MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
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EMPOWERING THROUGH INNOVATIONS
MLRS

Applied Physics Laboratory Manual

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Common
To
ALL BRANCHES
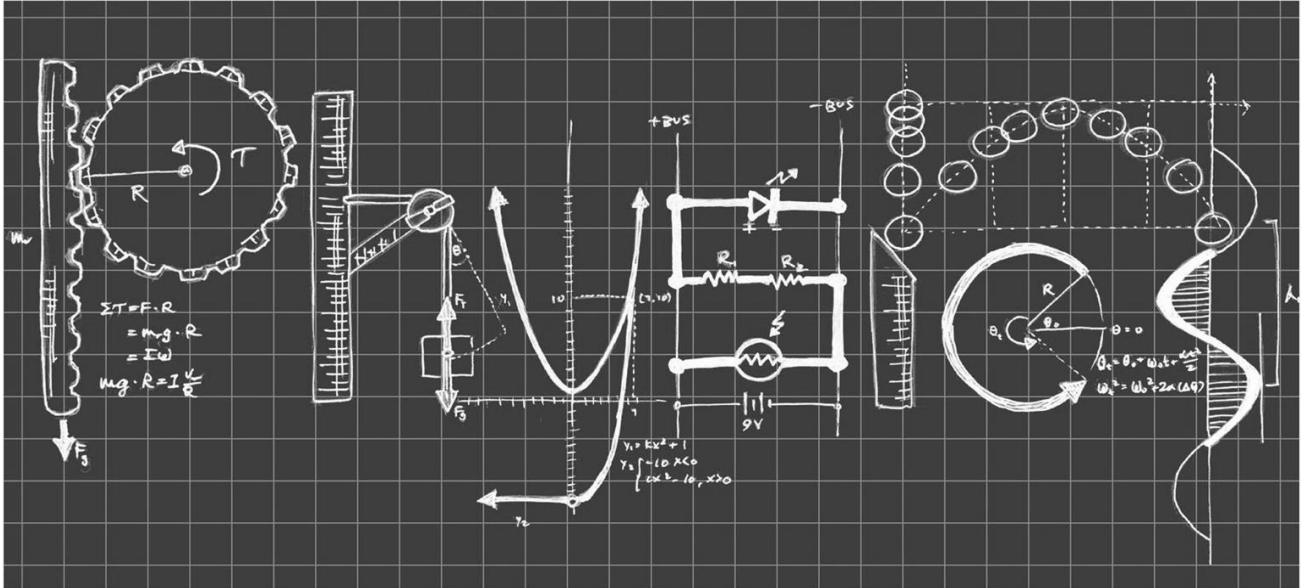
Lab Manual

APPLIED PHYSICS

(B.Tech. I st Year 2023-24 Academic Year)

INDEX

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PREFACE

This book entitled "Applied Physics Lab Manual" is intended for the use of First yearB.Techstudents of Marri Laxman Reddy Institute of Technology and Management, Dundigal, Hyderabad. The main objective of the Engineering Physics Lab Manual is to furnish the conceptual understanding of the basic principles. The experiments are selected from various areas of Physics like Lasers, Fiber Optics, Electricity & Magnetism and Basic Electronics.Thelab manual was written as per the new syllabus prescribed by the JNTUH University in a simple language. Viva voice questions also included in the manual. These experiments will help the students to expertise in the analysis of various concepts in Optical,Magnetic and Electronics related topics.Hence we hope this lab manual serve for better understanding by the student community with all experimental details.

ACKNOWLEDGEMENT

We deeply indebted and gratefully acknowledge the constant support and valuable patronage of Dr.R.Kotaih, Director, Marri Laxman Reddy Institute of technology & Management.

We express sincere thanks to Dr.K.Venkateswara Reddy, Principal, Marri Laxman Reddy Institute of technology & Management, for giving us this wonderful opportunity for preparing the Engineering Physicsmanual.

GENERAL INSTRUCTIONS

1. Students are instructed to come to Applied Physics laboratory on time. Late comers are not entertained in the lab.

2. Students should be punctual to the lab. If not, conducted experiments will not be repeated.

3. Students are expected to come prepared at home with the experiments which are going to performed.

4. Students are instructed to display their identity cards and apron before entering into the lab.

5. Students are instructed not to bring mobile phones to the lab.

6. Theinstruments used in Applied Physicsshould be handled with care and responsibility.

7. Any damage to equipment during the lab session is student's responsibility and penalty or fine will be collected from the student.

8. Students should update the records and lab observation books session wise. Before leaving the lab the student should get his lab observation book signed by the faculty.

9. Students should submit the labrecords 2/3 days in advance to the concerned faculty members in the staffroom for their correction and return.

10. Students should not move around the lab during the lab session.

11. If any emergency arises, the student should take the permission from concerned faculty member in written format.

12. The faculty members may suspend any student from the lab session on disciplinary grounds.

13. Never cook up the result by recording false observations or by making manipulated calculations.

14. All the data should be prettified with the relevant units.

SAFETY PRECAUTIONS

1. While working in the laboratory suitable precautions should be observed to prevent accidents.

2. Always follow the experimental instructions strictly.

3. The laboratory apron should be worn while working in the laboratory .

4. Use the first aid box in case of any accident/mishap.

6. Never work in the laboratory unless a demonstrator or teaching assistant in present.

7. All the equipments must be carefully handled.

8. Keep all the doors and windows open while working in the laboratory .

INSTITUTION VISION AND MISSION

VISION

To establish as an ideal academic institutions in the service of the nation, the world and the humanity by graduating talented engineers to be ethically strong, globally competent by conducting high quality research, developing breakthrough technologies, and disseminating and preserving technical knowledge.

OUR MISSION

To fulfill the promised vision through the following strategic characteristics and aspirations:

○ Contemporary and rigorous educational experiences that develop the engineers and managers.

○ An atmosphere that facilitates personal commitment to the educational success of students in an environment that values diversity and community.

○ Undergraduate programs that integrate global awareness, communication skills and team building.

○ education and training that prepares students for interdisciplinary engineering research and advanced problem solving abilities.

PROGRAMME OUT COMES

a) **An ability to apply knowledge of mathematics, science, and engineering.**
Graduates should transform knowledge of mathematics, Physics, chemistry, Engineering Mechanics, probability and statistics, and engineering drawing in solving a wide range of civil engineering problems.
b) **An ability to design, implement, evaluate a system and conduct experiments, as well as to analyze and interpret data .**
 Graduates should show that they can make decisions regarding type, and number of data points to be collected, duration of the experiment to obtain intended results, and demonstrate an understanding of accuracy and precision of data
(c) **An ability to design, implement and evaluate a system, or process to meet desired needs**
 Graduates should be able to: identify the project goal; define the project; search for alternative possibilities; choose the best of the possible solutions; create a design drawing, design plan, or computer simulation; evaluate the design; and justify the final design in written and oral forms.
d) **An ability to function effectively on multi-disciplinary teams**
 Graduates should show that they can participate effectively as team members with people who bring different skills, expertise, and perspectives to a project; and with people from different sub-disciplines of civil engineering and interdisciplinary groups.
e) **An ability to identify, formulate, analyse and solve engineering problems**
 Graduates should be able to describe the important components of a given problem, apply mathematical, engineering principles and to find the unknowns and arrive at appropriate and effective solutions.
f) **An understanding of professional, ethical, legal, security and social responsibilities**
 Graduates should be familiar with the applicable professional code of conduct for engineers. They should be able to apply the codes, where appropriate, to particular cases in which ethical issues arise. Graduates should also understand the importance of professionalism.
g) **An ability to communicate effectively both in writing and orally**

Civil engineering graduates should have the ability to speak and write effectively in various domains like laboratory reports, technical reports, technical presentations, project reports etc.

h) The broad education necessary to analyse the impact of engineering solutions on a global and societal context

Graduates should get exposed to the interactions among science, technology, and social values, understand the influence of science and technology on civilizations and how science and technology have been addressed for the betterment of humankind.

i) Recognition of the need for, and an ability to engage in continuing professional development and life-long learning

Graduates should show that they appreciate the need for further education and selfimprovement, understand the value of professional licensure the necessity of continuing professional developments, and the value of membership in appropriate professional organizations.

j) Knowledge of contemporary issues

Graduates should have knowledge and understand selected contemporary technical and social issues relevant to their field of study.

k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Graduates should have ability to use practical methods readily and effectively in the performance of engineering analysis and design. Graduates should be able to select and use modern engineering tools used by practicing engineers, including computer software such as computer aided drawing (CAD)

l) An ability to apply design and development principles in the construction of software and hardware systems of varying complexity

Graduates should have ability to design and develop principles involved in construction of different structures.

COURSE STRUCTURE, OBJECTIVES & OUTCOMES

COURSE STRUCTURE

Applied Physics lab will have a continuous evaluation during First year First semester for40 Internal marks and 60 end semester examination marks.

Out of the 40 marks for internal evaluation, day-to-day work in the laboratory shall be evaluated for 15 marks and internal practical examination shall be evaluated for 15 marks conducted by the laboratory teacher concerned 10 marks for PPT presentation .

The end semester examination shall be conducted with an external examiner and internal examiner. The external examiner shall be appointed by the principal / Chief Controller of examinations

Course Objectives: The objectives of this course for the student to

1. Capable of handling instruments related to the Hall effect and photoelectric effect

Experimentsand their measurements.

2. Understand the characteristics of various devices such as PN junction diode, Zener diode,

BJT,LED, solar cell, lasers and optical fiber and measurement of energy gap and

Resistivity ofsemiconductor materials.

3. Able to measure the characteristics of dielectric constant of a given material.

4. Study the behavior of B-H curve of ferromagnetic materials.

5. Understanding the method of least squares fitting.

Course Outcomes: The students will be able to:

1. Know the determination of the Planck's constant using Photo electric effect and identify

    thematerial whether it is n-type or p-type by Hall experiment.

2. Appreciate quantum physics in semiconductor devices and optoelectronics.

3. Gain the knowledge of applications of dielectric constant.

4. Understand the variation of magnetic field and behavior of hysteresis curve.

5. Carried out data analysis.

1. Photo electric effect

-

AIM: To determine the Work function (w) of a given material byusing Photo cell.

APPARATUS: 0-10 V power supply, a one way key, a rheostat, a digital milliammeter, a digital voltmeter, a 1 K resistor and different known wavelength LED's (Light-Emitting Diodes).

THEORY:

The phenomenon of emission of electrons from the surface of a material when light falls on it,is known as the photoelectric effect. The emitted electrons are called photoelectrons. A typicalexperimental setup for observing the photoelectric effect is shown in Fig.1.Light falls on atarget metal plate T enclosed in a vacuum tube and as a result electrons are ejected from thesurface of the plate. When the ejected electrons reach the collector electrode C placed oppositeto T, an electric current, called photocurrent flows through the circuit. This photocurrent canbe measured by an ammeter connected to the circuit. The kinetic energies of the emittedelectrons can be estimated by applying a negative potential to the collector C and tuning thepotential such that it is just enough to prevent the electrons from reaching the collector. Thisnegativepotential,$V_0$to C at which the photocurrent becomes zero, is called the stopping potential, Obviously,

$eV_0 = K_{Max}$

Where
$E$is ---- the electronic charge

K_{Max}-----is the maximum kinetic energy of the emitted electrons.

The photoelectric effect was first explained by Einstein on the basis of quantum theoryof light. Accordingto it, light,i.e. electromagneticradiationconsistsofdiscreteenergypacketsor energy quanta. Each energy packet behaves as particle and is called photon. The energy of aphotonis given by,

$$E = hf$$

where
h---is called Planck's constant
f--- is the frequency of radiation.

When the photons fallson metal surface, an electron can absorb the energy of a photon and acquire enough energyto escape the surface potential barrier.
φ(also called work function).
Themaximum kineticenergywithwhich the electron canejectout,
Accordingtotheprincipleofenergyconservation,is given by

$$K_{Max} = hf - \varphi$$

the relationship can also be written as

$$eV_0 = hf - \varphi$$

The above equation shows that a graph of V_0 versus f will be a straight line with the slope being equal to h/e.

The work function can be written as

$$\varphi = hf - eV_0$$

Experimental setup

violet, blue1, blue2 and yellow. The circuit diagram for the connections is displayed in the panel.

The Planck's constant measurement unit is shown in Fig. It consists of a light source, a photo vacuum tube, DC voltmeter, DC ammeter and connecting ports. Also supplied along with the units are four filters of different colors, e.g. violet, blue
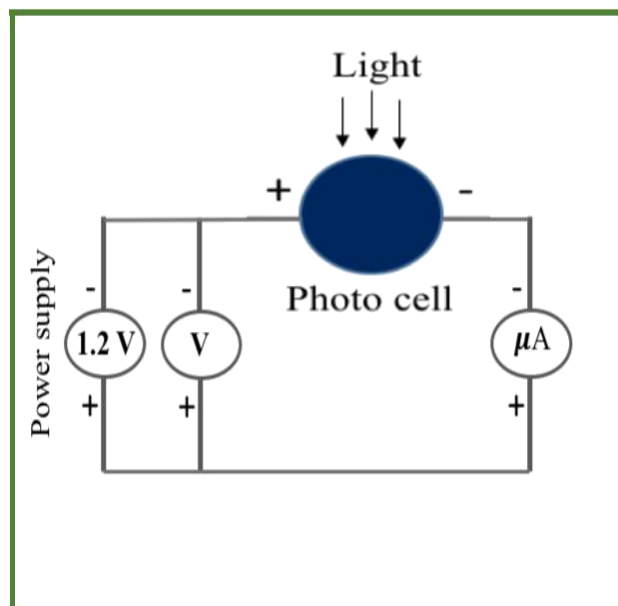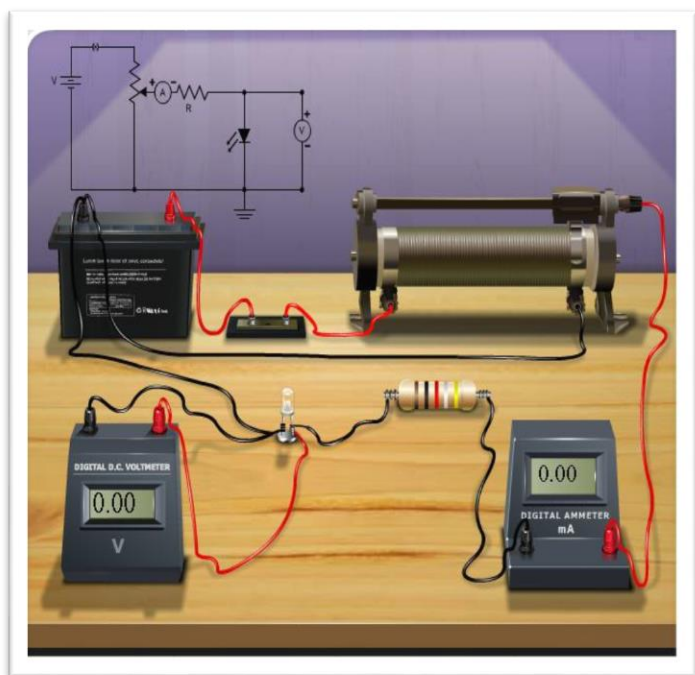

Fig 1: Experimental set up-photo electric effect

Procedure:

1. Take the Planck's constant setup & fix the photo vacuum tube at particular position.

2. Complete the circuit connections as shown in the diagram in the panel of the unit.

3. Set the range of the DC voltmeter at 200 mV and the ammeter at 2μA.

4. Connect the mains cord and switch on the power supply and light source. Now you canobserve some value of current on ammeter.

5. First insert the 'red' color filter in front of photo vacuum tube.

6. If the observed current is too low, then slide the photo vacuum tube towards light sourcetill you get some appreciable current. Fix the photo tube at this distance (position 1).

7. Switch on the DC voltage source.

8. Now vary the DC voltage slowly by variable resistance pot and see the value of current.It should decrease as the voltage is increased.

9. When the current becomes zero, note the value of applied voltage by DC voltmeter. Thisis the stopping potential,$V_0$for the given color.10. Switch off the DC voltage source.

11. Repeat steps 7-10 for the other color filters, e.g. orange, yellow, green and blue respectively, keeping the position of the photo vacuum tube fixed.

12. Tabulate all the readings as indicated in Table 1.

13. Now reduce the distance between the light source and the photo vacuum tube to approximately half of whatwastaken in the above setofreadings. This is position2ofthephoto tube.

14. Repeat steps 7-12 with the same set of color filters for position 2 of the photo tube.

15. The stopping potential,V_0should be same for both the positions of the photo tube. Findthe mean$V_0$from the two values obtained for position 1 & 2 (see Table 1)'

16. Plot a graph of V_0 versus$f($ Hz).

Observations
Velocity of light ,$c = 3\times10^8$ms^{-1}.
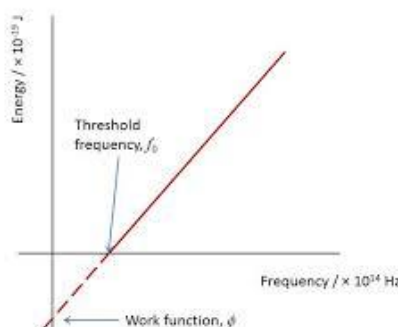
Variation in stopping potential with frequency.

Table: Determination of V_0 as a function of frequency, f

Colours	Frequency (10^{14} Hz)	Wavelength (nm)	Stopping voltage (V_0)	Work function $\varphi = hf - eV_0$ (eV)

Graph:
Plot a graph of V_0 versus f from data in Table 1.

Calculation:
Value of $e = 1.6 \times 10^{-19}$ C.
Slope of the V_0 -f graph,

PRECAUTIONS:

1. Fix the incident light source and filter postions exactly with suitable distance.

2. Stopping potential shoud be note down exactly at zero ammeter reading.

3. The negative potential must be applied very slowly until zero current value is reached.

Result:

Value of Work function from the experiment, $\varphi =$ **eV**

VIVA VOCE:

1. What is Photo electric effect?
2. Define threshold frequency.
3. What is work function and its significance?
4. What are the units for plank's constant?
5. What is the visible wavelength range?
6. What type of material we can use in the photo cell?
7. What are the applications of Photo electric effect?
8. Define wavelength.
9. Define semiconductor.
10. What are the types of semiconductors?
11. Explain the type of impurities present in p-type semiconductor.

12. What are extrinsic semiconductors?
13. Classify solids based on band theory.
14. Explain the formation of conduction band and valence band.
15. Define Energy gap in solids.
16. What are the majority charge carriers in n-type semiconductor?
17. What is the function of photo cell?
18. Define photon.
19. What is the value of Planck's constant?
20. According to Planck's theory energy of one photon.
21. Which instrument we are using to measure current.
22. What is the functionality of rheostat in circuit?
23. Define resistivity.
24. Differentiate conductors and semiconductors.
25. Explain biasing.
26. What are the types of biasing?
27. Mention any two applications for forward biased devices.
28. What is recombination?
29. What are the types of recombination?
30. What is the principle of Photoelectric effect?
31. Define frequency.
32. Draw the graph between stopping potential and photo current.
33. Write the units of band gap.
34. What Is Based Upon The Conservation Of Energy ?
35. One A^o = -- in cm, m.
36. Write the units of frequency.
37. Which Are The Different Type Of Photo Electric Cell ?
38. Define stopping potential.
39. Write the formula for work function.
40. What Is The Rest Mass Of Photon ?
41. Define the Compton effect.
42. Write the units of work function.
43. Which one has the same units as plank's constant ?
44. What Is Electron ?
45. Who First Explained The Phenomena Of Photo Electric Effect ?
46. The Phenomenon Of Emission Of Electrons By Light Is Known As.
47. What Converts Light Energy Into Electric Energy ?
48. Write relation between the wavelength and frequency.
49. Draw the graph between stopping potential and frequency.
50. Explain difference between Photo electric effect and Compton effect.

2. Hall effect

AIM: To determine the Hall co-efficient and carrier concentration of a given semiconductor.

APPRATUS: Halleffectpanel, Hall probe, Electromagnet, Constant current power supply, Digital gauss meter with hall probe, Hall probe stand (wooden).

PRINCIPLE:A static magnetic field has no effect on charges unlessthey are in motion. When the charges flow, a magnetic fieldis directed perpendicular to thedirection of flow produces a mutually perpendicular force on the charges. When thishappens, electrons and holes will be separated by opposite forces. They will in turn produce an electric field (E_H) which depends on the cross product of the magnetic intensity, H, andthe current density, J .

$E_h = R J x H$

Where R is called the Hall coefficient.

Then the Hall coefficient can be written as

$$R = \frac{dV_H}{B.I} \text{cm}^3 \text{ Coulomb}^{-1}$$

B - Magnetic flux density
I$_H$ - Current through the semi conductor
d - Thickness of the conductor
V_H - Hall voltage

THEORY: When a transverse magnetic field (B) is applied to a semiconductor carrying current (I), an voltage is induced in the direction perpendicular to both current (I) & magnetic field (B). This phenomenon is known as Hall Effect. If the sign of Hall Coefficient is positive the semiconductor is of P-type& if the sign of Hall Coefficient is negative the semiconductor is of n-type.

EXPERIMENT 1: Hall current Vs Hall Voltage at constant Magnetic field.

 PROCEDURE:

1. Connect the IC regulated power supply terminals to Electromagnetic coils in their respective sockets.

2. Connect Hall probe to Gauss meter. Switch "ON" the Gauss meter, set the Gauss meter reading to "0.00" by adjusting the knob.

 3. Now place the Hall probe in the magnetic field exactly at the center of the electromagnet cores. Set the gauss meter reading to 0.5KG magnetic field. This is achieved by applying suitable current to electromagnets & by simultaneously positioning the electromagnet cores by turning the knobs.

 4. Connect the crystal mounted PCB to constant current power supply to their respective sockets.

 5. Remove Hall probe from the magnetic field and place crystal in the same position without disturbing the position of magnetic cores.

6. Switch "ON" the constant current power supply & apply current in steps of 0.1mA, rotate the crystal till it becomes perpendicular to magnetic field. Hall voltage will be maximum in this adjustment, note the corresponding Hall voltage at constant magnetic field.

7. Plot the graph between current (I) and hall voltage (V_H) which is a straight line & find the slope.

8. Repeat the above steps from 3 to 7 for different values of magnetic fields say 0.75KG, 1KG, 1.25KG, 1.5KG, 1.75KG & 2KG.

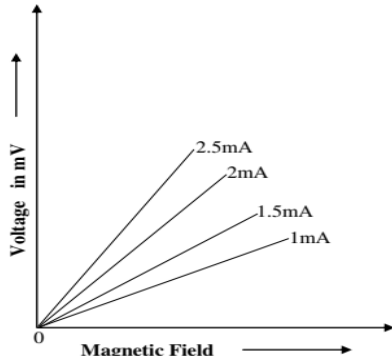| Magnetic Field (KG) X10³	current (mA)	HALL VOLTAGE V,(mV)x10⁻³

NOTE: 1. There may be some voltage even outside the magnetic field. This is due to the imperfect alignment of the four contacts of the crystal and is generally known as the "Zero Field Potential". In all the cases this error should be subtracted from the Hall voltage reading. 2. Gap between the magnetic cores should remain fixed for one set of readings.

EXPERIMENT 2: Magnetic Field Vs Hall Voltage at constant current across the Semiconductor.

PROCEDURE:

1. To demagnatise the coils, place the sensor mounted PCB exactly at the center of the core. Apply reverse current through the coils till the Gauss meter reads '0.00'

2. Switch "OFF" all the sources, set the IC regulated power supply (to the magnetic coils) knob to minimum.

3. Increase the gap between magnetic cores to maximum by turning the core knobs.

4. Place crystal & sensor mounted PCB together in the magnetic field exactly at the center of the magnetic cores gap.

5. Connect the crystal mounted PCB to constant current power supply to their respective sockets.

6. Connect Hall probe to Gauss meter. Switch "ON" the Gauss meter, set the Gauss meter reading to "0.00" by adjusting the knob.

7. Switch "ON" IC regulated power supply to the magnetic coils & constant current power supply.

8. Set the current across the crystal to 1mA, vary magnetic field (starting from 0.00 KG) in steps of 0.25KG.This can be achieved by applying current to electromagnetic coils & simultaneously changing the position of electromagnetic cores.

9. Note the corresponding Hall voltage at constant current through semiconductor sample.

10. Plot the graph between magnetic field (B) and hall voltage (V_H), which is a straight line & find the slope of the line.

11. Repeat the above steps from 2 to 6 for different values of current applied to semiconductor crystal say 1mA, 1.5mA, 2mA & 2.5mA.

TABULAR COLUMN: IDEAL GRAPH:

Current	Magnetic Field (KG) X10³	HALL VOLTAGE V,(mV)x10⁻³

DESCRIPTION OF EXPERIMENTAL SETUP:

Fig (1) shows the experimental set up consisting of IC Regulated Power Supply of 2Amps for Magnetic Coils, Constant Current Source of 2mA for Crystal, Gauss Meter, Semiconductor Crystal mounted on PCB, Hall Sensor mounted on PCB

Coil arrangement with magnetic coils mounted on the wooden base, handles provided the coils moves the cores of the magnetic coils to change the magnetic field as desired. Brass bars provided on either side of the coils is used to hold the crystal & sensor PCB.
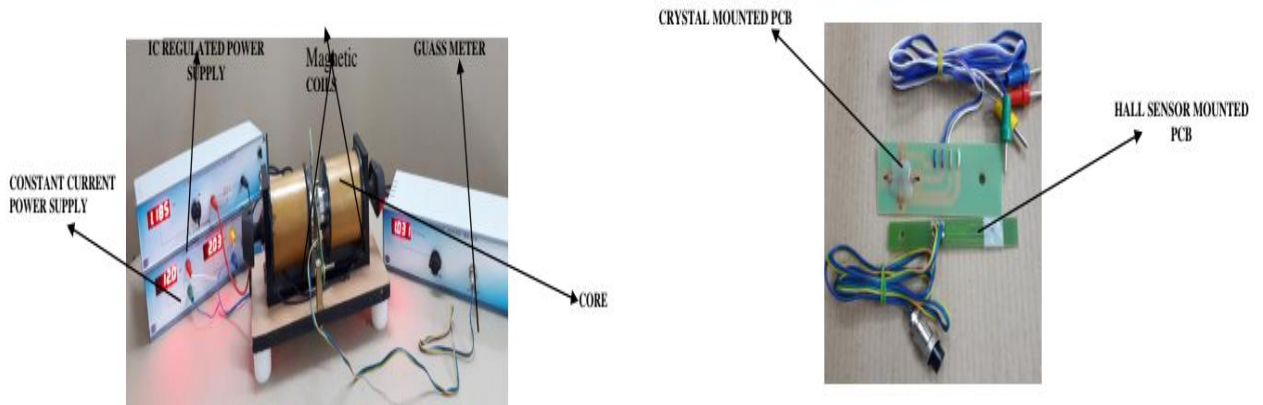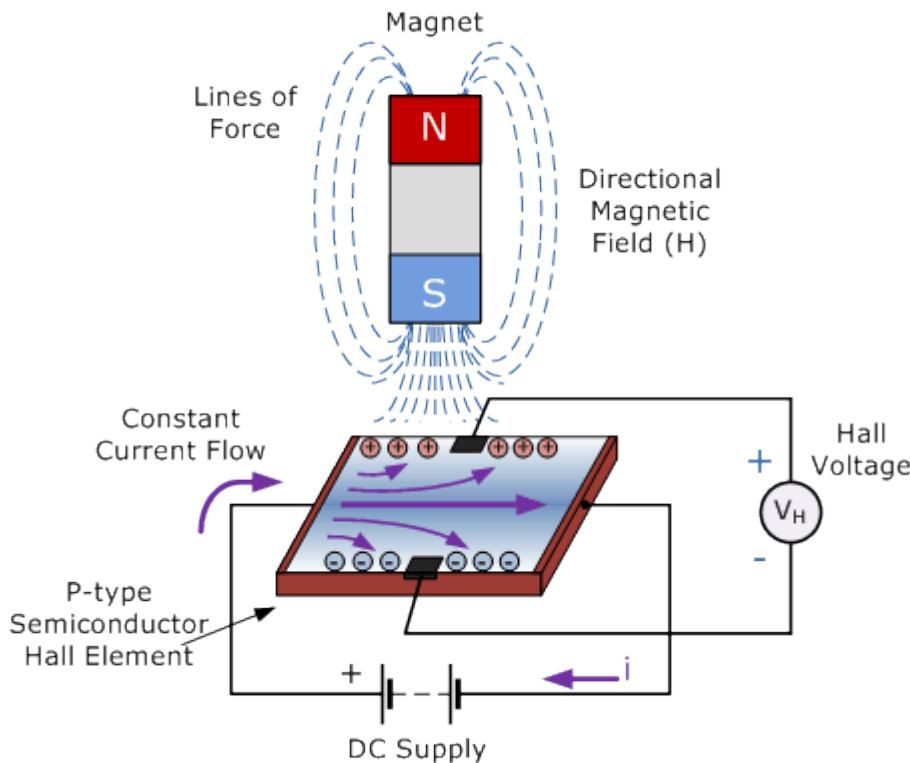
Fig. 1. Hall effect Setup

SAMPLE CALCULATION FOR HALL COEFFICIENT (R_H):

Hall Coefficient (R_H) = $\frac{dxV_H}{BxI}$ $volts$ cm^2 Amp^{-1}Gauss^{-1} =388.58x10^{-6}=V$_{H/B}$

d-samples thickness =1x10^{-2} cm I= 1mA=1x10^{-3}A, V/B= slope from graph

R$_H$=$volts$ cm^2 Amp^{-1}Gauss^{-1}

VIVA – VOCE
1. What is Hall Coefficient?
2. What are the applications of Hall Effect?
3. Define Hall Effect.
4. Write the Hall Coefficient equation.
5. What is the difference between Electric field and Magnetic field?
6. What are the different materials used for the Hall Effect?
7. Define magnetic induction.
8. How many types of magnetic materials are there.
9. Differentiate Soft and Hard magnetic materials.
10. Define n-type semiconductor.
11. Define p-type semiconductor.
12. How are solids classified based on band theories.
13. What are majority and minority charge carriers in a p-type semiconductor?
14. What are majority and minority charge carriers in a n-type semiconductor?
15. What is meant by forward biasing?
16. What is meant by reverse biasing?

17. Explain ohm's law.
20. What are the units for current?
21. Write the units for Hall coefficient.
22. Define magnetic field intensity.
23. Explain the term magnetization.
24. Define energy gap in solids.
25. What is the energy gap value in semiconductors?
26. State Fleming right hand condition.
27. Define voltage.
28. Which instrument we are using to measure current.
29. Define BhorMagnaton.
30. What is the value of one BhorMagnaton?
31. What are the applications of Hall Effect?
32. What is the relation between Gauss and Tesla?
33. Magnetic flux over a unit area of a surface held normal to the flux is ---.
34. What are the uses of Hard magnetic materials ?
35. Write the formula relations between Electric field and Magnetic field?
36. What will be the Magnetic field value at the center of a current carrying coil?
37. Write example of Ferro, Para and Dia magnetic materials.
38. What are the of soft magnetic materials ?
39. What are the best examples of intrinsic semiconductor?
40. Write the relation between the Resistance and temperature.
41. What is the domain ?
42. Draw the circuit symbols of npn and pnp transistors.
43. What is the saturation?
44. Write the formula for slope .
45. What is doping?
46. Write the formula for Hall Coefficient in presence of thickness and Magnetic field?
47. What is the Bhor magneton value ?
48. Write the units of Electric field.
49. Write the relation between the conductivity and temperature.
50. What is the Fermi energy?
51. What is the Hall coefficient for n-type semiconductor?

52. Explain the semiconductor nature at 0°C temperature.

3. LCR CIRCUIT

AIM: To study the characteristics of series and parallel resonance of LCR Circuit and to find resonance frequency and quality factor.

APPARATUS: LCR Circuit board contains set of resistors, capacitors, inductors and milliammeter.

THEORY: In this LCR circuit, it consists of inductor(L), capacitance (C), and resistance(R), are connected in series with a sinusoidal frequency of e.m.f of source, electromagnetic oscillations are set in the circuit and it behaves as an oscillator. As the circuit is driven by the external A.C. power source, it behavior is similar to the force oscillations in spring mass system. Therefore the study of the LCR circuit allows us to study the phenomenon of forced oscillations and hence resonance. The conditions for resonance in the circuit can be obtained. When L and C are connected in series with R, at a particular frequency, the capacitive reactance X_C is equal in magnitude with inductive reactance X_L and they are out of phase by 180^0. At this frequency the current through the circuit is maximum, and this frequency is called resonance frequency.

The frequency of oscillations in series is given by $\quad f_{series} = \dfrac{1}{2\pi\sqrt{LC}}$ --------- (1)

In a parallel resonance circuit, at resonance, the circuit does not allow the current to flow and works as a perfect choke for A.C, such a circuit is called rejecter circuit, which is shown in the figure 1. In a parallel circuit, the impedance maximum at the resonant frequency and consequently the current is minimum.

The parallel resonant frequency is given by

$$f_{parallel} = \dfrac{1}{2\pi\sqrt{1/LC - (R/L)^2}}$$ ------------- (2)

RLC Series circuit
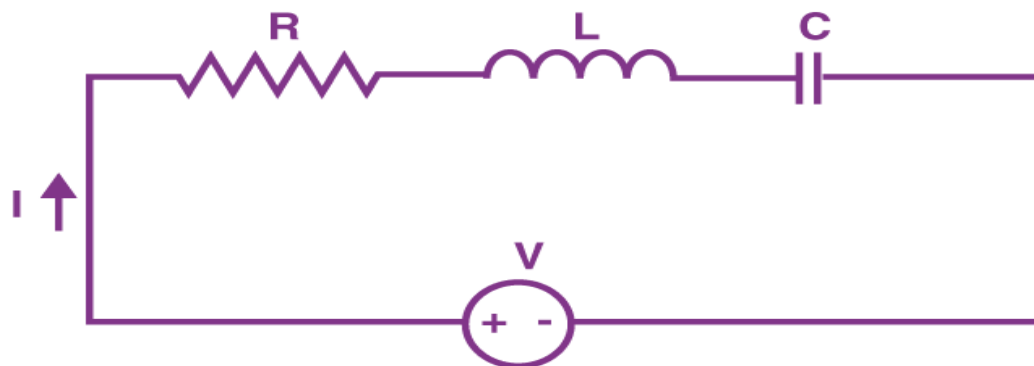
Bandwidth of a Series Resonant Circuit
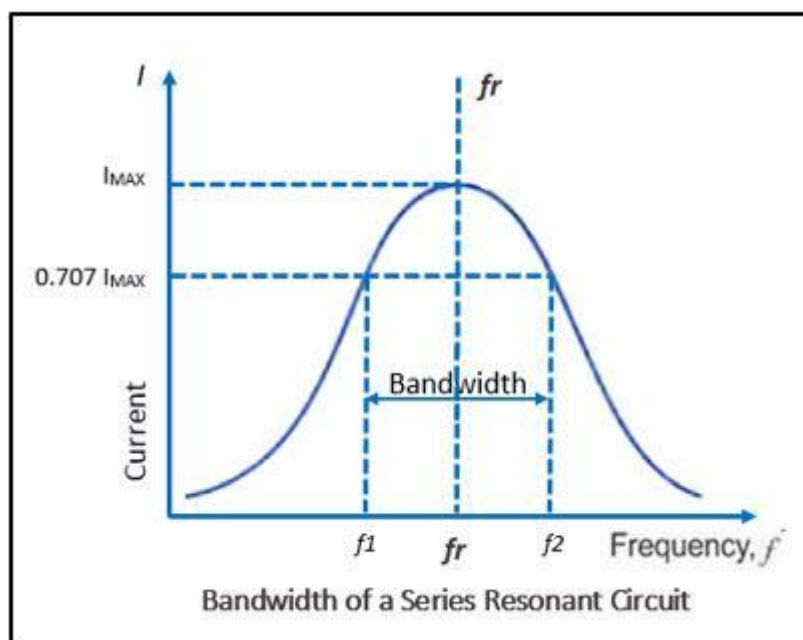
PROCEDURE:-

SERIES RESONANCE OF LCR CIRCUIT:-

-Connect the circuit as shown in the circuit diagram.Apply input signal using signal OR function generator.

-In this case the output should be 10 V only. Take the output across the resistor and set it to Ammeter input sockets.

- Change the frequency till the ammeter readings should be a sharp rise and fall, adjust the signal such that the maximum possible ammeter readings should be a sharp rise and fall.

-Adjust the signal such that the maximum possible Ammeter deflection is to be counted. This is the resonant frequency of the connected combination of the circuit.

-Again adjust the amplitude of the function generator such that the full scale deflection. Now reduce the frequency till the deflection falls in ammeter.

-After that increase the frequency in regular intervals & note down the ammeter readings.

-Plot the graph between the deflection readings and frequency and repeat the same study how resonant frequency depends up on the different combination of L.C.R. the readings are tabulated as follows

PARALLEL RESONANCE:-

-Connect the circuit as per the parallel resonance circuit diagram.

-Apply the input signal from a reliable signal generator. The output should be 10 V only. Take the output across the tank circuit connect to input ammeter sockets.

-Change the frequency till the ammeter readings sharp fall and adjust the signal such that the deflection falls down considerably then increase the frequency generator amplitude such that to get full scale deflection.

-Now reduce the frequency till the deflection till the deflection falls down and then increase the frequency in regular intervals and note down the deflection.

-Plot the graph between the metre deflection divisions and frequency and repeat the procedure for different values of R and study how Q is affected & also study the how the resonant frequency depends on different combinations of L.C.R.

LCR PARALLEL RESONANCE

Parallel Resonance Circuit

figure 4
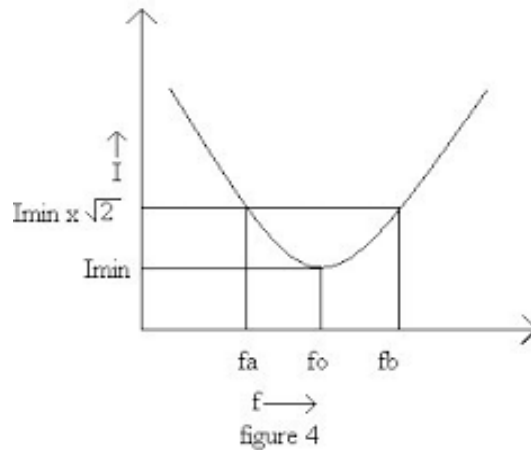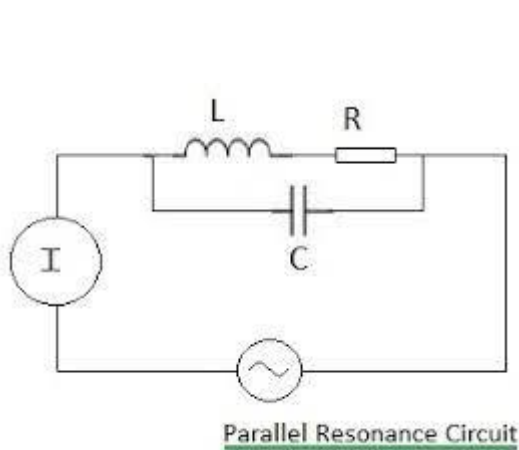
Band width BW = $f_1 - f_2$ = ------------------------------Hz

Resonant frequency = $f_r = 1/2\pi\sqrt{LC}$ =--Hz

Quality factor Q = f_r/BW =--

Series resonance:-

S.No	$L_1C_1R_1$	
	Frequency(Hz)	Current(A)

Parallel resonance:-

S.No	$L_1C_1R_1$	
	Frequency(Hz)	Current(A)

RESULT:-Series resonance of frequency of circuit (f_r) = _____ Hz

VIVA QUESTIONS:

1. Write the condition for resonance.
2. Define Capacitance.
3. Define Resistance.
4. Define Inductance.
5. Difference between series resonance & parallel resonance.
6. Write the SI unit of Resistance, Capacitance and Inductance.
7. Differentiate between A.C & D.C.
8. Define Frequency.
9. Write the Formula for quality factor .
10. Define resonant frequency.
11. On what factors the capacity of a capacitor depends.
12. Explain the importance of band width.
13. What are f1, f2?
14. What is meant by impedance in LCR circuit?
15. Define band width.
16. Write equation for resonant frequency.
17. On what factors does quality factor depends.
18. Write equation to calculate quality factor of an LCR circuit.
19. Difference between series and parallel connections in a LCR circuit.
20. The frequency at which the maximum Current occurs is known as.
21. Express the value of pico farads into micro farads.
22. Write the units of current.
23. What does a series circuit specifies?
24. Write the equation for energy stored in a capacitor.
25. Write the difference between capacitor and Resistor.

26. Write the full form of LCR.

27. List out types of semiconductors.

28. Classify types of solids based on band gap.

29. What are the types of impurities present in n-type semiconductors?

30. According to Ohms law V=-------

31. Write the units for quality factor .

32. What is the resonance frequency formula?

33. Define self Inductance.

34. Define mutual Inductance.

35. Write the relation between band width and resonance frequency.

36. Define Amplitude.

37. At maximum amplitude , that frequency known as.

38. When the frequency increases amplitude will be---.

39. What is Current?

40. write the relation between the I_{rms} and I_{max}.

41. What are advantages of series and parallel connections in LRC circuit?

42. Convert the value of milli farads into pico farads.

43. Write the uses of capacitor.

44. Write the relation between the frequency and angular frequency.

45. Write the relation between the frequency and time.

46. Convert the value of milli farads into micro farads.

47. Why parallel resonance circuit is called a rejecter circuit?

48. What is the importance of series resonance circuits?

49. Write the applications of RC circuit.

50. As frequency increases in series and parallel, the RC impedance will be---.

4.ZENER DIODE AND PN JUNCTION DIODE CHARACTERISTICS

AIM: To find V-I Characteristics Curve of Zener Diode and PN Junction Diode.

MICRO BOARD CONSISTS OF:

1. Variable power supply (0-2V) and (0-10v).
2. Dual range Digital Ammeter.
3. Dual range Digital Voltmeter.
4. Set of PN diode and Zener diodes
5. Resistors

THEORY:

Forward Bias Characteristics

The Junction is said to be forward biased when the "P" sections of the diode is to positive terminal and "N" section of the diode is connected to negative terminal of the source, with an increase in the voltage the current also increase, for silicon diode Knee Voltage rises from 0.5 – 0.75V & for Germanium 0.2 – 0.3V.

PROCEDURE:Forward Bias of PN Junction Diode

1. The circuit connections are made as shown in the diagram.
2. Switch on power supply note zero on meters.
3. Vary the power supply note down the readings of voltage and the correspondingly current in milli amps.
4. Plot a graph between voltage and current.
5. Note the forward voltage at which a significant amount of current starts flowing through the diode is the knee voltage of the diode.
6. Diodes IN4007& IN4148 are silicon diodes OA79 is Germanium diode.
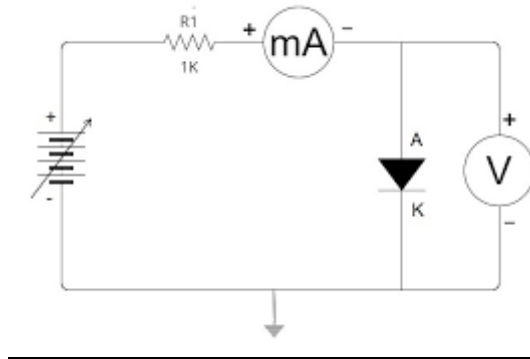
V_{TH}**FOR SILICON DIODE 0.5V- 0.7V**

V_{TH}**FOR GERMANIUM DIODE 0.2V- 0.3V**

Reverse bias Characteristics

The Junction is said to be reverse biased when the "P" section of the diode is connected to Negative terminal and" N" section of the diode is connected to positive terminal of the source, with an increase

in the voltage there is a small change in the current, reverse current increases to higher value with an increase in the voltage.

Reverse Bias of PN Junction Diode

1. The circuit connections are made as shown in the diagram.
2. Switch on power supply, note zero on meters.
3. Vary the power supply & note down the voltage and its correspondingly current in micro amps.
4. Plot a graph between voltage and current.
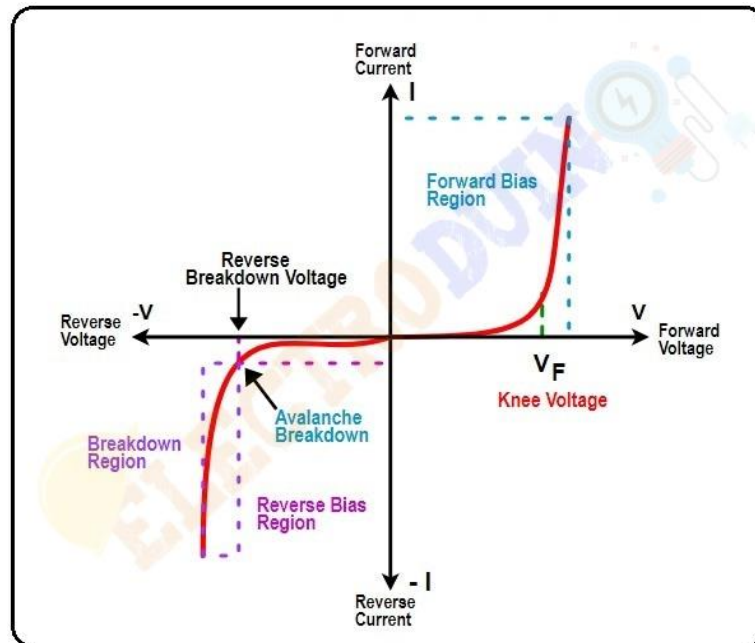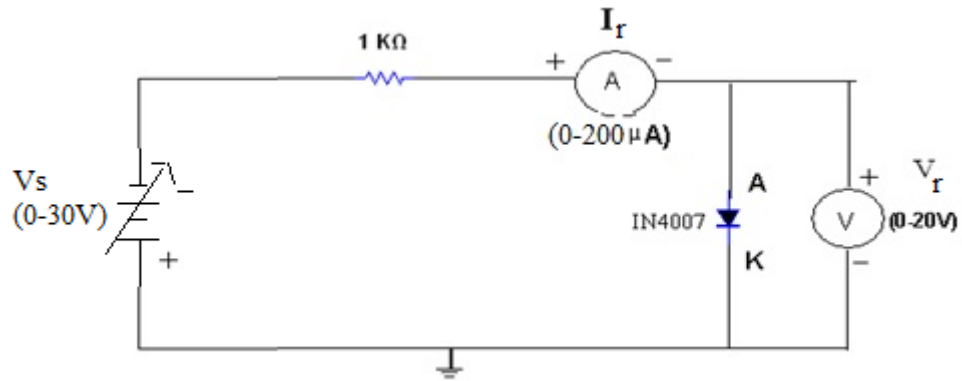
V- I Characteristic of pn junction diode in forward and Reverse bias.

ZENER DIODE

THEORY:

Zener diode is a heavily doped PN junction diode. Due to heavily doped, its depletion layer is very thin and is order of micrometer. The forward bias characteristic of Zener diode is same as the normal PN junction diode but in reverse bias it has different characteristic. Initially, a negligible constant current flow through the Zener diode in its reverse bias but at certain voltage, the current becomes abruptly large. This voltage is called as Zener voltage. This sudden and sharp increase in Zener current is called as Zener breakdown.

Avalanche Breakdown: This type of breakdown occurs in the presence of a high electric field. When we apply a high electric field in a reverse biased condition, the electrons start gaining high kinetic energy. These electrons start breaking other covalent bonds and start creating more hole-electron pairs. These pairs start crossing the depletion region and contribute to a high reverse reverse biased current. The breaking of bond is an irreversible process, and the p-n junction is completely destroyed after an avalanche breakdown.

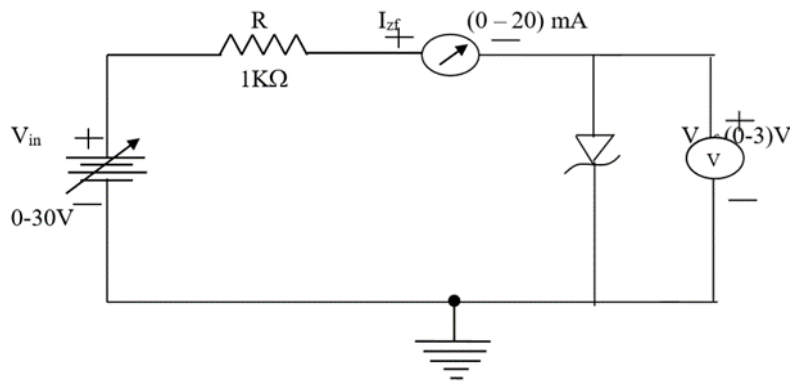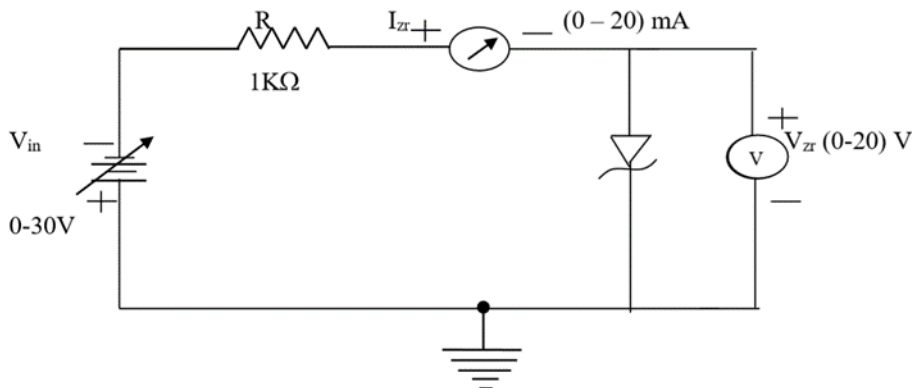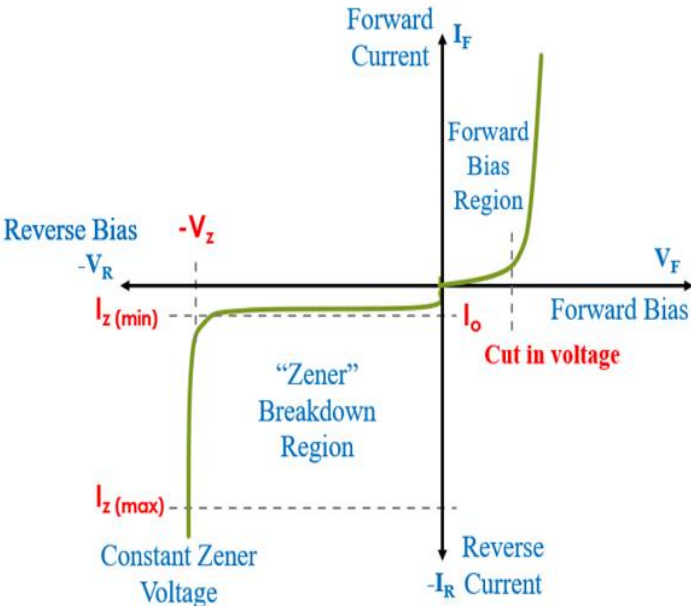Fig (1) – Forward Bias Condition:

Fig (2) – Reverse Bias Condition:

5.BJT TRANSISTOR CHARACTERISTICS

AIM: To Study and plot the input and output Characteristics of both PNP and NPN transistors for CE, CB, CC configurations.

MICRO BOARD CONSISTS OF:

1. Variable power supply (0-3V) -01,(0-10V)-01
2. Dual range Digital Ammeter. µA/mA - 01
3. Digital Voltmeter- 02
4. Digital Ammeter (mA) – 01
5. SL 100 – NPN Transistor
6. SK 100 – PNP Transistor
7. Resistors

.

COMMON EMITTER CONFIGURATION:-

 INPUT CHARACTERISTICS: -It is the curve between the base current I_B and base emitter voltage V_{BE} at constant collector-emitter voltage V_{CE}.

The input characteristics of a CE connection can be determined by the circuit shown in fig (3). Keeping V_{CE} constant, note the base current I_B for various values of V_{BE}. Then plot the readings obtained on the graph, taking I_B along Y-axis and V_{BE} along X-axis. This gives the input characteristics at constant V_{CE} at some voltage. Following a similar procedure, a family of input characteristics can be drawn. The following points may be noted from the characteristics.

1. The characteristic resembles that of a forward biased diode curve. This is expected since the base-emitter section of transistor is a diode and it is forward biased.
2. As compared to CB arrangement, I_B increases less rapidly with V_{BE}. Therefore, input resistance of a CE circuit is higher than that of CB circuit.
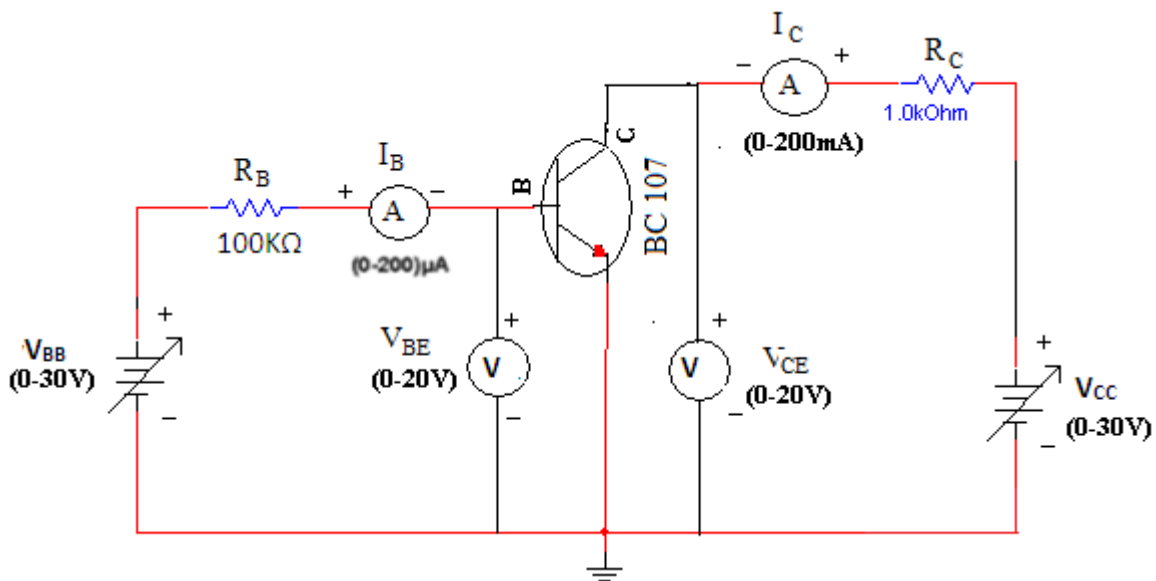
NPN TRANSISTOR IN CE MODE

I/P characteristics CE configuration
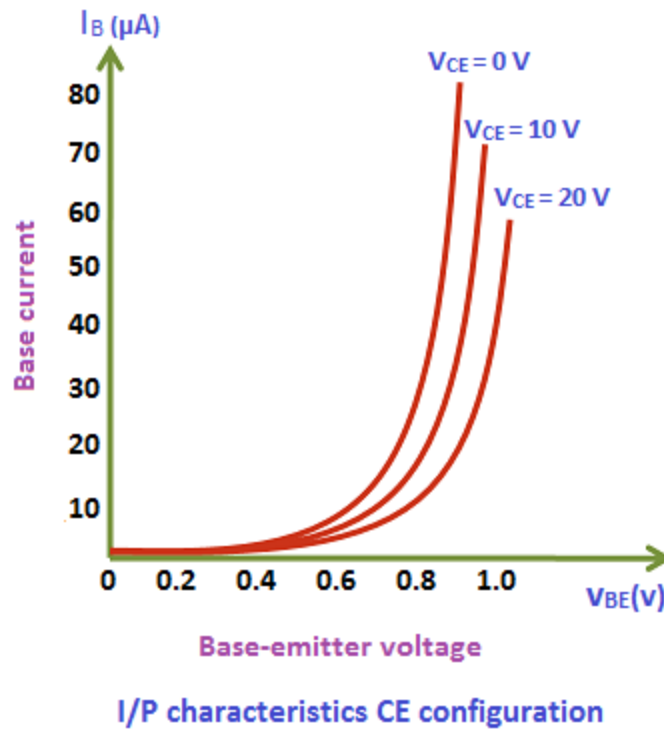
OUTPUT CHARACTERISTICS: - It is the curve between collector current IC and collector emitter voltage VCE at constant base current.

The output characteristics of CE circuit can be drawn with the help of the circuit shown in fig (2). Keeping the base current IB fixed to some value, note the collector current IC for various values of VCE. Then plot the readings on a graph taking IC along Y-axis and VCE along X-axis. This gives the output characteristics at different values of IB. following the same procedure, a family of output characteristics can be drawn as shown in fig (3a)).

The following points may be noted from the characteristics.

1. The collector current IC varies with VCE for VCE between 0&1V only. After this, collector current becomes almost constant and independent f VCE. This value of VCE upto which the collector current IC changes with VCE is called the knee voltage (Vknee). The transistors are always operated in the region above knee voltage.
2. Above knee voltage, IC is almost constant. However, a small increase in IC with increasing VCE is caused by the collector depletion layer getting wider and capturing a few more majority carriers before electron hole combinations occur in the base area.
3. For any value of V_{CE} above knee voltage, the collector current I_C is approximately equal to β x I_B.
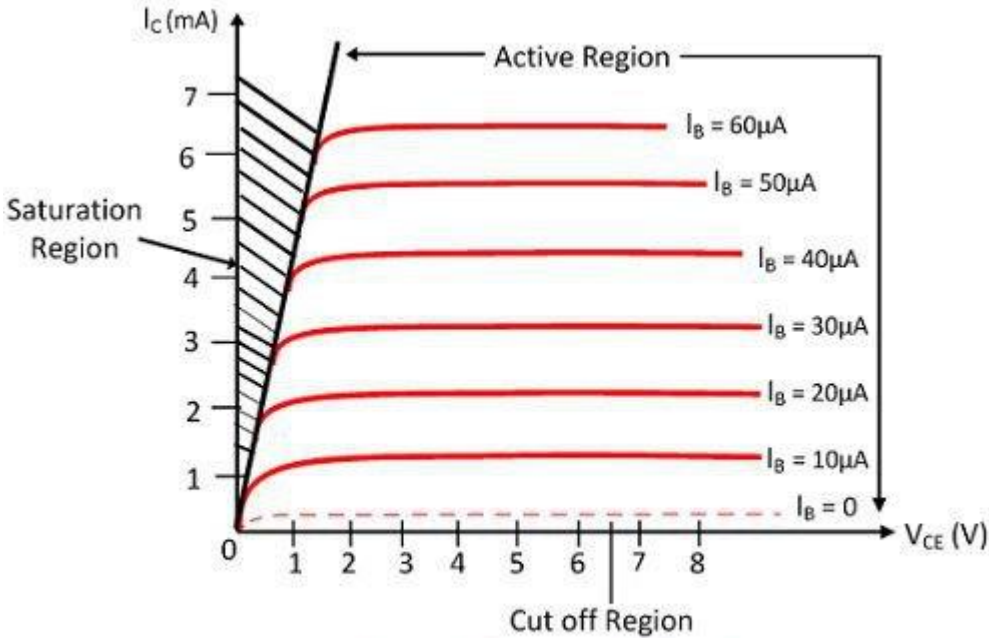
Output Characteristic Curve

Circuit Globe

6. Light Emitting Diode& Laser

AIM: To Study the V-I and P-I characteristics of LED& Laser.

APPARATUS: LED trainer kits, digital multimeter.

THEORY: A p-n junction diode, which emits lightin forward biasing is known as light emitting diode.The emitted light may be in the visible range or invisible range and the intensity of light depends on the applied potential. In this experiment LED is represented by standard diagram along with its source of resistance. The V-I characteristics of the diode are measured by applying sweep voltage by a source V to the diode. It is monitoring the current by ammeter. In general the V-I characteristics curve of a diode gives the relationship by the following equation

$$I = I_s[\exp(ev/KT) - 1]$$

Where I_s is the saturation current.

IV Characteristics of Light Emitting Diode

Circuit Diagram

Model Graph

Forward Biasing condition of LED

MODEL GRAPH:

LED

Forward Bias V-I Curve

Output characteristics Curve

www.CircuitsToday.com
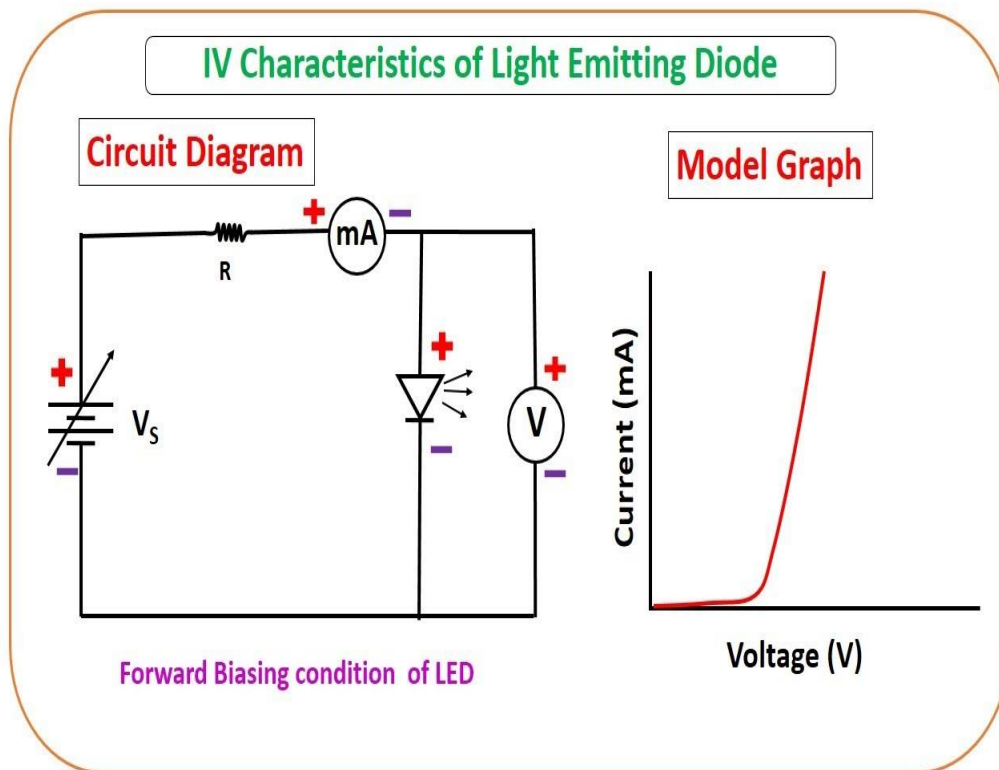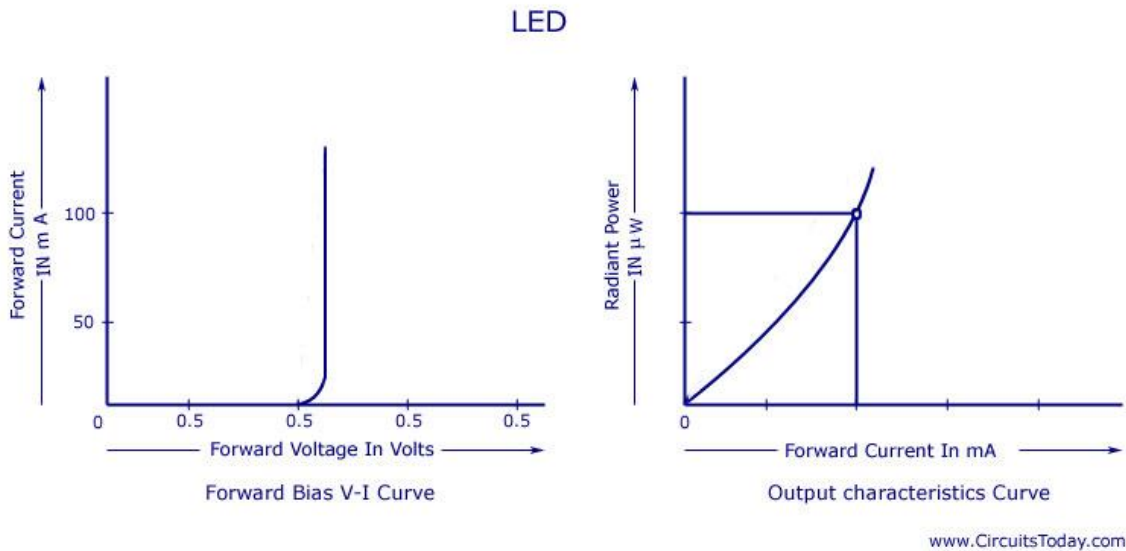
PRINCIPLE: In a P-N junction charge carrier recombination takes place when the electrons cross from the n-layer to the p-layer. The electrons are in the conduction band on the p-side while holes are in the valence band on the p-side. The conduction band has a higher energy level compared to the valence 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, where as incase of the gallium-arsenide and gallium phosphate, it is in the form of light. But this light is in the invisible region & so these materials cannot be used in the manufacture of LED. Hence gallium-arsenidephosphate which emits light in the visible region is used to manufacture and LED.

CONSTRUCTION: An n-type layer is grown on a substance and a p-type layer is grown over it by diffusion process. The p-layer is kept at the top because carrier recombination takes place in it. The terminals anode and cathode are taken out of the n-layer and p-layer respectively. The anode connections are made at the edge in order to provide more surface area for the emission of light. A metal film is applied to the bottom of substance to reflect light to the surface of the device and also to protect them from destruction.

PROCEDURE:-Connect one end of the optical fiber cable to the output terminal of LED and the other end is coupled to the power supply.

-It consists of P-N diode and then switch on the power supply.

- Adjust the set knob to extreme end into anticlock wise direction.

-It gives the minimum output in the power meter and observes the output power in the power meter.

- Next slowly turn the set knob into clock wise direction then note down the current I_L .Through the LED terminals again note down the reading in the power meter(p_0) then tabulate the readings in the following tableRepeat the same method for nothing the various of I_L and power meter readings and next plot the graph between I_L and P_0

V-I values of LED

S.NO	$V_L(mv)$	$I_L(mA)$

Procedure for V-I characteristics of a LASER:-

- Connect one end of the optical fibre to the output terminal of the LASER and the other end is coupled to the power meter.

- It consists of P-N diode then switch on the power supply.

- Adjust the set knob of power meter to the extreme end in the clock wise direction and it gives the minimum output in the power meter. Observe the power in the power meter.

-slowly turn the set knob in to clock wise direction the note down the current I_L across the LASER input terminals.

-Note the readings in the power meter and tabulated following table and repeat the procedure for finding the various values of I_L and the P_0.

- Plot the graph between I_L and the P_0 from the experiment and determine the slope before and after the value of the threshold current.

S.NO	V_L(mv)	I_L(mA)

PRECAUTIONS:

- Make sure that the volt meter is measuring the voltage across the LED only.
- Increase the power supply very slowly until led just starts to glow.
- Continously monitor the current so that it do not exceed the maximum current, with this the damage of the LED with high current can be avoided.

RESULT: HenceV-I characteristics of LED and LASER diode are studied.

VIVAVOICE:

1. What is n-type semiconductors?
2. What is p-type semiconductors?
3. Define conduction and valence band in a semiconductor?
4. What are LED materials and give some examples.
5. What is the basic mechanism of LED?
6. What are the input and output energies of LED?
7. What are the majority charge carriers in a p-type semiconductor?
8. What are the majority charge carriers in a n-type semiconductor?
9. What are different types of lasers?
10. What is laser? Explain?
11. What is the difference between laser and conventional light?
12. What is stimulated emission?
13. Write the characteristics of laser.

14. What are the applications of laser in industry, research?
15. What are the different types of semi conductors?
16. How is a PN junction formed?
17. What is meant by forward biasing?
18. What is meant by reverse biasing?
19. Give an example of a solid state laser.
20. Write the differences between spontaneous and stimulated emission?
21. What are direct band gap semiconductors?
22. What are indirect band gap semiconductors?
23. Define semiconductor.
24. Give examples of conductor, semiconductor and insulator.
25. Define doping.
26. Write two applications of LED.
27. Write the Laser applications in communications.
28. Define intrinsic semiconductor.
29. Define extrinsic semiconductor.
30. Explain Recombination.
31. What are the types of recombination's?
32. Give any two examples where recombination occurs.
33. Define coherence.
34. Define spontaneous emission.
35. Write two differences between stimulated emission and spontaneous emission.
36. Give any advantages of LED in electronic display.
37. Write two differences between Laser and LED.
38. Name the different types of semiconductor lasers.
39. Define Modulation.
40. Mention the different types of modulations.

7. SOLAR CELL

AIM: To Study V-I characteristics of a Solar cell.

APPARATUS: Solar panel, Illuminator, Voltmeter, Milliammeter and Potentiometer, etc.

CIRCUIT DIAGRAM:
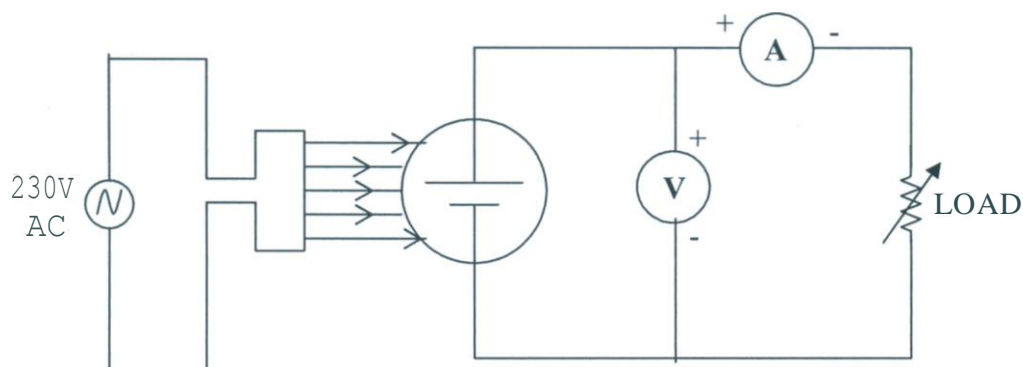
MODEL GRAPH:
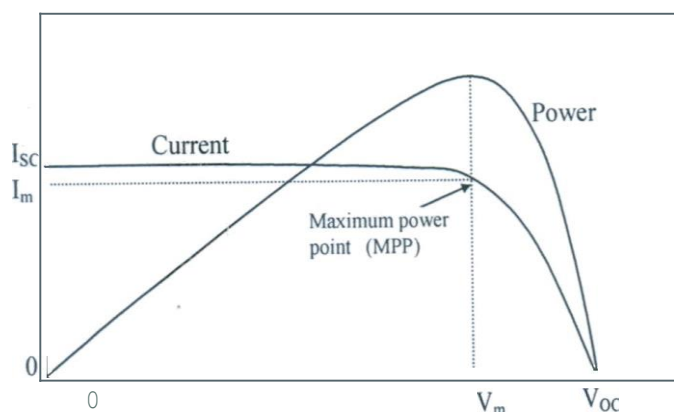
PROCEDURE:

Complete the idealized equivalent circuit of solar cell connections. Then place the light source S at a distance of 15 cm from solar cell. Adjust the potentiometer R_L until you obtain the zero voltage in voltmeter and maximum current in the ammeter (if it shows out of scale then decrease the light intensity). This maximum current is called the short circuit current Isc. Then, with the help of potentiometer increase the voltage in equal steps and note down the corresponding current till you get

maximum voltage in the voltmeter. Now remove all the connections of the circuit and find out the open circuit voltage (Voc) [i.e. connecting +ve of cell to the +ve of voltmeter and –ve of the cell to the -ve of the voltmeter]. Repeat the experiment for other intensities placing the light source at 20 cm and 25 cm, plot the graphs between V and I.

OBSERVATION TABLE:

Voltage (V) (Volts)	Current (I) (mA)	Power (V x I)W

RESULTS: Hence V-I and P-I characteristics of a solar cell are studied.

VIVA QUESTIONS:

1. What is solar cell?
2. What is the other name of solar cell?
3. What is the principle of solar cell?
4. Draw the schematic symbol of solar cell.
5. Define semiconductor.
6. What are the types of semiconductors?
7. Explain extrinsic semiconductor.

8. What are the types of semiconductors?

9. What type of impurities is present in intrinsic semiconductor?

10. What type of impurities is present in extrinsic semiconductor?

11. What is the difference between solar cell and a photodiode?

12. What are the types of semiconductor materials used for solar cell?

13. How can be a PN junction is formed.

14. Define intrinsic semiconductor.

15. What is the meaning of valence and conduction band in semiconductor?

16. How isthe Fermi energy level in a semiconductor defined.

17. Give some practical uses of the solar cell.

18. Define direct band gap semiconductor.

19.What is the depletion region?

20.Define energy gap.

21. What are the units for energy gap?

22. Write the units of Power.

23. When will be a PN junction is said to be forward bias.

24. What is meant by reverse bias of a PN junction?

25. In this experiment, the diode is connected, in which bias.

26. Creation of holes in the valence band leads to.

27. Write a formula to calculate the power.

28 Write the condition for an intrinsic semiconductor.

29. Draw the rough graph of VI- characteristics of solar diode.

30. Draw the rough graph of PI- characteristics of solar diode.

31. What is drift current in solar cell?

32. Define ohms law.

33. How does solar cell produce voltage?

34. What are the characteristics of solar cell?

35. Write the applications of P-N junction diode.

36. Define an electric circuit.

37.What is a diode ?

38. Write the SI and CGS units of charge.

39. What is the semiconductor?

40. On what factors, solar energy depends.

41. What is the difference between solar cell and a photodiode?

42. Write the applications of solar cell.

43. How does changing solar energy with distance.

44. What is the Photon?

45. Explain the relation in between photon and phonon.

46. Write the units of current.

47.What is a solar cell fill factor?

48. Solar cell stored energy in the form of ---.

49. Write the relation in between current and voltage.

50. What is the efficiency of solar cell?

8. ENERGY BAND GAP OF SEMICONDUCTOR

AIM: To determine the energy band gap of a given semiconductor using a diode in reverse bias.

APPARATUS: P-N diode, power supply, voltmeter, microammeter, thermometer and heatingarrangement for the diode.

FORMULA: Energy band gap of semiconductor (E_g) = slope x 2 x 1.38 x 10^{-23} Joule

<div align="center">OR</div>

<div align="center">(E_g) = slope x 1.983 x 10^{-4} eV</div>

$$\left[\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\ln I_s}{1/T} \right]$$

where

I_s is reverse saturation current

T is absolute temperature

MODEL GRAPH:
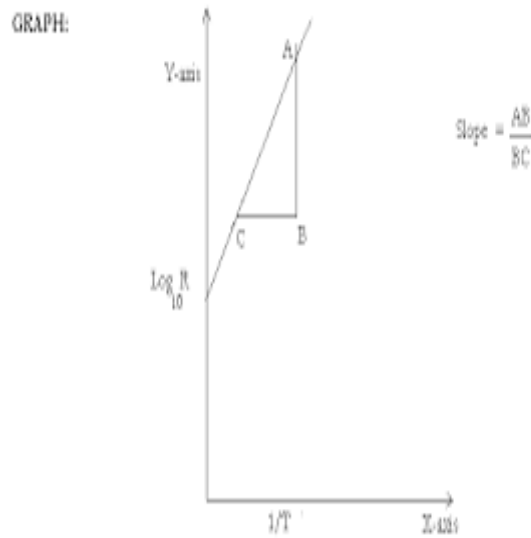
CIRCUIT DIAGRAM:
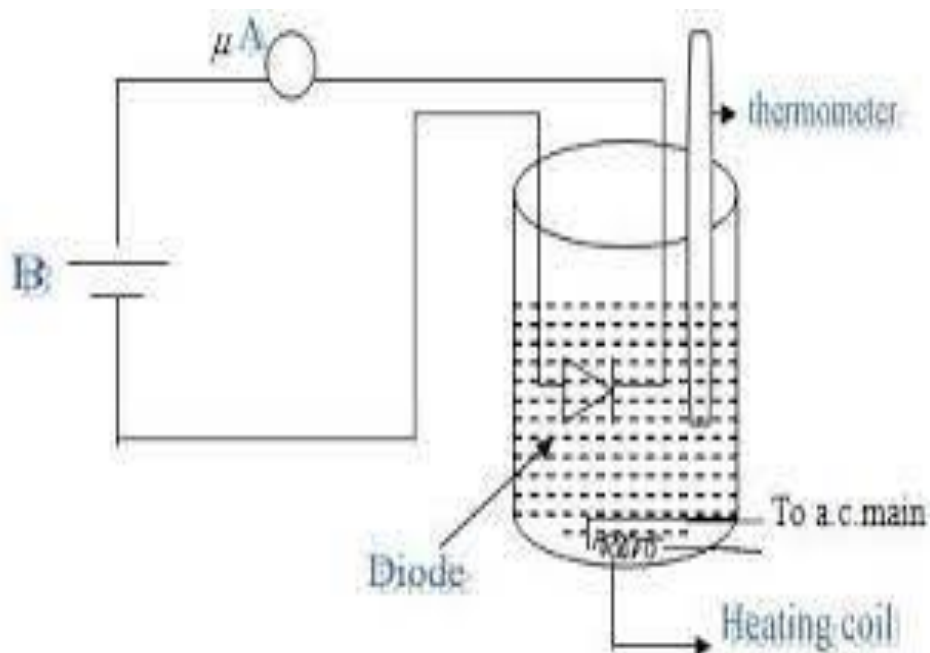
PROCEDURE:

The diode is connected in reverse bias as shown in the circuit diagram.The diode is placed in an oil bath. The temperature of the oil is noted. A constant potentialdifference (say 10 V) is applied and the current $I_s$is noted. The temperature is raised to $80^{\circ}C$ and the corresponding current is noted. The experiment is repeated by decreasing temperature in steps of $10^{\circ}C$ (upto $40^{\circ}C$). A graph is plotted between ($\ln I_s$) and $1/T$ and astraight line graph is obtained with negative slope. We can also plot a graph by taking the numerical values of $\ln I_s$ on Y-axis and on $1/T$ the x-axis. Then we get a straight line graph with positive slope. The slope of the graph is found out. The band gap energy is calculated using formula.

OBSERVATION TABLE:

Temperature		1/T (x 10⁻³)	Reverse bias current (I_s) μA	ln I_s
t^0(C)	T(K)			

RESULT: The energy band gap of a given semiconductor is**eV**.

VIVA QUESTIONS:

1. Define an intrinsic semiconductor.
2. Distinguish between an N-type semiconductor and a P-type semiconductor
3. Explain the formation of P-N junction in a diode.
4. What is the depletion layer in P-N junction?
5. Explain conduction band and valence band in an intrinsic semiconductor.
6. Define energy gap in an intrinsic semiconductor.
7. On what factors energy gap depends.
8. What is forward bias and reverse bias?
9. Explain the formation of covalent bonds in an intrinsic semiconductor.
10. Write the applications of P-N junction diode.
11. Charge is defined as.
12. Write the SI and CGS units of charge.
13. Define time constant.
14. Convert the value of pico-farads into micro farads.
15. What are the units of resistance?
16. What are the units of capacitance?
17. Define an electric circuit.
18. What are series and parallel connections in a circuit?
19. Define ohms law.
20. Write the relation between resistance and specific resistance.
21. State four types of capacitors.

22. Define capacitance and resistance.
23. What is meant by charging a capacitor?
24. What is meant by discharging a capacitor?
25. Write the formula to determine time constant of an RC circuit.
26. Give the symbolic representation of a resistor and capacitor.
27. Write the units of current.
28. Differentiate between charging and discharging modes.
29. Write the equation for energy stored in a capacitor.
30. Define electro motive force.
31. Write the formula for charging of an RC circuit in terms of Voltage.
32. Write the formula for discharging of an RC circuit in terms of Voltage.
33. Explain the semiconductor nature at 0^oC temperature.
34. Explain the semiconductor nature at 0^oC temperature.
35. What is the Hall coefficient for n-type semiconductor?
36. Write the example of n-type n-type semiconductor.
37. Write the Fermi energy formula for p-type semiconductor.
38. What are the best examples of intrinsic semiconductor?
39. What is the insulator?
40. What is the Fermi energy?
41. Explain the Fermi energy level in p-type semiconductor.
42. What are two different types of impurities?
43. Write the relation between the Resistance and temperature.
44. Write the Fermi energy formula for n-type semiconductor.
45. Write the units of temperature.
46. Explain the Fermi energy level in n-type semiconductor with diagram.
47. What is the saturation?
48. Write the relation between the conductivity and temperature.
49. What is doping?
50. Draw the circuit symbols of npn and pnp transistors.
51. Write the Fermi energy formula for intrinsic semiconductor.

9.R-C Circuit

AIM: To study the charging and discharging of voltage in a circuit containing resistance and capacitor and compare the experimental RC time constant with theoretical RC time constant.

APPARATUS: Power supply, Resistors, Electrolyte, capacitors, voltmeter, stop watch, commutator, connecting wires.

Principle:

The charging voltage across the capacitor is given

$$V = V_o (1 - e^{-t/RC})$$

The discharging voltage across the capacitor is given

$$V = -V_o \, e^{-t/RC}$$

Where

t – Time constant

R - Resistance

C - Capacitance

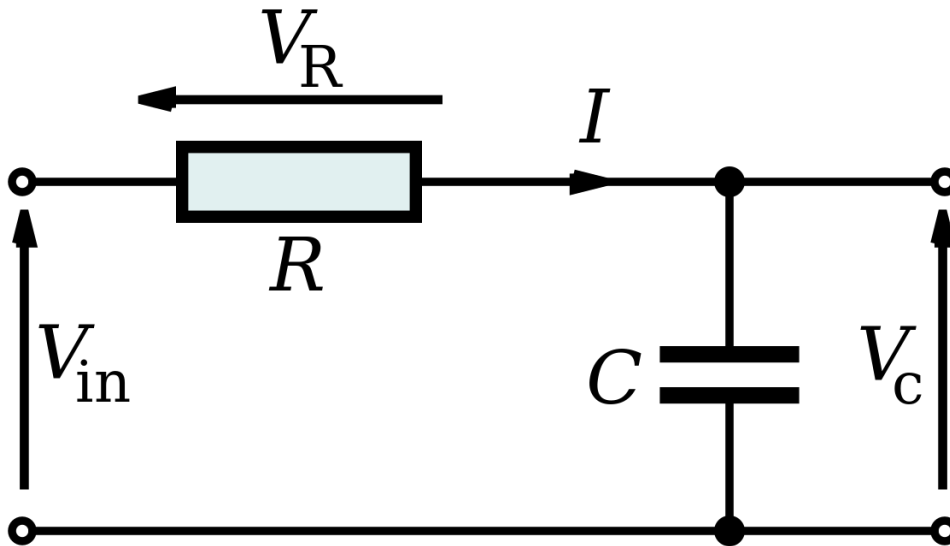Theoretical Time constant of RC circuit **T =RC sec**

CIRCUIT DIAGRAM:

Fig.: Capacitor charging and discharging circuit diagram.

Graph:

Discharging mode

Charging mode

(a)
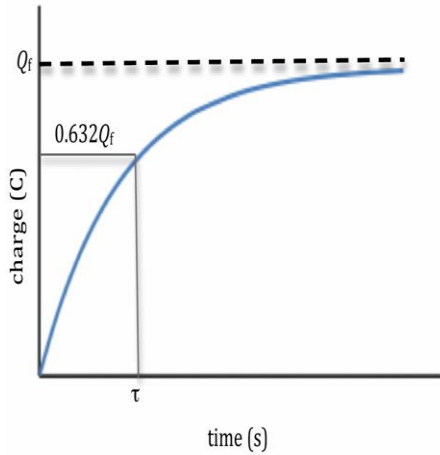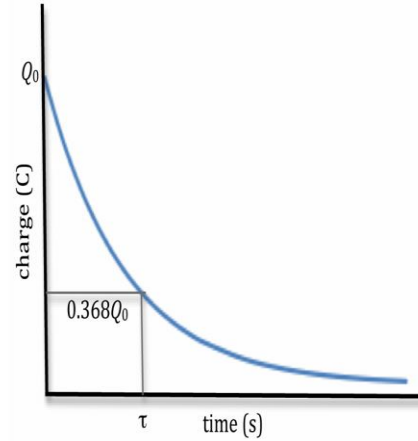
(b)

PROCEDURE:

This circuit is connected as shown in fig, taking one set of R and C values.

Charging:

When the terminal1 is connected to A, the capacitor will change with time. This changing in charge is noted as a voltage across the capacitor with time. The change in charging voltage is noted for every 5sec with help of stop watch and recorded in the observation table. The graph is drawn between time on x-axis and voltage on y-axis. The time constant is calculated from the graph by calculating the time corresponding to 63% value of maximum value and comparing with theoretical value of time constant(RC).

Discharging:

When the terminal1 is connected to B, the charged capacitor will be discharged with time. The decayed voltage across the capacitor is noted with 5sec time interval upto zero voltage. The graph is drawn between the voltage across the capacitor and time on x-axis. The time constant is calculated at 36% of maximum voltage across the capacitor and comparing with theoretical value of time constant (RC).This experiment is repeated with different set of R and C values.

OBSERVATIONS:

R=   C=

Charging mode		Discharging mode	
Time (sec)	Voltage (Volts)	Time (sec)	Voltage (Volts)

APPLICATIONS:

1. When a capacitor is charged by a DC Voltage, the accumulation of charge on its plates is a method of storing energy which may be released at different rates. An example of the energy storage application is the photoflash capacitor used in flashguns of photographic cameras.
2. The charging time and discharging time is calculated for a R.C circuit and is connected to series of decorative bulbs.
3. Capacitors are of two types; a) fixed and b) variable, both of which are used in a wide range of electronic devices. Fixed capacitors are further divided into electrolytic and non-electrolytic.

RESULT:

The theoretical value of time constant is _____ sec.

The experimental value of time constant is _____ sec in charging mode

The experimental value of time constant is _____ sec in discharging mode

VIVA QUESTIONS:

1. Charge is defined as.
2. Write the SI and CGS units of charge.
3. Define time constant.
4. Convert the value of picofarads into micro farads.
5. What are the units of resistance?
6. What are the units of capacitance?
7. Define an electric circuit.
8. What are series and parallel connections in a circuit?
9. Define ohm's law.
10. Write the relation between resistance and specific resistance.
11. State four types of capacitors.
12. Define capacitance and resistance.
13. What is meant by charging a capacitor?
14. What is meant by discharging a capacitor?
15. Write the formula to determine time constant of an RC circuit.
16. Give the symbolic representation of a resistor and capacitor.
17. Write the units of current.
18. Differentiate charging and discharging modes.
19. Write the equation for energy stored in a capacitor.
20. Define electro motive force.
21. Write the formula for charging of an RC circuit in terms of Voltage.
22. Write the formula for discharging of an RC circuit in terms of Voltage.
23. Write the units of current.
24. What does a series circuit specifies?
25. Write the equation for energy stored in a capacitor.
26. Write the difference between capacitor and Resistor.
27. List out types of semiconductors.
28. Classify types of solids based on band gap.
29. What are the types of impurities present in n-type semiconductors?
30. Define energy gap in solids.
31. What is happening in capacitor in the case of charging?
32. Write the relation between the capacitor and voltage.
33. What is happening in capacitor in the case of discharging?
34. Write the applications of RC circuit.
35. As frequency increases in series and parallel, the RC impedance will be---.
36. What is Voltage Divider Rule?
37. Write the importance of capacitor .
38. Write the relation between the frequency and angular frequency.
39. Convert the value of milli farads into micro farads.
40. Write the uses of capacitor.
41. What is Current?

42. Could you measure Voltage in series.

43. Write the relation between the frequency and time.

44. What are the units of voltage?

45. Convert the value of pico farads into milli farads.

46. Write the formula for current in terms of charge.

47. Write the importance of voltage.

48. What are the units of current?

49. Write the relation between the current and voltage.

50. What are advantages of capacitor in series and parallel connections in RC circuit?

10.OPTICAL FIBER

AIM: To determine the Numerical aperture of a given fibre.

APPARATUS: Optical fiber kit, NA jig, Mandrel, optical fiber.

THEORY: Numerical aperture of any optical system is a measure of how much light can be collected by the optical system. It is the product of the refractive index of the incident medium and the sine of the maximum ray angle.

$$NA=n_i. \sin\theta_{max}\quad n_i \text{ for air is } 1$$

$$NA=Sin\theta_{max}$$

For a step index fiber, as in the present case, the numerical aperture is given by

$$N=\sqrt{n_{core}-n_{cladding}}$$

For very small difference in refractive indices the equation reduces to

$$N=n_{core}\sqrt{2\Delta}$$

where Δ is the fractional difference in refractive indices.
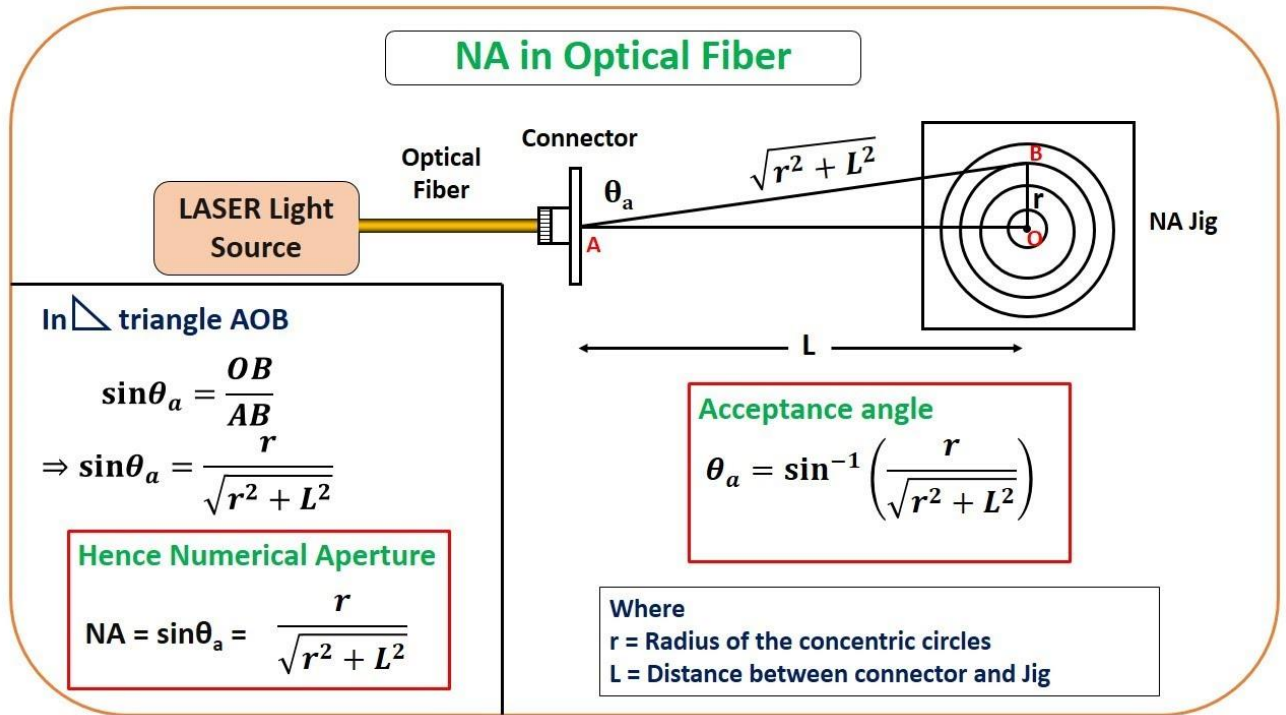
The experiment may refer to the specifications of the PMMA fiber and record the manufacturer's NA ,$n_{cladding}$, and n_{core} and Δ.

$$N.A=\sin\alpha=D/(4L^2+D^2)^{1/2}$$

Where L=perpendicular distance between the fiber end and the screen.

D=diameter of the light falling on the screen.

NA MEASUREMENT SCHEME OF DIAGRAM

NA in Optical Fiber

In $\triangle$ triangle AOB

$$\sin\theta_a = \frac{OB}{AB}$$

$$\Rightarrow \sin\theta_a = \frac{r}{\sqrt{r^2 + L^2}}$$

Hence Numerical Aperture

$$NA = \sin\theta_a = \frac{r}{\sqrt{r^2 + L^2}}$$

Acceptance angle

$$\theta_a = \sin^{-1}\left(\frac{r}{\sqrt{r^2 + L^2}}\right)$$

Where
r = Radius of the concentric circles
L = Distance between connector and Jig

PROCEDURE:-The schematic diagram of the numerical aperture measurement system is shown below and itself explanatory.

The step by step procedure is given below as follows:-

Step 1:-Connect one end of the cable 1 (1-meter FI cable) to FO LED of TNS20A and the other end to the NA jig as shown.

Step2:- Plug the AC mains. Light should appear at the end of the fiber on the NA Jig. Turn the knob clockwise to set to maximum P_0.The light intensity should increase.

Step3:- Hold the white screen with the concentric circles (10,15,20, and 25mm diameter) vertically at a suitable distance to make the red spot from the emitting fibre coincide with the 10mm circlce.

Another method:-

In this method the experiment set up for the N.A Measurement is shown in the above figure.

First of all, one end of the optical fiber is connected to the power output LED. The other end of the fiber is connected to N.A. Jig through the connector.

The A.C main supply is switched on. The light emitted by LED passes through the optical fiber cable to the other end. The set knob is adjusted such that maximum intensity is observed on the screen and it should not be further disturbed.

A screen with concentric circles of known diameter is moved along the length of the NA jig to observe the circular spreading of light intensity on the screen.

The screen is adjusted such that the first circle from the centre of the screen is completely filled with the light. At this position, the distance (L) from the fiber end to the screen is noted on the NA jig. The experiment is repeated of the subsequent circles by adjusting the length L along NA jig and the readings are noted in table. The diameter of the circles may be determined using a travelling microscope.

S.NO	Distance of the screen(L)mm	Diameter of the circle D(mm)	N.A	Θ(degrees)

RESULT: Numerical aperture of the fiber cable is _____

Acceptance angle of the fiber cable is _____

VIVA QUESTIONS:

1. Define Numerical aperture .
2. What are the parts of optical fiber?
3. On what principle does an optical fiber works.
4. What is meant by attenuation in optical fibers?
5. Mention the different types of optical fibers are.
6. Define step index optical fiber .
7. Define graded index optical fiber.
8. What are the types of losses in optical fiber?
9. What is total internal reflection?
10. What is critical angle?
11. Write the formula for Numerical aperature.
12. Define acceptance angle of an optical fiber.
13. Define snells law.

14. Write the formula for Numerical aperature in terms of fractional refractive index change.
15. Write the applications of optical fibers.
16. Write applications of optical fibers in medicine .
17. What is meant by scattering loss?
18. Write the unit for losses in fibers.
19. What is meant by intermodal dispersion?
20. What are the different components of fiber optic communication system?
21. Write the unit for losses in fibers.
22. What is meant by intermodal dispersion?
23. What are the different components of fiber optic communication system?
24. Explain single mode optical fiber.
25. What is the core diameter in multi mode optical fiber?
26. Determine critical angle from Snell's law.
27. List out reasons for attenuation in fibers.
28. Explain scattering losses in optical fibers.
29. Describe absorption losses in optical fibers.
30. What are the two important sections in optical fiber communication system?
31. Photo detector use in optical fiber communication is.
32. Listout two usese of optical fiber in medical field.
33. State dispersion in optical fibers.
34. What is cut off wave length of fiber?
35. Fiber coupler functionality in communication system is.
36. List out advantages of optical fibers.
37. Why do prefer Laser diode over LED's for communication applications.
38. How does refractive index varies in Stepindex fiber?
39. Discuss refractive index variation in Graded index optical fiber.
40. If a optical fiber accepts more than one mode it is called as.
41. Mention the formula for Numerical aperture of a optical fiber.
42. Size of singlemode optical fiber core diameter is.
43. Multimode optical fiber core diameter varies between.
44. Which materials we are using for fabrication of optical fiber.
45. Maximum launching angle is called what?
46. State Intermodel dispersion.
47. Give reason behind $n_2 > n_1$.
48. What are the mechanisms of losses occurs in optical fiber?
49. What is macro bending and micro bending losses?
50. What are the possible noicec occur in optical reciver?

11.Torsional pendulum

AIM : To determine the modulus of rigidity (η) of the material of the given wire using a Torsional pendulum.

APPARATUS: A circular brass disc provided with a chuck and nut at its centre, steel wire, a rigid clamp, stop watch, meter scale, screwguage, and Vernier calipers.

PRINCIPLE:

Rigidity Modulus: $\quad \eta = \dfrac{4\pi MR^2}{a^4}\left(\dfrac{L}{T^2}\right)$ dynes/cm^2

M - Mass of the disc.
R - Radius of the disc.
a - Radius of the wire.
L - Length of the pendulum.
T - Time period.

DESCRIPTION: The Torsional pendulum consist of a uniform circular metal disc of about 8 to 10cm diameter with 1 or 2cm thickness, suspended by a wire at the centre of the disc as shown in figure. The lower end is gripped into another chuck, which is fixed to a wall bracket.
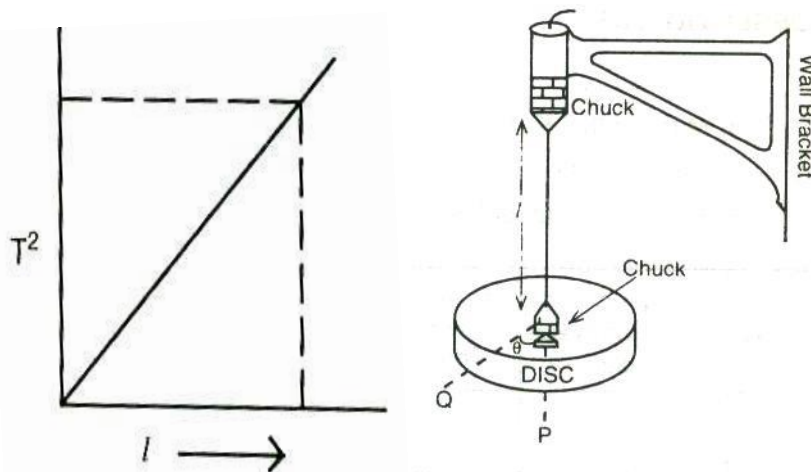
GRAPH:

Figure 1 : Torsional Pendulum

PROCEDURE:

The circular metal disc is suspended as shown in above figure. The length of the wire between the chucks is adjusted to 100cm. when the disc is in equilibrium position; a small mark is made on the curved edge of the disc. This marking will help to note the number of oscillations made by slowly turning the disc through a small angle. Care is to be taken to see that there is no lateral movement of the disc.

When the disc is oscillating the time taken for 20 oscillations is noted with the help of a stopwatch and recorded in the observations table in trail 1. The procedure is repeated for the same length of the wire and again the time taken for 20 oscillations is noted and noted as trail2 in the

observation table. From trail 1 & 2 the mean time for 20 oscillations is obtained. The time period (T), i.e., the time taken for one oscillation is calculated.

The experiment is repeated by decreasing the length of the wire in steps of10cm and the results are tabulated in the table.

By using the Vernier calipers the radius of the disc (R) is calculated, the radius of the wire (a) is calculated by means of screw gauge and the mass of the disc (M) is found by means of rough balance and these values are substituted in the formula. The mean value of $(1/ T^2)$ is calculated from the observations and hence η is determined.

A graph is drawn with 'l' on X-axis and T^2 on Y-axis. It is a straight line graph and the value of $(1/ T^2)$ is calculated and the rigidity modulus of the material of the wire η is calculated .

PRECAUTIONS:
1.The wire should not have any bending.
2. The chuck nuts should be tight because the wire becomes loose and the oscillations may not
   be perfect.
3.The time period between the oscillations must be uniform.

OBSERVATIONS:
To determine the radius of the disc:

Least count of the Vernier calipers= $\dfrac{\text{One Main scale division}}{No. of Vernier scale divisions}$ =

S.No	Main scale reading(a)	Vernier coincidence	Vernier Reading(b=L.C*V.C)	Total Reading(a+b)cm
1 2 3				

To determine the radius of the wire:

Least count of the Screw Gauge = $\dfrac{\text{pitch of the screw}}{No. of Head scale divisions}$ =

Screw Gauge Error -   Correction:

S.No	P.S.R (a)	H.S.C	Correction	H.S.R (b=L.C*H.S.C)	Total (a+b) (mm)
1 2 3					

Mass of the disc (M) =

Radius of the disc (R) =

Radius if the wire (a) =

Time Period of the Pendulum:

S.No	Length of the wire'L' (cm)	Time taken for 20 oscillations			Time for one Oscillation (Timeperiod) $T=\frac{t}{20}$ sec	T^2	$\frac{L}{T^2}$
		trail1	trail2	Average (t) sec			

RESULT : The rigidity modulus of the material of the given steel wire is _____dyne/cm^2

VIVA QUESTIONS:

1.Distinguish between elastic materials and plastic materials.

2. State Hook's law?

3. What is Elastic   limit?

4. Define Young's   modulus.

5. Explain Rigidity modulus

6. What is the   S.I. Unit of Rigidity modulus?

7. On what factors Rigidity modulus depends?

8.   The shape of   l - T^{2}graph in this experiment is _____

9. Define the term time period (T).

10.What is the difference between a   Simple pendulum and Torsional pendulum?

11. Write the formula for bulk modulus?

12. Write the relation between three moduli of elasticity?

13. What is the equation for energy stored in a stretched wire?

14. Define stress.

15. Define strain.

16. What are the different types of Stresses?

17. Define least count.
18. What is Torsional Oscillation?
19. Write two applications of torsional pendulum.
20. Define young's modulus.
21. Explain elasticity.
22. Describe yielding point of material.
23. What is the difference between elastic and plastic materials?
24. Explain the behavior of a material under stress.
25. What are different types of stresses?
26. Describe elastic limit of a material.
27. Write the relation between three moduli.
28. What is the unit for stress?
29. Define moment of inertia.
30. Explain elastic modulus.
31. Define Torque.
32. Write the unit for frequency.
33. Mention the unit for Moment of Inertia.
34. What happens to time period when length was increased.
35. Write the value of rigidity modulus of steel.
36. Instrument used to determine the radius of disc?
38. Which instrument is used to determine the radius of wire.
39. What is the least count of vernier calipers.
40. Write the formula for least count.
41. How many scales are available with vernier calipers?
42. What are errors available with vernier calipers?
43. Write the least count of screw guage?
44. Formula used to estimate rigidity modulus.
45. Define lateral strain.
46. Define longitudinal strain.
47. Write the unit for strain.
48. Draw the curve for elastic behavior of a material?
49. Define Poisson's ratio.
50. Give the example of elatic materials.

12. Stewart and Gees method

AIM: To determine the field of induction at several points on the axis of a circular coil carrying current using Stewart and Gee's type of tangent galvanometer.

APPRATUS: Stewart and Gee's galvanometer, Battery eliminator, Ammeter, Commutator, Rheostat, Plug keys, connecting wires.

PRINCIPLE:

When a current of i-amperes flows through a circular coil of n-turns, each of radius a, the magnetic induction B at any point(P) on the axis of the coil is given by

$$\mathbf{B} = \frac{\mu_0 nia^2}{2(x^2+a^2)^{\frac{3}{2}}} \text{Tesla} _____ \quad 1)$$

Where B is the magnetic induction on the axial line of the coil

$\mu_0 = 4\pi \times 10^{-7}$

n is number of turns in the coil =

i is the current through the coil =

a is the radius of the coil (in cms) =

x is the distance from the centre of the coil(in cms)=

When the coil is placed in the magnetic meridian, the direction of the magnetic field will be perpendicular to the magnetic meridian; i.e., perpendicular to the direction f the horizontal component of the earth's field, say B_e .When the deflection magnetometer is placed at any point on the axis of the coil such that the centre of the magnetic needle lies exactly on the axis of the coil, then the needle is acted upon by two fields B and B_e, which are at right angles to one another. Therefore, the needle deflects obeying the tangent law,

$$B = B_e \tan\theta _____(2)$$

B_e the horizontal component of the earth's field is taken from standard tables. The intensity of the field at any point calculated from equation (2) and verified using equation(1).

PROCEDURE:

With the help of the deflection magnetometer and a chalk, a long line of about one meter is drawn on the working table, to represent the magnetic meridian. Another line perpendicular to this line is also drawn. The Stewart and Gee's galvanometer is set with its coil in the magnetic meridian, as shown in the figure. The external circuit is connected , keeping the ammeter, rheostat away from the deflection magnetometer. This precaution is very much required because, the magnetic field produced by the current passing through the rheostat and the permanent magnetic field due to the magnet inside the ammeter affect the magnetometer reading, if they are close to it.

The magnetometer is set at the centre of the coil and rotated to make the aluminum pointer read (0,0) in the magnetometer. The key, K, is closed and the rheostat is adjusted so as the deflection in the magnetometer is about 60^0. The current in the commutator is reversed and the deflection in the magnetometer is observed. The deflection in the magnetometer before and after reversal of current should not differ much. In case of sufficient difference say above 2^0 or 3^0 , necessary adjustments are to be made.
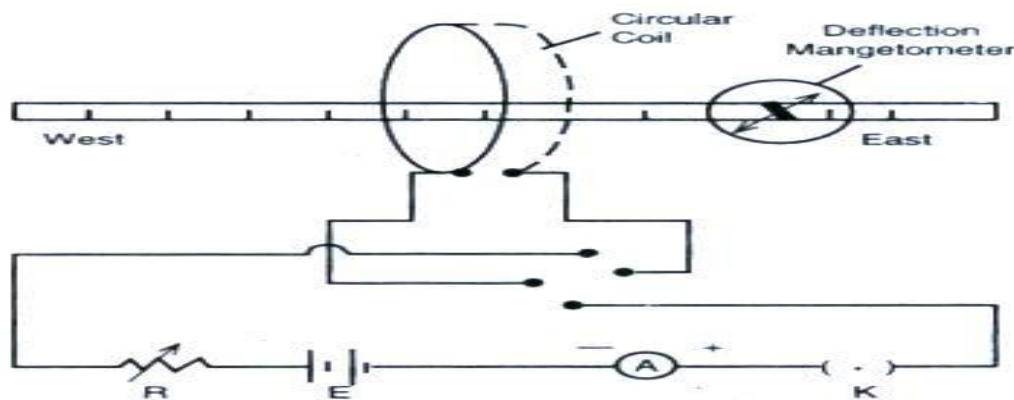
Figure 2 : Arrangement for the measurement of magnetic field along the axis of a current carrying coil

The deflections before and after reversal of current are noted when d = 0. The readings are noted in Table 1. The magnetometer is moved towards East along the axis of the coil in steps of 5 cm at a time. At each position, the key is closed and the deflections before and after reversal of current is noted. The mean deflection be denoted as θ_E. The magnetometer is further moved towards eastin steps of 5cm each time and the deflections before and after reversal of current are noted, until the deflection falls to 30^0.

The experiment is repeated by shifting the magnetometer towards west from the centre of the coil in steps of 5cm, each time and deflections are noted before and after reversal of current. The mean deflection is denoted as θ_W.

It will be found that for each distance (X) the values in the last two columns are found to be equal verifying equation (1) and (2).

A graph is drawn between X on x-axis and the corresponding $\text{Tan}\theta_E$ and $\text{Tan}\theta_W$ along y-axis. The shape of the curve is shown in the figure. The points A and B marked on the curve lie at distance equal to half the radius of the coil (a/2) on either side of the coil.

MODEL GRAPH:
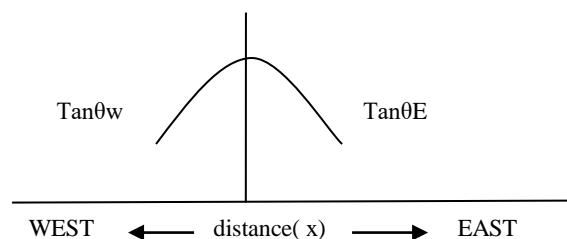
PRECAUTIONS:

1. The ammeter, voltmeter should keep away from the deflection magnetometer because these meters will affect the deflection in magnetometer.

2.The current passing through rheostat will produce magnetic field and magnetic field produced by the permanent magnet inside the ammeter will affect the deflection reading.

OBSERVATIONS:

Current through the coil   i = __1_amps.   Number of the turns n = _10_____

Radius of the coil (in mts) a = __8x10^{-2}m_____ μ_o = ___4π_x10^{-7}_____

B$_e$ = 0.39x10^{-4}

S.No	Distance of deflection magnetometer from centre of the coil(X) in meters	Deflection in the magnetometer East side						Deflection in the magnetometer West side						$\theta=\frac{\theta e+\theta w}{}$	Tan θ	B=B$_e$ tan θ	$B=\frac{\mu_0 nia2}{2(x2+a2)^{3/2}}$
		θ$_1$	θ$_2$	θ$_3$	θ$_4$	Meanθe	Tan θe	θ$_1$	θ$_2$	θ$_3$	θ$_4$	Meanθw	Tan θw				

Sl. No.	Distance from the centre of the coild (meters)	$B = B_E Tan\theta$ (Tesla)	$B = \dfrac{\mu_0 nia^2}{2(x^2 + a^2)^{3/2}}$ (Tesla)	Remarks
1.				
2.				
3.				
4.				

RESULT: The theoretical and calculated values are approximately same.

VIVA VOCE:

1. Define electric field.
2. What is permeability?
3. Define magnetic meridian & magnetic field.
4. What is the use of an ammeter?
5. Define the magnetic field of induction and give its units.
6. State Biot-savarts law.
7. What is deflection magnetometer?
8. What is tangent law?
9. What is the difference between magnetic induction & earth's magnetic field?
10. What is a commutator?
11. What do you observe in this experiment?
12. What is tangent galvanometer?
13. What is the use of tangent galvanometer?
14. What is the value of permeability of free space?
15. Write the equation for Biot-savarts law.
16. Define flux density.
17. What are the units of permeability?
18. Define relative permeability.
19. Purpose of rheostat in the experiment.
20. State ampere law.
21. How to define a magnet.
22. Define dipole moment.
23. Units of Dipole moment.
24. Magnetic moment in magnetic material is due to.
25. Differentiate Soft and Hard magnetic materials.
26. What are ferrites?
27. Compare and contrast between Anti ferro magnetic and Ferri magnetic materials.
28. How many types of magnetic materials are there.
29. Write the relation between permeability and field induction.
30. Explain Magnetic levitation.
31. How does the magnetic field vary along the axis of the coil?
32. Why do you put apparatus (Wooden Frame along with circular coil) in East-West Direction?
33. What is the relation between Gauss and Tesla?
34. Do you feel any application of this experiment.
35. What is the magnetic induction formula at center point ?
36.magnetic flux over a unit area of a surface held normal to the flux is ---.
37. What is the susceptibility for Ferro magnet?
38. The magnetic field of induction decreases on both sides due to.

39. What is the magnetic induction formula at center point ?

40. What are the uses of Hard magnetic materials ?

41. What is the susceptibility for Para magnet ?

42. What will be the Magnetic field value at the center of a current carrying coil?

43. What are the of soft magnetic materials ?

44. Write the relation between susceptibility and temperature.

45. What is the susceptibility for Dia magnet ?

46. Write example of Ferro, Para and Dia magnetic materials.

47. Write the relation between magnetic induction and temparature.

48. Write the relation between susceptibility and magnetic field strength.

49. The magnetic moment of atom due to what.

50. What is the Bhor magneton value ?

51. What is the domain ?