{-6}}{2} = \frac{I_C}{V_{CE}}$

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$R_{(out)} = \left(\frac{V_{CE}}{I_C}\right)^{18} I_B = \text{constant}$

$= \left(\frac{2}{25.4 \times 10^{-6}}\right) = 78000$

Result :

1) The output resistance of Transistor R_{out} ....78000....Ω

References

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Project work of T.Y.B.Sc Sem-6

Conversion of Galvanometer into Ammeter and Voltmeter

Project work to be submitted to

M. P. Shah arts and Science College, surendranagar

Department of Physics

For the degree of

Bachelor of Science

In

Physics

M.P.Shah Arts and Science College

Surendranagar

:: Certificate::

This is to certify that the Project Work Satisfactory has been carried out in the Physics Department, Shree M.P.Shah Arts and Science College, Surendranagar and hence recorded in this project work of Miss Vaghela Archana Govindbhai Roll no.:182 Enrolment no.:003101165753 of the T.Y.B.Sc sem-6 class in the Physics Department during the academic year 2018-2019.

- Professor in charge:________________
- Head of the department:________________
- Project examiner:________________

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A. G. Vaghela

Vaghela Archana G.

(003101165753)

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4.Conversion of Galvanometer into Voltmeter

5. Conversion of Galvanometer into Voltmeter

6.Result

1. GALVANOMETER

1.1 Definition:

The galvanometer is the device used for detecting the presence of small current and voltage or for measuring their magnitude.

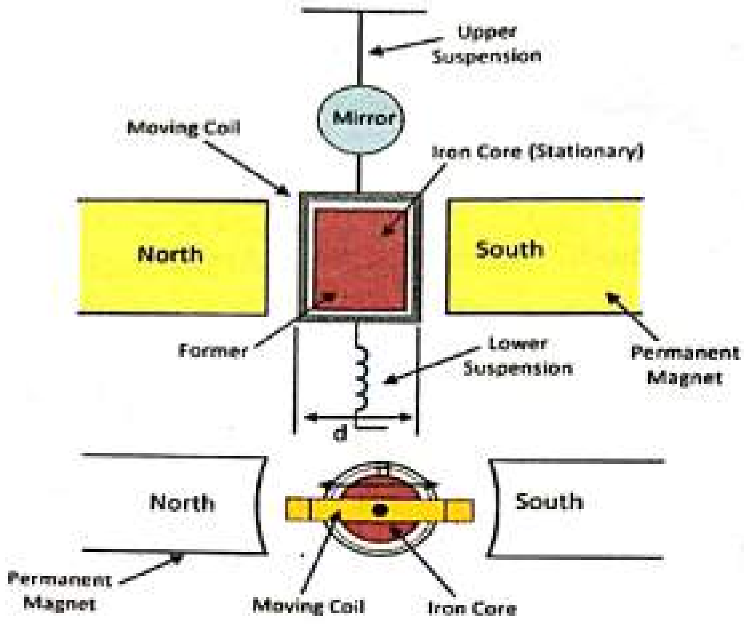
The galvanometer is mainly used in the bridges and potentiometer where they indicate the null deflection or zero current.

1.3 Principle:

When a current carrying coil is suspended in a uniform magnetic field it is acted upon by a torque. Under the action of this torque, the coil rotates and the deflection in the coil in a moving coil galvanometer is directly proportional to the current flowing through the coil.

1.4 Construction

The construction of the potentiometer is shown in the figure below.



Moving Coil Galvanometer

The moving coil, suspension, and permanent magnet are the main parts of the galvanometer:

Moving coil

The moving coil is the current carrying part of the galvanometer. It is rectangular or circular and has the number of turns of fine copper wire. The coil is freely moved about its vertical axis of symmetry between the poles of a permanent magnet. The iron core provides the low reluctance flux path and hence provides the strong magnetic field for the coil to move in.

Suspension:

The coil is suspended by a flat ribbon which carries the current to the coil. The other current carrying coil is the lower suspension whose torque effect is negligible. The upper suspension coil is made up of gold or copper wire which is made in the form of a ribbon. The mechanical strength of the wire is not very strong, and hence the galvanometers handle carefully without any jerks.

Mirror:

The suspension carries a small mirror which casts the beam of light. The beam of light placed on the scale on which the deflection is measured.

Torsion Head:

The torsion head is used for controlling the position of the coil and for adjusting the zero setting.

1.5 Types of Galvanometer

Tangent Galvanometer

Astatic Galvanometer

Mirror Galvanometer

Ballistic Galvanometer

1.6 Application of Galvanometer

The galvanometer has following applications. They are

It is used for detecting the direction of current flows in the circuit. It also determines the null point of the circuit. The null point means the situation in which no current flows through circuit.

It is used for measuring the current.

The voltage between any two points of the circuit is also determined through galvanometer.

1.7 Advantages & Disadvantages

Advantages

Uniform scale, high sensitivity, very accurate and reliable and very effective and efficient eddy current damping.

It consumes quite less power. This is because the resistance of moving coil is small. The scale of moving coil instrument is uniform.

Disadvantages

It can be used only for D.C measurement. More costly than moving iron instruments.

It produces errors due to friction and temperature variations so readings are may not be accurate and fresh calibration of meters may become necessary.

Overloading can damage any type of galvanometer.

2. AMMETER

2.1 Definition:

The meter uses for measuring the current is known as the ammeter. The current is the flow of electrons whose unit is ampere. Hence the instrument which measures the flows of current in ampere is known as ampere meter or ammeter.

UNIT: AMPERE

2.2 Symbol of Ammeter

2.3 Principle

The main principal of ammeter is that it must have a very low resistance and also inductive reactance

For an ideal ammeter, it must have zero impedance so that it has zero voltage drop across it so the power loss in the instrument is zero. But the ideal is not achievable practically.

2.4Types of Ammeter

The classification of the ammeter depends on their design and the type of current flows through the ammeter. The following are the types of an ammeter regarding construction.

1. Permanent moving coil ammeter.
2. Moving iron ammeter.
3. Electro-dynamometer ammeter.
4. Rectifier type ammeter.

By the current, the ammeter categories into two types.

- AC ammeter
- DC ammeter

1. PMMC Ammeter –

In PMMC instrument the conductor is placed between the poles of the permanent magnet. When the current flows through the coil, it starts deflecting. The deflection of the coil depends on the magnitude of current flows through it. The PMMC ammeter used only for the measurement of the direct current.

2. Moving Coil Ammeter (MI) –

The MI ammeter measures both the alternating and direct current. In this type of ammeter, the coil freely moves between the poles of a permanent magnet. When the current passes through the coil, it starts deflecting at a certain angle. The deflection of the coil is proportional to the current passes through the coil.

3. Electro-dynamometer Ammeter –

It is used for the measurement of both AC and DC. The accuracy of the instrument is high as compared to the PMMC and MI instrument. The calibration of the instrument is same both for AC and DC, i.e. if DC calibrates the instrument then without re-calibration; it is used for AC measurement.

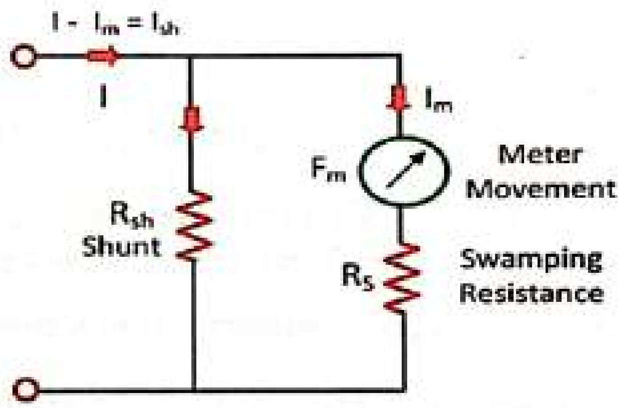
4. Rectifier Ammeter –

It is used for measuring the alternating current. The instruments using the rectifying instrument which converts the direction of current and pass it to the PMMC instrument. Such type of instrument is used for measuring the current in the communication circuit.

The instrument which measures the DC is known as the DC ammeter and ammeter which measures AC is known as the AC ammeter

2.5 Ammeter Shunt

The high-value current directly passes through the ammeter which damages their internal circuit. For removing this problem, the shunt resistance is connected in parallel with the ammeter.



Meter Shunt and Swamping Resistance

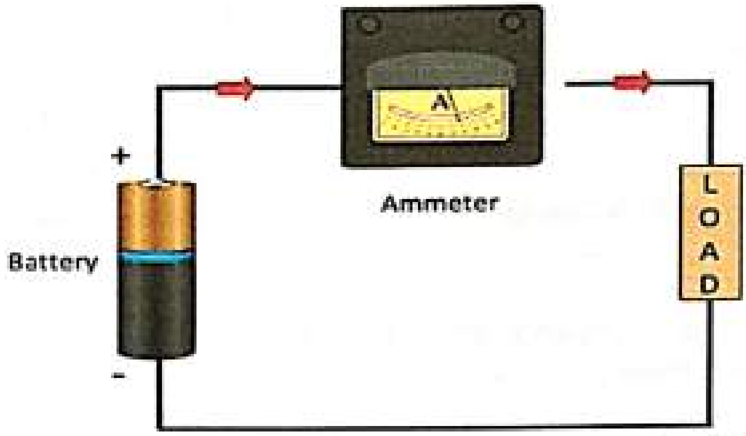
The high-value current directly passes through the ammeter which damages their internal circuit. For removing this problem, the shunt resistance is connected in parallel with the ammeter.

2.6 Connection of Ammeter in circuit

The ammeter is connected in series with the circuit so that the whole electrons of measured current pass through the ammeter. The power loss occurs in ammeter because of the measured current and their internal resistance. The ammeter circuit has low resistance so that the small voltage drop occurs in the circuit.

The resistance of the ammeter is kept low because of the two reasons.

- The whole measured current passes through the ammeter.
- The low voltage drop occurs across the ammeter.



2.7 Uses of Ammeter

It can be used for measurement of much higher current than its rating, by use of shunt resistors or by use of current transformers.

Low current ammeter is used to measure voltages by connecting series resistors.

2.8 Advantages & Disadvantages

Advantages:

It has very low resistance against current in order to able to provide readings.

They are able to provide accurate reading that can easily be noted.

Disadvantages:

Ammeters are unable to resist current, if they are connected to an incompatible device, it could damage the ammeters and even cause a short circuit, along with permanent damage to ammeter.

3. VOLTMETER

3.1 Definition:

The instrument which measures the voltage or potential difference in volts isknown as the voltmeter.

It works on the principal that the torque is generated by the current which induces because of measured voltage and this torque deflects the pointer of the instrument.

The deflection of the pointer is directly proportional to the potential difference between the points. The voltmeter is always connected in parallel with the circuit.

3.2 Symbol of Voltmeter:

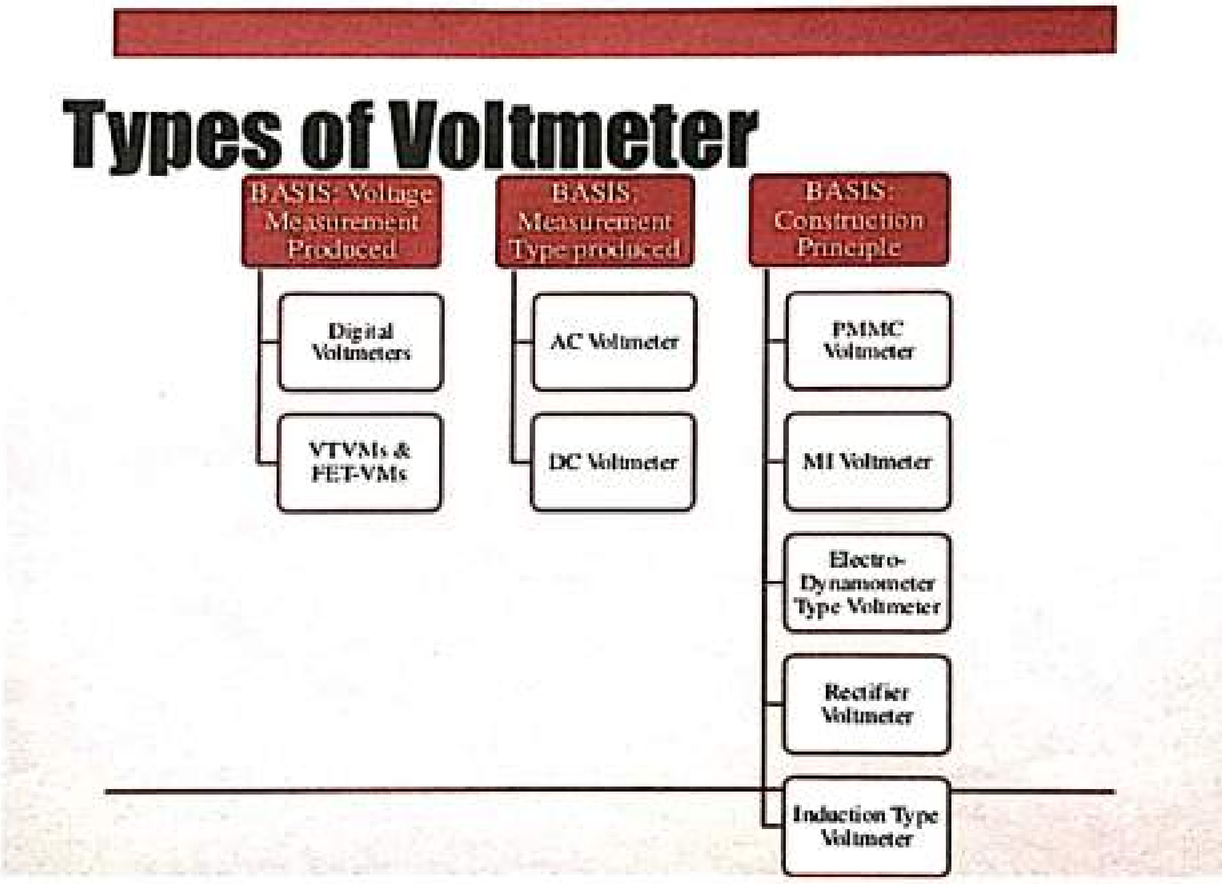
The voltmeter is represented by the alphabet V inside the circle along with the two terminals.

3.3 Principle:

The main principal of voltmeter is that it must be connected in parallel in which voltage is measured.

The parallel connection is used because a voltmeter is constructed in such a way that it has a very high value of resistance. So if that high resistance is connected in series than the current flow will be almost zero which means the circuit has become open.

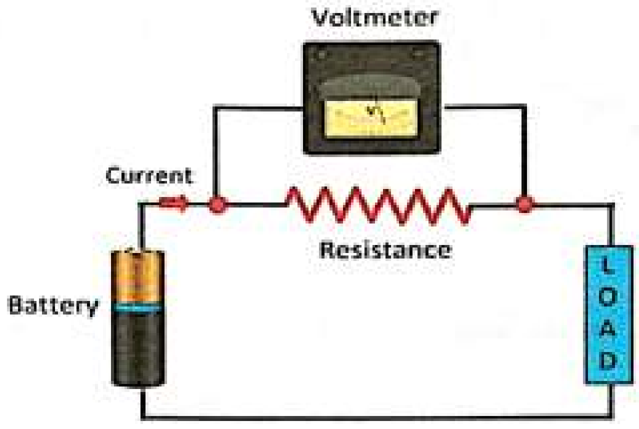
3.4 Types of voltmeter:



3.5 Voltmeter connected in parallel circuit:

The voltmeter constructs in such a manner that their internal resistance always remains high. If it connects in series with the circuit, it minimizes the current which flows because of the measured voltage. Thus, disturb the reading of the voltmeter.

The voltmeter always connects in parallel with the circuit so that the same voltage drop occurs across it. The high resistance of the voltmeter combines with the impedance of the element across which it is connected. And the overall impedance of the system is equal to the impedance that the element had. Thus, no obstruction occurs in the circuit because of the voltmeter, and the meter gives the correct reading.



3.6 Application of Voltmeter:

It is of utmost importance that the electrical connections in the circuit are correct; else the values read by the measuring instruments can be often incorrect. The rule of current says –

$V = I \times R$ (V = voltage, I = current, R = resistance)

The voltmeter offers high resistance. If the resistance is low, then it will withdraw a larger current (lower the resistance higher the current). As such, the circuit under consideration would not receive the proper amount of current. Therefore, voltmeter would give incorrect readings then.

Therefore, voltmeter is designed to have high resistance. It is always connected in parallel to the circuit.

3.7 Uses of Voltmeter:

A Voltmeter also known as a voltage meter is an instrument used for measuring the potential difference, or voltage between two points in an electrical or electronic circuit.

Some voltmeters are intended for use in direct current (DC) circuits; others are designed for alternating circuits.

3.8 Advantages & Disadvantages

Advantages

It gives the accurate reading because of high input resistance; it detects the signals of very weak strength and small signal.

It avoids the load error so detection of low level signal occur.

The circuit of the electronic voltmeter consumes very less power

Voltmeter is free from frequency range because of transistor. Along with the voltage, the signal of very high and low frequency can also be measured through their meter.

Disadvantages

Multiple scales can cause confusion

Voltmeter have lack auto polarity technology. Incorrectly connected test leads can result in needle deflection and damage to the device.

Parallax error which occurs due to improper reading of voltmeter measurement.

4. CONVERSION OF GALVANOMETER INTO AMMETER

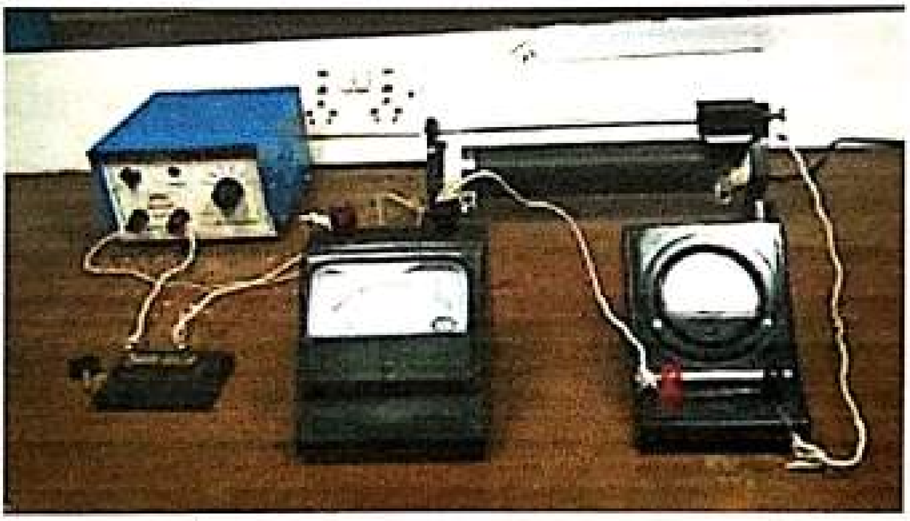
AIM: To convert the galvanometer into ammeter.

APPARUTUS: Galvanometer, Ammeter, Voltmeter, Shunt, Resistance-box, rheostat Battery, Connecting-wire.

4.1 Theory:

A galvanometer can detect only small currents. Thus, to measure large currents it is converted into an ammeter.

It can be converted into an ammeter by connecting a low resistance called shunt resistance in parallel to the galvanometer.



Let G be the resistance of the galvanometer and Ig be the current for full scale deflection in the galvanometer, the value of the shunt resistance required to convert the galvanometer into an ammeter of 0 to I ampere is,

$S = I g \times G I - I g$

Ig is calculated using the equation, Ig = nk, Where n is the number of divisions on the galvanometer and K is the figure of merit of galvanometer.

The galvanometer is used as an ammeter by connecting the low resistance wire in parallel with the galvanometer. The potential difference between the voltage and the shunt resistance are equal.

4.2 Circuit Diagram

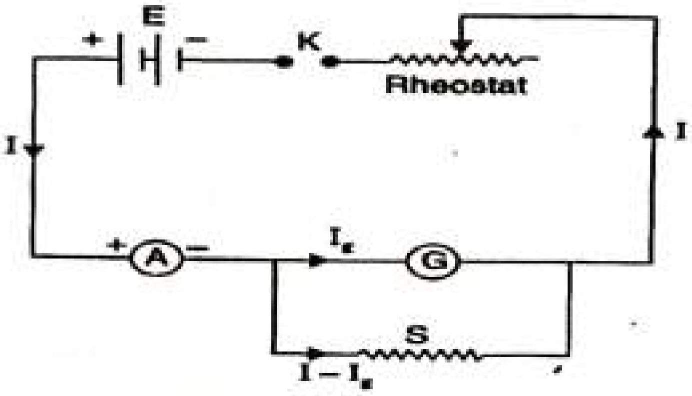


Fig. Circuit diagram for verification for ammeter.

4.3 Procedure:

Connect the circuit as shown in figure.

Select the range of the Ammeter and Calculate the Shunt Resistance for the selected range.

Connect nearest shunt resistance in parallel with the galvanometer.

Verify the value of the conversion of galvanometer into the ammeter.

Repeat the experiment for the different range of Ammeter.

4.4 Observations:

1. Resistance of Galvanometer G=50Ω

2. Current capacity of Galvanometer Ig=600mA

4.5 Observation Table:

Ob no	Range of ammeter in mA	Calculated shunt Resistance $S = \frac{GI_g}{(I - I_s)}$ Ω	Given shunt resistance SΩ
1.	50	0.5	0.5
2.	100	0.21	0.21
3.	150	0.12	0.12

4.6 Calculations

$$S = \frac{GI_g}{(I - I_s)}$$

$$S = \frac{50 \times 600 \times 10^{-3}}{50 - 600 \times 10^{-3}} = 0.5 \ \Omega$$

$$S = \frac{50 \times 600 \times 10^{-3}}{100 - 600 \times 10^{-3}} = 0.21 \ \Omega$$

$$S = \frac{50 \times 600 \times 10^{-3}}{150 - 600 \times 10^{-3}} = 0.12 \ \Omega$$

CONVERSION OF GALVANOMETER INTO VOLTMETER

AIM: To convert galvanometer into the voltmeter.

APPARATUS: Galvanometer, Ammeter, Voltmeter, Shunt, Resistance-box, rheostat Battery, Connecting-wire.

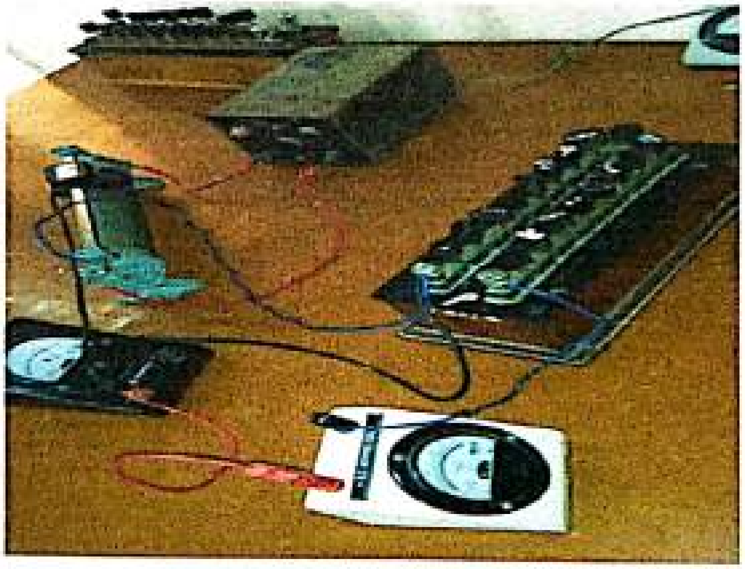
5.1 Theory:

Voltmeter is an instrument used to measure the potential difference between any two points in a circuit.

It is always connected in parallel to the circuit across the component where we want know the potential difference and will not alter the current flowing through the circuit neither will it draw current from the main circuit.

The current should be negligible through the voltmeters if the resistance of the voltmeter should be high.

For an ideal voltmeter the resistance should be infinity which is impractical. A galvanometer is the sensitive instrument used to measure small currents.



5.3 Circuit Diagram

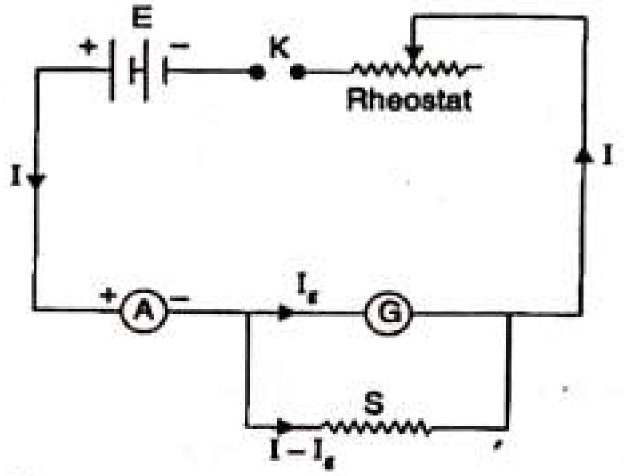


Fig. Circuit diagram for verification for ammeter.

5.3 Procedure:

1. Connect the circuit as shown in figure.

2. Select the range of the voltmeter and calculate the shunt resistance for the selected range.

3. Connect the nearest shunt resistance in series with the Galvanometer.

4. Verify the value of the conversion of galvanometer into the voltmeter.

5. Repeat the experiment for the different range of voltmeter.

5.4 Observations:

1. Resistance of Galvanometer=50 Ω

2. Current capacity of l Galvanometer=600mA

5.5 Observation Table:

Ob. No.	Range of Voltmeter Volt	Calculated Shunt Resistance Rs=V/Ig-G Ω	Given Shunt Resistance S Ω
1	1.5	2.4K Ω	2.4K Ω
2	3	4.9K Ω	4.9K Ω
3	5	8.2K Ω	8.2K Ω

5.6 Calculations:

Rs=V/Ig-GKΩ

$$R_s = \frac{1.5}{600 \times 10^{-3}} - 50 = 2.4 \times 10^{3} \ \Omega$$

$$R_s = \frac{3}{600 \times 10^{-3}} - 50 = 4.9 \times 10^{3} \ \Omega$$

$$R_s = \frac{5}{600 \times 10^{-3}} - 50 = 8.2 \times 10^{3} \ \Omega$$

Result:

By taking readings from practical part 1 and part 2, we can say that Galvanometer can convert into Ammeter and Voltmeter succefully.