INDEX

DEPARTMENT OF FRESHMAN ENGINEERING

CERTIFICATE

This is to certify that this manual is a Bonafide record of practical work in the **ADVANCED ENGINEERING PHYSICS LABORATORY** in I/II **Semester of I-year B. Tech Program** during the academic year **2025-2026.** This book is prepared by **Team Physics** Department of Freshman Engineering.

Signature of HOD

DEPARTMENT OF FRESHMAN ENGINEERING

PREFACE

This book entitled "ADVANCED ENGINEERING PHYSICS LABORATORY Manual" is intended for the use of First year B.Tech students of Marri Laxman Reddy Institute of Technology and Management, Dundigal, Hyderabad. The main objective of the Advanced 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.The lab 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.

By,

Team physics

DEPARTMENT OF FRESHMAN ENGINEERING

ACKNOWLEDGEMENT

It was really a good experience, working with Advanced Engineering Physics laboratory**.** At first, we would like to thank Dr. K. Ashok, Assoc. Professor, HOD, Department of Freshman Engineering, Marri Laxman Reddy Institute of technology & Management for his concern and valuable technical support in preparing the document.

We express our deep sense of gratitude and sincere thanks to Dr. Ravi Prasad, Dean of Academics, Marri Laxman Reddy Institute of Technology & Management, for his constant support, encouragement, and valuable guidance. His esteemed patronage and unwavering motivation provided us with the opportunity to prepare this Advanced Engineering Physics Laboratory Manual.

We sincerely thank Dr. R. Murali Prasad, Principal, Marri Laxman Reddy Institute of Technology & Management, for his valuable guidance and timely improvements.

At last, but not the least I would like to thanks the entire Freshman Department faculty those who had inspired and helped us to achieve our goal.

By

Team physics

DEPARTMENT OF FRESHMAN ENGINEERING

GENERAL INSTRUCTIONS

1. Students are instructed to come to Advanced Engineering 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. The equipment's and other accessories used in Advanced Engineering Physics lab should be handled with care and responsibility.

7. Any damage to the equipment's 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 lab records 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 faculty member concerned in written format.

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

DEPARTMENT OF FRESHMAN ENGINEERING

SAFETY MEASURES

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

2. Always follow the experimental instructions strictly.

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

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

5. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.

DEPARTMENT OF FRESHMAN ENGINEERING

VISION & MISSION OF THE INSTITUTE

Vision of the Institute:

To be a globally recognized institution that fosters innovation, excellence, and leadership in education, research, and technology development, empowering students to create sustainable solutions for the advancement of society.

Mission of the Institute:

To foster a transformative learning environment that empowers students to excel in engineering, innovation, and leadership.

To produce skilled, ethical, and socially responsible engineers who contribute to sustainable technological advancements and address global challenges.

To shape future leaders through cutting-edge research, industry collaboration, and community engagement.

VISION & MISSION OF THE DEPARTMENT

Vision of the Department:

To empower the students to be technologically adept, innovative, self-motivated and responsible global citizen possessing human values and contribute significantly towards high quality technical education with ever changing world.

Mission of the Department:

DM1:To offer high-quality education in the computing fields by providing an environment where the knowledge is gained and applied to participate in research, for both students and faculty.

DM2:To develop the problem solving skills in the students to be ready to deal with cutting edge technologies of the industry.

DM3:To make the students and faculty excel in their professional fields by inculcating the communication skills, leadership skills, team building skills with the organization of various co-curricular and extra-curricular programmes.

DM4:To provide the students with theoretical and applied knowledge, and adopt an education approach that promotes lifelong learning and ethical growth.

Program Educational Objectives (PEOs)

PEO 1	**Professional Excellence** Analyze, design, build, maintain, or improve civil engineering-based systems, considering environmental, economic, and societal requirements.
PEO 2	**Multidisciplinary Approach** Develop a strong educational foundation to design and conduct experiments, meeting needs within multidisciplinary constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, while analyzing and interpreting data.
PEO 3	**Continued Self-Learning** Identify, formulate, and solve engineering problems, and engage in lifelong learning in advanced areas of civil engineering and related fields.
PEO 4	**Effective Contribution to Society** Utilize modern engineering techniques, skills, and tools necessary for civil engineering practice, serving the community as ethical and responsible professionals.

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NAAC with 'A' Grade & Recognized Under Section 2(f) & 12(B) of the UGC act,1956

ACADEMIC CALENDAR 2025 - 26

2025 - B.Tech. I & II Semesters (MLRS-R24)

I Semester

SNo.	Description	Period From	Period To	Duration
1	Induction Program	11.08.2025	16.08.2025	1 Week
2	Commencement of Class work	18.08.2025		
3	1st Spell of instructions	18.08.2025	27.09.2025	6 Weeks
4	**Dussehra Recess**	29.09.2025	04.10.2025	1 Week
5	1st Spell of instructions (Contd.)	06.10.2025	18.10.2025	2 Weeks
6	First Mid Term Examinations	20.10.2025	25.10.2025	1 Week
7	Parent-Teacher Meeting	01.11.2025		
8	2nd Spell of instructions	27.10.2025	13.12.2025	7 Weeks
9	Second Mid Term Examinations	15.12.2025	20.12.2025	1 Week
10	Semester End Examinations/Supply	22.12.2025	03.01.2026	2 Weeks
11	Practical End Examinations	05.01.2026	10.01.2026	1 Week
12	**Sankranthi Recess**	12.01.2026	17.01.2026	1 Week

II Semester

SNo.	Description	Period From	Period To	Duration
1	Commencement of Class work	19.01.2026		
2	1st Spell of instructions	19.01.2026	14.03.2026	8 Weeks
3	First Mid Term Examinations	16.03.2026	21.03.2026	1 Week
4	2nd Spell of instructions	23.03.2026	09.05.2026	7 Weeks
5	Last date of instructions	09.05.2026		
6	**Summer Vacation/Internship**	11.05.2026	06.06.2026	4 Weeks
7	Second Mid Term Examinations	08.06.2026	13.06.2026	1 Week
8	Semester End Examinations/Supply	15.06.2026	27.06.2026	2 Weeks
9	Practical End Examinations	29.06.2026	04.07.2026	1 Week

***Commencement of III Semester class work: 06.07.2026**

Dr.B.Ravi Prasad
Dean Academics

Bhushan Kundeti
Controller of Examinations

Dr.R.Murali Prasad
Principal

Dr.P.Sridhar
Director

Department of Freshman Engineering

Course: I B. TECH I SEM A.Y: 2025-2026 W.e.f: 25-08-2025

Advanced Engineering Physics Laboratory (25100071)

Day	10:35 AM To 11:30AM	11:30AM To 12:25PM	12:25PM To 01:20PM	02:10PM To 03:5 PM	03:05PM To 04:00 PM
Monday	ECE-B& EEE		LUNCH	CSD-A	
Tuesday	Civil/Mech			CSM-B	
Wednesday	CSM-A			CSD-C	
Thursday	ECE-A			CSD-B	
Friday	CSM-C				
Saturday					

ADVANCED ENGINEERING PHYSICS LABORATORY

1	Department	CSE							
2	Course Name	ADVANCED ENGINEERING PHYSICS LABORATORY							
3	Course Code	2510071							
4	Year/Semester	I/II							
5	Regulation	MLRS-BT25							
6	Structure of the course	Theory				Practical			
		Lecture	Tutorials	Practical	Credit	L	T	P	C
		0	0	0	0	0	0	3	1.5
7	Type of course	BS	HS	ES	PC	PE	OE	PS	MC
		✓	×	×	×	×	×	×	×

8	Course Offered	Odd Semester	X	Even Semester		✓
9	Total lecture, tutorial and practical hours for this course Offered (16 weeks of teaching per semester)					
	Lectures: 0 Hours	Tutorials: 0 hours		Practical: 48 hours		
10	Course Coordinator	✓				
11	Date Approved by BOS	15.07.2024				
12	Course Webpage	www.mlritm.ac.in/				
13	Prerequisites/ Co-requisites	Level	Course Code	Semester	Prerequisites	
		-	-	-	Basic principles of physics	

14. Course Overview:

The aim of the course is to provide hands on experience for experiments in different areas of physics. This laboratory includes experiments involving, electrical, electromagnetism and optoelectronics. This course enhances student knowledge to apply the various physical concepts in current technology.

15. Course Objectives:

The objectives of this course for the student to

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

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.

3. Apply the analytical techniques & graphical analysis for Stewart Gees, LCR & RC.

4. Understanding the method of least squares fitting.

5. Develop intellectual communication skills through discussion on basic principles of scientific concepts in a group.

16. Course Outcomes:

After successful completion of the course, students should be able to:

CO1	Know the determination of the Planck's constant using Photo electric effect and identify the material whether it is n-type or p-type by Hall experiment.
CO2	Appreciate quantum physics in semiconductor devices and optoelectronics.
CO3	Synthesis of magnetic (Fe 3 O 4) nanoparticles using sol-gel method
CO4	Analyse the variation of magnetic field induction produced at various points along the axis of current carrying coil.
CO5	Carried out the data of different experiments and analysing them by plotting the graphs.

17. Employability Skills:

Example: Technical skills / Project based skills / collaboration skills
Advanced Engineering Physics lab improves the student technical skills to understand current technology. By doing the various experiments as a team, students can gain lot of collaborative skills to perform a technical project and writing a scientific draft.

18. Content Delivery / Instructional Methodologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	✓	Open Ended Experiments
x	Competitions	x	Hackathons	x	Certifications	✓	Probing Further Questions

19. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for Continuous Internal Evaluation (CIE) and 60 marks for semester end lab examination. Out of 40 marks for internal evaluation:

- A write-up on day-to-day experiment (aim, components/procedure, expected outcome) which shall be evaluated for 10 marks
- 10 marks for viva-voce/ tutorial/ case study/ application/ poster presentation.
- Internal practical examination shall be evaluated for 10 marks.
- The remaining 10 marks are for Laboratory Project (Presentation/Design/ Software / Hardware Model/ App Development/ Prototype).

Table 1: CIE marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIE marks	20	10	10	40

Continuous Internal Evaluation (CIE): One CIE exams shall be conducted at the end of the 8^{th} week and 16^{th} week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

Table 2: Experiment/ Programming based marks distribution

Experiment	Record	Viva	Total
5	5	10	20

Semester End Examination:

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

- 12 marks for write-up
- 12 for experiment/program
- 12 for evaluation of results
- 12 marks for presentation on another experiment/program in the same laboratory course and
- 12 marks for viva-voce on concerned laboratory course.

20. Course content:

CO 1	Know the determination of the Planck's constant using Photo electric effect and identify the material whether it is n-type or p-type by Hall experiment.
	1. Determine the hall coefficient of given semiconductor 2. Calculate the work function of given photoelectric material and calculate the Planck's constant.
CO 2	Appreciate quantum physics in semiconductor devices and optoelectronics.
	1.Study the V-I characteristics of LASER and LED. 2. Understand the importance of renewable energy sources using solar cell experiments. 3. Analyse the working of P-N junction, Zener diode and BJT in various mode of operations.
CO 3	Synthesis of magnetic (Fe 3 O 4) nanoparticles using sol-gel method
CO 4	Analyse the variation of magnetic field induction produced at various points

	along the axis of current carrying coil.
	1.Understand the concept of electromagnetism and magnetic field variation at different points.
CO 5	Carried out the data of different experiments and analysing them by plotting the graphs.
	1. Calculate the Energy gap of a semiconductor. **2.** Determination of Acceptance Angle and Numerical Aperture of an optical fiber. **3.** Understanding the method of least squares – Torsional pendulum as an example.

21. Course Plan:

The course plan is meant as a guideline. Probably there may be changes.

S. No	Topics to be covered	CO's	Reference
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	--	--
2	Determination of work function and Planck's constant using photoelectric effect.	CO1	R1:9.1,9.2
3	Determination of Hall co-efficient and carrier concentration of a given semiconductor.	CO1	R1:9.4,9.5
4	Energy Band Gap	CO1	R1:8.6,8.7
5	Sol - Gel Method	CO3	R1:11.8
6	B-H Curve	CO4	R1:11.9
7	Continuous Internal Evaluation –I		
8	Determination of magnetic field induction along the axis of a current carrying coil.	CO2	R1:11.12
9	Dielectric Constant	CO2	
10	Solar Cell	CO5	R1:12.9
11	Laser and Grating	CO5	R1:16.1

12	Determination of Acceptance Angle, Numerical Aperture and optical Fiber Losses.	CO5	R1:16.1,16.2
13	Continuous Internal Evaluation –II		
14	Revision	CO5	R1:12.3,12.4

1. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers,2017.

22. Experiments for Enhanced Learning:

S. No	Current Technology
1	Solar cell
2	BH Curve
3	LASER's

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering. specialization to the solution of complex engineering problems.
PO 2: Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.
PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4: Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
PO 8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO 10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies iii) critical thinking in the broadest context of technological change.
Program Specific Outcomes
PSO 1: Applications of Computing: Ability to use knowledge in various domains to provide solution to new ideas and innovations.
PSO 2: Programming Skills: Identify required data structures, design suitable algorithms, develop and maintain software for real world problems.
PSO 3: Entrepreneur and higher studies: Make use of computational and experimental tools for creating innovative career paths, to be an entrepreneur

and desire for higher studies.

24. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering. specialization to the solution of complex engineering problems.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PO2	**Problem analysis:** Identify, formulate, research literature, and analyse engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PO7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PO11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.	2	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation

25. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PSO1	Applications of Computing: Ability to use knowledge in various domains to provide solution to new ideas and innovations. Key components: 1. Develop innovative Project 2. Problem Identification and Analysis: Accurately identify and analyze specific problem requirements and constraints. 3. Data-Driven Applications: Develop data-centric applications that leverage concepts from algorithms, system software, web design, etc. Data Structure Utilization: Employ appropriate data structures to represent and manipulate data effectively.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PSO2	Programming Skills: Identify required data structures, design suitable algorithms, develop and maintain software for real world problems. Key components: 1. Identify Data Structure 2. Design Algorithms 3. Implementation of projects using programming skill. 4. Secure Software Development: Create robust software systems that are resistant to vulnerabilities and attacks. Information Retrieval System Design: Design and implement efficient information retrieval systems tailored to specific application needs.	4	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation
PSO3	Entrepreneur and higher studies: Make use of computational and experimental tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	3	CIE/ SEE/ Viva-Voce/ Day to Day Performance / Project & Presentation

	Key components: 1. Usage of Computational Tools. 2. Computational base for higher studies. 3. Technical Proficiency: Acquire a deep understanding of advanced frameworks, platforms, and technologies relevant to engineering practice and higher education. Entrepreneurial Mindset: Develop the entrepreneurial skills and mindset required to identify and pursue innovative business opportunities		

3 = High; 2 = Medium; 1 = Low

26. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	**PSOs**												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	✓	✓				✓	✓				✓			✓
CO2	✓	✓				✓	✓				✓			✓
CO3	✓	✓					✓				✓			✓
CO4	✓	✓				✓	✓				✓			✓
CO5	✓	✓				✓	✓				✓			✓

27. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

Course Outcomes	PO'S/ PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies

CO1	PO1	**Understand** the band formation of solids, types of semiconductors, **Mathematical** representation of Hall effect and **integrate** the various diodes working .	3
	PO2	**Explain** the given problem statement and **formulate** quantum confinement problems related to particle enclosed in small dimension from the provided **information** and data in reaching substantial conclusions by the **interpretation** of results.	6
	PO6	**Knowledge** and understanding of commercial and economic context, **promote** sustainable development, **awareness** on legal requirements, safety off structure and health	2
	PO7	**Professional** and ethical principles, **evaluate** ethical dimensions of professional practice and demonstrates ethical behavior	2
	PO11	Professional certification, Utilization of current methods/advanced techniques, Knowledge on industry trends/ new technology	3
CO2	PO1	**Understand** the band formation of solids, types of semiconductors, **Mathematical** representation of Hall effect and **integrate** the various diodes working	3
	PO2	**Information** and **data** collection about semiconductors, **interpret** the characteristics of diode and transistor.	6
	PO6	**Knowledge** and understanding of commercial and economic context, **promote** sustainable development, **awareness** on legal requirements, safety off structure and health	2
	PO7	**Professional** and ethical principles, **evaluate** ethical dimensions of professional practice and demonstrates ethical behavior	3
	PO11	Professional certification, Utilization of current methods/advanced techniques, Knowledge on industry trends/ new technology	3
CO3	PO1	**Utilize** electrons and protons motion in atoms/molecules	3

		to **determine** dipole moment of materials in terms of dielectric constant having specific energy storage and **engineering** applications.	
	PO2	**Data** collection about magnetic materials and **implementation** of magnetic materials in **engineering** aspects.	6
	PO7	**Professional** and ethical principles, **evaluate** ethical dimensions of professional practice and demonstrates ethical behaviour	2
	PO11	Professional certification, Utilization of current methods/advanced techniques, Knowledge on industry trends/ new technology	3
CO4	PO1	**Illustrate** the different principal factors affecting particle size, **calculate** their surface to volume ratio and use those expressions to **integrate** with other engineering disciplines.	3
	PO2	**Explain** the given problem statement and **formulate** fabrication, characterization of nanomaterials provided **information** and **data** in reaching substantial **conclusions** by the **usage** of nanomaterials in different fields.	6
	PO6	**Knowledge** and understanding of commercial and economic context, **promote** sustainable development, **awareness** on legal requirements, safety off structure and health	2
	PO7	**Professional** and ethical principles, **evaluate** ethical dimensions of professional practice and demonstrates ethical behavior	2
	PO11	Professional certification, Utilization of current methods/advanced techniques, Knowledge on industry trends/ new technology	3
CO5	PO1	**Compare** the concepts of laser and fiber optics, mechanisms and **working principle** for applications in different fields of **engineering** and **scientific** practices.	3
	PO2	**Explain** different components involved in laser	6

		system/optical fibers by using the basic **information**.	
	PO6	**Knowledge** and understanding of commercial and economic context, **promote** sustainable development, **awareness** on legal requirements, safety off structure and health	2
	PO7	**Professional** and ethical principles, **evaluate** ethical dimensions of professional practice and demonstrates ethical behavior	2
	PO11	Professional certification, Utilization of current methods/advanced techniques, Knowledge on industry trends/ new technology	3

28. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

Course Outcomes	PSOs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
	3	8	7	9	4	3	3	2	3	8	3	3	5	3
CO1	3	6				2	2				3			2
CO2	3	6				2	3				3			2
CO3	3	6				0	2				3			2
CO4	3	6				2	2				3			2
CO5	3	6				2	2				3			2

29. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/ PSO):

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	100	75				66	66	-	-	-	100			66
CO2	100	75				66	100	-	-	-	100			66
CO3	100	75				--	66	-	-	-	100			66
CO4	100	75				66	66	-	-	-	100			66
CO5	100	75				66	66	-	-	-	100			66

30. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO’S and PO’S, CO’S and PSO’S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0≤ C≤ 5% – No correlation,

2 - 40 % < C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

Course Outcomes	PROGRAM OUTCOMES													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3				3	3				3			3
CO2	3	3				3	3				3			3
CO3	3	3				0	3				3			3

CO4	3	3				3	3				3			3
CO5	3	3				3	3				3			3
Total	15	15				12	15				15			15
Average	3	3				2.4	3				3			3

31. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE	✓	Laboratory Practices	✓
Certification	--	Viva-Voce / PPT/ Project	✓	Open Ended Experiments	✓

32. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Projects by Experts	✓	Course End Survey (CES)

33. RELEVANCE TO SUSTAINABILITY GOALS:

Advanced Engineering Physics is a basic science lab which enhances the student knowledge about current technology.

	1	NO POVERTY	**No Poverty**: Research and innovation can be a tool for ending global poverty; physics qualifications are instrumental in reducing poverty.
✓	2	GOOD HEALTH AND WELL-BEING	**Good Health and well-being:** Advanced Engineering Physics is extensively used in bioinformatics, medical imaging, and other healthcare applications, supporting advancements in medical research and improving healthcare delivery.
	3	QUALITY EDUCATION	**Quality Education:** We must improve scientific temper to the students. To improve the practical knowledge in a scientific way. Develop Critical and logical thinking in scientific experiment. This can help bridge educational gaps and promote lifelong learning.

	4	AFFORDABLE AND CLEAN ENERGY	**Affordable and clean Energy:** Advanced Engineering Physics is useful in modelling and optimizing energy systems, analysing energy consumption patterns, and promoting the use of renewable energy sources.
	5	DECENT WORK AND ECONOMIC GROWTH	**Decent Work and Economic Growth:** Research and development will contribute to energy efficient LEDs, solar cells, electric vehicle batteries, water desalination, bio diagnostics, advanced materials for durable clothing, aerospace, defence, agriculture, nanotechnology, additive manufacturing as well as health and medicine.
	6	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry Innovation and Infrastructure:** Advanced Engineering Physics is widely used for data analysis, allowing researchers to analyse large datasets related to health, education, and infrastructure. This can lead to better decision-making and resource allocation.
	7	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities**: Nano design electronic devices leads to lower costs, less energy usage for sustainable cities and communities.
✓	8	PARTNERSHIPS FOR THE GOALS	**Partnerships For the Goals**: Physics will help meet the Affordable and Clean Energy goal through the development of new materials for renewable energy, by being more energy efficient in the chemical processing industries, and by advancing cleaner fuel technologies.

Signature of Course Coordinator **HOD**

Mrs.V.Krishna veni

Assistant Professor

25X0071: ADVANCED ENGINEERING PHYSICS LAB

(Civil, EEE, Mech, ECE, CSE, CSM & CSD)

I Year B.Tech. I/II SEM	**L T P C**
Pre-requisites:10+2 Physics	**0 0 2 1**

Course Objectives: The student will try to

1. Capable of handling instruments related to the Hall effect Experiment and their measurements.
2. Understand the characteristics of various devices such as solar cell, lasers and optical fiber.
3. Apply the analytical techniques & graphical analysis for Stewart Gees, B-H curve.
4. Synthesize and study the physical properties of materials like semiconductors ferromagnetic and ferroelectric substances.
5. Develop intellectual communication skills through discussion on basic principles of scientific concepts in a group.

Course outcomes: After successful completion of the course, students should be able to

CO1: Demonstrate the Planck's constant using Photo electric effect and Apply the Hall effect and band gap measurement techniques to examine semiconductor properties.

CO2: Determine key electrical, magnetic and optical properties of semiconductors and other functional materials.

CO3: Describe the steps involved in the Synthesis of magnetic nanomaterials using chemical methods.

CO4: Compare the variation of magnetic and electric field and the behaviors of hysteresis curve. Interpret data analysis.

CO5: Demonstrate working of laser systems, optical fiber and solar cell parameters through experimental study.

List of Experiments: (Any 8 experiments are to be performed)

1. Determination of work function and Planck's constant using photo electric effect
2. Determination of Hall coefficient and carrier concentration of a given semiconductor
3. Determination of energy gap of a semiconductor
4. Synthesis of magnetic (Fe_3O_4) nanoparticles using sol-gel method.
5. Study of B-H curve of a ferromagnetic material
6. Determination of magnetic field induction along the axis of a current carrying coil.
7. Determination of dielectric constant of a given material.
8. Study of V-I and P-I characteristics of solar cell.
9. Determination of wavelength of a laser using diffraction grating and to study of V-I & L-I characteristics of a given laser diode
10. Determination of numerical aperture of a given optical fibre and to determination of bending losses of a given optical fibre.

Open Ended Experiments: (Any 2 experiments are to be performed)

1. To calculate the concentration of charge carriers in the sample using Hall effect -NITK, Surathkal Virtual Lab.
2. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss - IIT Kanpur Virtual Lab.
3. To calculate the beam divergence and spot size of the given laser beam - Amritha Viswa Vidya Peetham Virtual Lab
4. To study various crystals structures - Amritha Viswa Vidya Peetham Virtual Lab

References / E-sources:

1. Kittel, Charles, and Paul McEuen. Introduction to solid state physics. John Wiley & Sons, 2018. https://ph1-nitk.vlabs.ac.in/exp/hall-effect/references.html.
2. Kasap S O., Principles of Electronic Materials and Devices, 3rd Ed, Mcgraw Hill, 2006). https://bop2-iitk.vlabs.ac.in/exp/hysteresis-loss/references.html.
3. Koechner, Walter. Solid-State Laser Engineering. Berlin: Springer, 2006. https://lo-amrt.vlabs.ac.in/exp/laser-beam-divergence/references.html.
4. Pillai, SO. Solid State Physics, City: New Age Publications (Academic), India, 2005.

DEPARTMENT OF FRESHMAN ENGINEERING

ADVANCED ENGINEERING PHYSICS LABORATORY
Virtual lab details

Name of the Virtual Lab: Advanced Engineering Physics

Virtual Lab Host Institute: NITK

URL/Link to Lab: https://ph1-nitk.vlabs.ac.in/exp/hall-effect/references.html.

Academic Year:2025-26

Semester:I/II

List of Experiments Available in Virtual Lab

1. Hall Effect

   To calculate the concentration of charge carriers and Hall Coefficient in the sample using Hall effect NITK, Surathkal Virtual Lab.

Name of the Virtual Lab: Advanced Engineering Physics

Virtual Lab Host Institute: IIT Kanpur .

URL/Link to Lab: https://bop2-iitk.vlabs.ac.in/exp/hysteresis-loss/references.html.

Academic Year:2025-26

Semester:I/II

List of Experiments Available in Virtual Lab

2.BH Curve

To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss - IIT Kanpur Virtual Lab.

Name of the Virtual Lab: Advanced Engineering Physics

Virtual Lab Host Institute: Amritha Viswa Vidya Peetham

URL/Link to Lab: https://lo-amrt.vlabs.ac.in/exp/laser-beam-divergence/references.html.

Academic Year:2025-26

Semester:I/II

List of Experiments Available in Virtual Lab

3.Wave length of Laser:

To calculate the beam divergence and spot size of the given laser beam - Amritha Viswa Vidya Peetham Virtual Lab

Name of the Virtual Lab: Advanced Engineering Physics

Virtual Lab Host Institute: Amritha Viswa Vidya Peetham

URL/Link to Lab: https://ssp-amrt.vlabs.ac.in/exp/crystal-structure/references.html.

Academic Year:2025-26

Semester:I/II

List of Experiments Available in Virtual Lab

Crystal structures:

To study various crystals structures - Amritha Viswa Vidya Peetham Virtual Lab

DEPARTMENT OF FRESHMAN ENGINEERING

ADVANCED ENGINEERING PHYSICS LABORATORY

LAB PLANNER

S.No	Experiment	CO	Virtual Lab Availabilty	Date planned	Date conducted
1	Planck's Constant	1	Yes		
2	Hall effect		Yes		
3	Energy band gap		Yes		
4	Sol-Gel		Yes		
5	B-H Curve				
6	MID-I				
7	Stewart Gees experiment				
8	Dielectric Constant				
9	Solar Cell				
10	Laser and Grating				
11	NA and Losses				
14	MID-II				

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

LAB PLANNER

Subject: AEP LAB **Branch: CSM B**

S.NO	Roll Number	Name of Student	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W
			LAB 1 (MG 112)					LAB 2 (MG 111)			
1	257Y1A6665	ADUSUMALLI SAI VENKAT KUSHAL	LAB INTRODUCTION	1	2	3	SOL-GEL METHOD	4	5	6	
2	257Y1A6666	AKULA SRINIVAS		2	3	1		5	6	4	
3	257Y1A6667	ALUBILLI SRI VIDYA		3	1	2		6	5	4	
4	257Y1A6668	BANDILA BHARATH BABU		1	2	3		4	5	6	
5	257Y1A6669	BAVU ASHWITH YADAV		2	3	1		5	6	4	
6	257Y1A6670	BIRADHAR BHAVANA		3	1	2		6	5	4	
7	257Y1A6671	BOYA PRASHANTH		1	2	3		4	5	6	
8	257Y1A6672	CHADA VAISHNAVI		2	3	1		5	6	4	
9	257Y1A6673	CHANDA SAMYUKTHA		3	1	2		6	5	4	
10	257Y1A6674	CHILUKA PREM KUMAR		1	2	3		4	5	6	
11	257Y1A6675	CHINNAM AKSHARA		2	3	1		5	6	4	
12	257Y1A6676	D AJAY NAIK		3	1	2		6	5	4	
13	257Y1A6677	DANALA DHANA LAKSHMI		1	2	3		4	5	6	
14	257Y1A6678	DANDE VENKATA RAMANA		2	3	1		5	6	4	
15	257Y1A6679	DESHAGONI AKSHITHA		3	1	2		6	5	4	

16	257Y1A6680	DEVULAPALLI HARICHARAN		1	2	3		4	5	6	
17	257Y1A6681	DHEERAVATH NIKHIL		2	3	1		5	6	4	
18	257Y1A6682	E GOPAL		3	1	2		6	5	4	
19	257Y1A6683	ESLAVATH SWARUPA DEVI		1	2	3		4	5	6	
20	257Y1A6684	GANGULA PRAVEEN KUMAR REDDY		2	3	1		5	6	4	
21	257Y1A6685	GATHE BHAVANA		3	1	2		6	4	5	
22	257Y1A6686	GATTU JITHIN		1	2	3		4	5	6	

EXPT.1-Hall co-efficient of a given semiconductor
EXPT. 2- V-I Characteristics of solar cell
EXPT.3- B-H Curve

EXPT4 : V-I characteristics of laser and grating
EXPT5: NA & Bending losses -optical fiber
EXPT6: Dielectric Constant

FACULTY

HOD

DEPARTMENT OF FRESHMAN ENGINEERING

ADVANCED ENGINEERING PHYSICS LABORATORY

RUBRICS USED TO ASSESS LEARNINGS IN LABORATORIES

1. RUBRICS FOR DAY TO DAY EVALUATION

Parameter	Max Marks	Level-1 (Very Poor)	Level-2 (Poor)	Level-3 (Average)	Level-4 (Good)	Level-5 (Excellent)
Observation Book	05	No observations or irrelevant data. (0–1)	Incomplete or incorrect data. (2)	Basic values with some errors. (3)	Mostly correct with good format. (4)	Fully correct, clear, and well-formatted. (5)
Result	05	No result or major errors. (0–1)	Result partially obtained. (2)	Acceptable result with limited error. (3)	Near-correct result and reasonable error. (4)	Accurate result. (5)
Viva-Voce	05	Did not answer any questions. (1)	Answered very few questions. (2)	Answered some questions with help. (3)	Answered most questions correctly. (4)	Answered all questions accurately. (5)
Avg(A)	5	1	2	3	4	5
Record Writing(B)	05	Not submitted. (0-1)	Submitted but mostly incomplete. (2)	Submitted with some missing/wrong parts. (3)	Submitted with minor issues. (4)	Fully complete, correct algorithm & flowchart. (5)
Total(A+B)	10	2	4	6	8	10

DEPARTMENT OF FRESHMAN ENGINEERING

ADVANCED ENGINEERING PHYSICS LABORATORY

2.RUBRICS FOR INTERNAL EVALUATION

Criterion	Max Marks	Level-1 *(Very Poor)*	Level-2 *(Poor)*	Level-3 *(Average)*	Level-4 *(Good)*	Level-5 *(Excellent)*
Design/Tool/Apparatus Selection	4 Marks	Incorrect tool/design and no reasoning. **(0)**	Tool/design selection attempted with unclear logic. **(1)**	Satisfactory selection with partial justification. **(2)**	Correct selection and proper analysis with few errors. **(3)**	Smart selection with accurate, relevant analysis. **(4)**
Execution (Code/Debug/Run) /Analysis/Method Used	4 Marks	Did not attempt or completely failed to execute. **(0)**	Attempted but unable to proceed or with major errors. **(1)**	Partial execution with some logic/syntax errors. **(2)**	Mostly correct execution with minimal help. **(3)**	Fully correct and independently executed program. **(4)**
Results& Documentation	2 Marks	Incomplete or poorly presented. **(0)**	Basic structure but lacks clarity or formatting. **(0.5)**	Complete but generic or with formatting issues. **(1)**	Well-structured and mostly clear. **(1.5)**	Well-organized, professional, and engaging documentation. **(2)**
Viva-Voce (Understanding of Concepts)	10 Marks	No understanding; could not answer questions. **(0)**	Answered a few with difficulty. **(4)**	Answered half the questions with basic clarity. **(6)**	Good understanding with confident answers. **(8)**	Answered all questions with clarity and depth. **(10)**
Open Ended Experiment or Virtual lab	10 Marks	Does not understand 0the aim or theory (0)	Very limited understanding; major errors (4)	Major calculation errors (6)	Logical conclusion with explanation (8)	Very neat, well-structured, and complete (10)

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3. RUBRICS FOR SEMESTER END EXAMINATIONS

Criterion	Max Marks	Level-1 (Very Poor (*0–2 marks*)	Level-2 (Poor) *(3–4 marks)*	Level-3 (Average) *(5–6 marks)*	Level-4 (Good) *(7–9 marks)*	Level-5 (Excellent) *(10–12 marks)*
Preparedness for the Experiment	15 marks	No clarity on objective or procedure. Unable to explain basics.	Limited idea of the objective/procedure. Needed prompting.	Has basic understanding; minor gaps in concept or preparation.	Well-prepared, with clear understanding of steps and background.	Fully prepared with strong conceptual clarity and confident explanation.
Performance in the Laboratory	15marks	Unable to perform experiment. Relied entirely on examiner's help.	Performed with multiple errors and constant support.	Performed with some errors; required occasional help.	Performed mostly independently with minimal support.	Performed independently, efficiently, and with precision.
Calculations & Graphs	10 marks	No or incorrect calculations. Graphs missing or irrelevant.	Multiple calculation errors. Graphs/plots inaccurate or poorly labeled.	Calculations partially correct. Graphs present but with some flaws.	Correct calculations and graphs with minor errors.	Accurate calculations and well-labeled graphs with proper interpretation.
Results & Error Analysis	10 marks	No result or invalid result. No error analysis attempted.	Incorrect result with vague or no error discussion.	Acceptable result. Error analysis attempted but limited.	Correct result with sound error discussion.	Accurate result with detailed and relevant error analysis.
Viva-Voce (Subject	10 marks	Unable to answer any	Answered few questions with	Answered half of the	Answered most	Answered all questions

Knowledge)		questions. No conceptual understandin g.	poor logic.	questions with average understanding.	questions with clarity and confidence.	with depth, clarity, and reasoning.

EXPERIMENT 1

PHOTO ELECTRIC EFFECT

AIM

To determine the Work function (φ) of a given material and Planck's constant by using Photo cell.

APPARATUS:

0-10V power supply, digital milliammeter, digital voltmeter, Filters with different colors (Wavelength's), Light Source.

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 typical experimental setup for observing the photoelectric effect is shown in Fig.1.Light falls on target metal plate T as a result electrons are ejected from the surface of the plate. When the ejected electrons reach the collector electrode C placed opposite to T, an electric current, called photocurrent flows through the circuit. This photocurrent can be measured by an ammeter connected to the circuit.

Stopping Potential: The minimum amount of voltage required to stop the photocurrent is known as stopping potential.

Work Function: The minimum amount of energy required to eject the electrons from metal surface is known as work function.

The energy of a photon is given by $E = hf$

where

h---is called Planck's constant

f--- is the frequency of radiation.

When the photons falls on metal surface, an electron can absorb the energy of a photon and acquire enough energy to escape the surface potential barrier.

φ(also called work function).

The maximum kinetic energy with which the electron can eject out,
According to the principle of energy conservation 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:

The Planck's constant measurement unit is shown in Fig.1. 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.

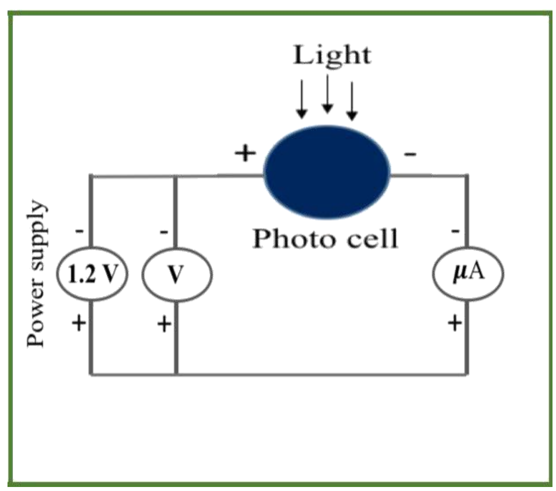


Fig 1: Experimental set up-photo electric effect

PROCEDURE:

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

2. Connect the ammeter positive to Voltmeter Positive. Photo cell positive to Voltmeter negative, Photocell negative to ammeter negative.

3. Connect the mains cord and switch on the power supply and light source. Now you can observe some value of current on ammeter.

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

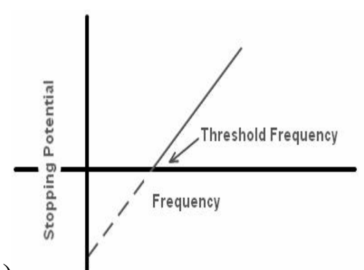
5. If the observed current is too low, then slide the photo vacuum tube towards light source till you get some appreciable current. Fix the photo tube at this distance (position 1).

6. Now Increase the Voltage until the current becomes zero.

7. When the current becomes zero, note the value of applied voltage by DC voltmeter. This is the stopping potential, $V_0$for the given color.

8. 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. Plot a graph of V_0 versus f (Hz)

OBSERVATIONS:

Velocity of light , $c= 3\times10^8 ms^{-1}$.

GRAPH: Variation in stopping potential with frequency.

TABLE: Determination of V_0 as a function of frequency f

S.no	Colours	Frequency (10^{14} Hz)	Wavelength (nm)	Stopping voltage (V)	Work function $\varphi = hf - eV_0$ joules

GRAPH:

Plot a graph of v_0 versus frequency from data in table 1.

The intercept of the graph gives the threshold frequency f_o

Planck's Constant h= $f_o/\ \varphi$ JS(Joules Sec)

CALCULATION:

Value of $e = 1.6\times10^{-19}$C.

Slope of the V_0 -f graph

Frequency f = C/λ

PRECAUTIONS:

1. Fix the incident light source and filter postions exactly with suitable distance
2. Stopping potential shoudbe 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 φ= joules

Plancks constant from the experiment h = jsec

Observations from Virtual Lab (If applicable):

Results from Virtual Lab (If applicable):

Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is Photo electric effect?	CO1	Understand
2	Define threshold frequency.	CO1	Remember
3	What is work function and its significance?	CO1	Remember
4	What are the units for plank's constant?	CO1	Remember
5	What is the visible wavelength range?	CO1	Remember
6	What type of material we can use in the photo cell?	CO1	Remember
7	What are the applications of Photo electric effect?	CO1	Remember
8	Define wavelength.	CO1	Remember
9	Define semiconductor.	CO1	Remember
10	What are the types of semiconductors?	CO1	Remember
11	Explain the type of impurities present in p-type semiconductor.	CO1	Remember
12	What are extrinsic semiconductors?	CO1	Remember
13	Classify solids based on band theory.	CO1	Remember
14	Explain the formation of conduction band and valence band.	CO1	Remember
15	Define Energy gap in solids.	CO1	Remember
16	What are the majority charge carriers in n-type semiconductor?	CO1	Remember
17	Differentiate conductors and semiconductors.	CO1	Remember
18	What are the types of biasing?	CO1	Remember
19	What is the principle of Photoelectric effect?	CO1	Remember
20	What is recombination?	CO1	Remember

Note :Each experiment should contain Minimum 20 Viva Questions

EXPERIMENT 2

HALL EFFECT

AIM:

To determine the Hall co-efficient of a given semiconductor Specimen.

APPARATUS:

Hall effect panel, Hall probe, Electromagnet, Constant current power supply, Digital gauss meter with hall probe, Hall probe stand (wooden).

PRINCIPLE:

When a piece of current carrying semiconductor placed in a transverse magnetic field, It expels the charge carriers to top and bottom surefaces of the material, which leads to generation of Voltage across the material which is perpendicular to both electric and magmetic fields. This generated voltage is known hall voltage. This phenomenon is knowns as Hall effect.

The electric field (E_H) which depends on the cross product of the magnetic intensity, H, and the current density, J .

E_h=RJxH Where R is called the Hall coefficient.

Then the Hall coefficient can be written as

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

B - Magnetic flux density

I - Current through the semi conductor

d - Thickness of the conductor 0.7 mm

V_H - Hall voltage

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.

S.no	Magnetic Field (KG) X10^3	Current I (mA)	Hall voltage V(mV)

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 (VH), 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:

S.NO	Current I (mA)	Magnetic Field (KG) X10^3	Hall Voltage V (mV)

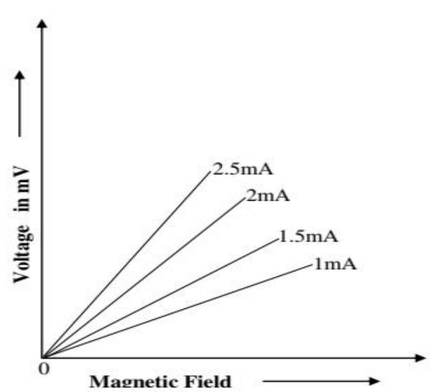


Fig (1) shows the experimental set up consisting of IC Regulated Power Supply of 2 Amps for Magnetic Coils, Constant Current Source of 2mA for Crystal, Gauss Meter, Semiconductor Crystal mounted on PCB, Hall Sensor mounted on PCB Coil arrangement with magnetic coils mounted on the wooden base, handles 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.

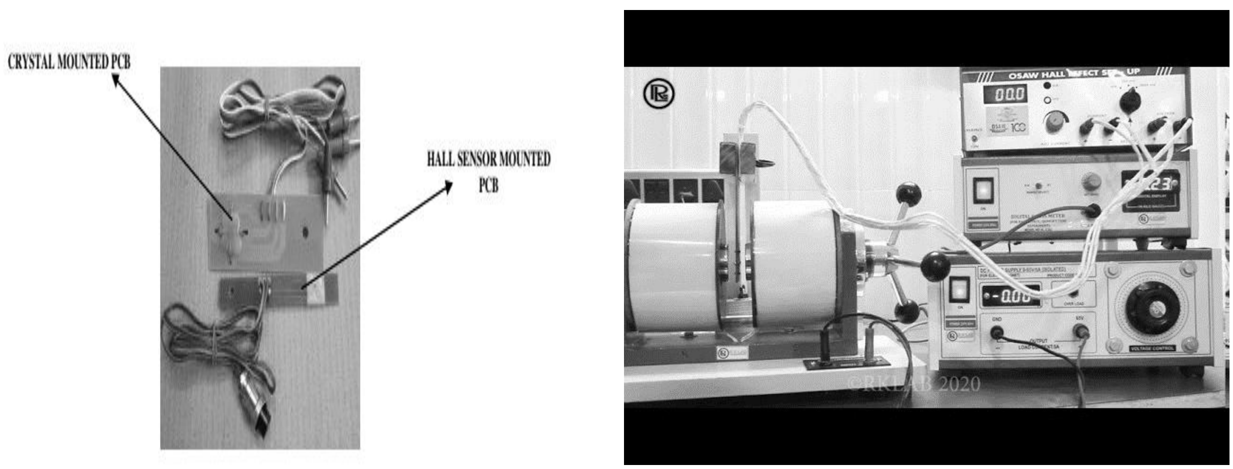
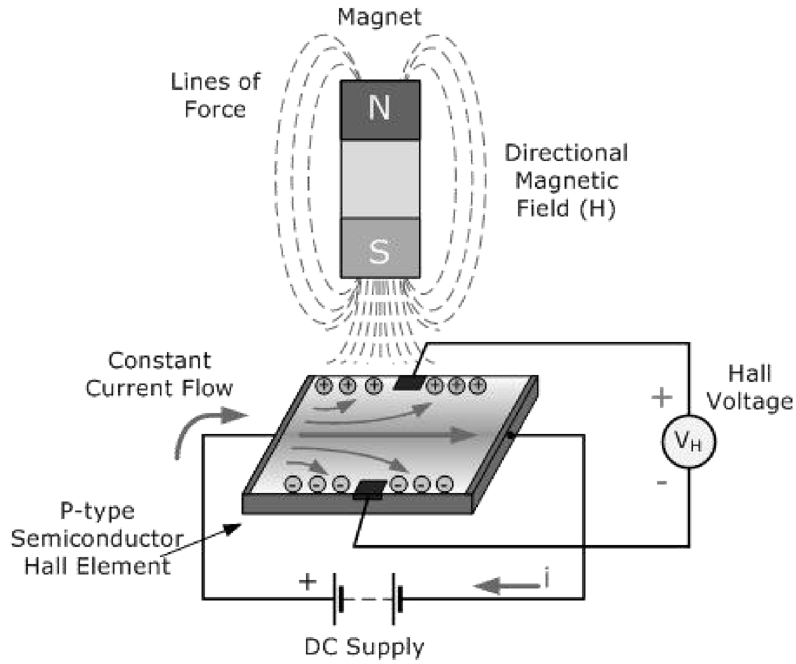


Fig. 1. Hall effect Setup



Result:

Hall coefficient of the given semiconductor is $\mathbf{R_H} =$

Observations from Virtual Lab (If applicable):

Results from Virtual Lab (If applicable):

Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is Hall Coefficient?	CO1	Understand
2	Mention the applications of Hall Effect?	CO1	Remember
3	Define Hall Effect.	CO1	Remember
4	Write the Hall Coefficient equation.	CO1	Remember
5	What is the difference between Electric field and Magnetic field?	CO1	Remember
6	List the different materials used for the Hall Effect	CO1	Remember
7	Define magnetic induction.	CO1	Remember
8	How many types of magnetic materials are there?	CO1	Remember

9	Differentiate between Soft and Hard magnetic materials.	CO1	Remember
10	Define n-type semiconductor.	CO1	Remember
11	Define p-type semiconductor.	CO1	Remember
12	How are solids classified based on band theories?	CO1	Remember
13	What are majority and minority charge carriers in a p-type semiconductor?	CO1	Remember
14	What are majority and minority charge carriers in a n-type semiconductor?	CO1	Remember
15	What is meant by forward biasing?	CO1	Remember
16	What is meant by reverse biasing?	CO1	Remember
17	Explain ohm's law.	CO1	Remember
18	What are the units for current?	CO1	Remember
19	Write the units for Hall coefficient.	CO1	Remember
20	Define magnetic field intensity.	CO1	Remember

Note :Each experiment should contain Minimum 20 Viva Questions

EXPERIMENT 3

ENERGY GAP OF A SEMICONDUCTOR

AIM:

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

APPARATUS:

P-N diode, power supply, microammeter, thermometer and heating arrangement for the diode.

FORMULA:

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

OR

(E_g) = slope x 1.983 x 10^{-4}eV

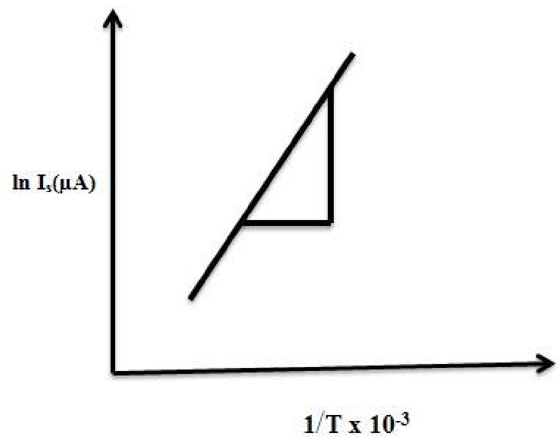
$$\left[\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\ln I_s}{1/T}\right]$$

where

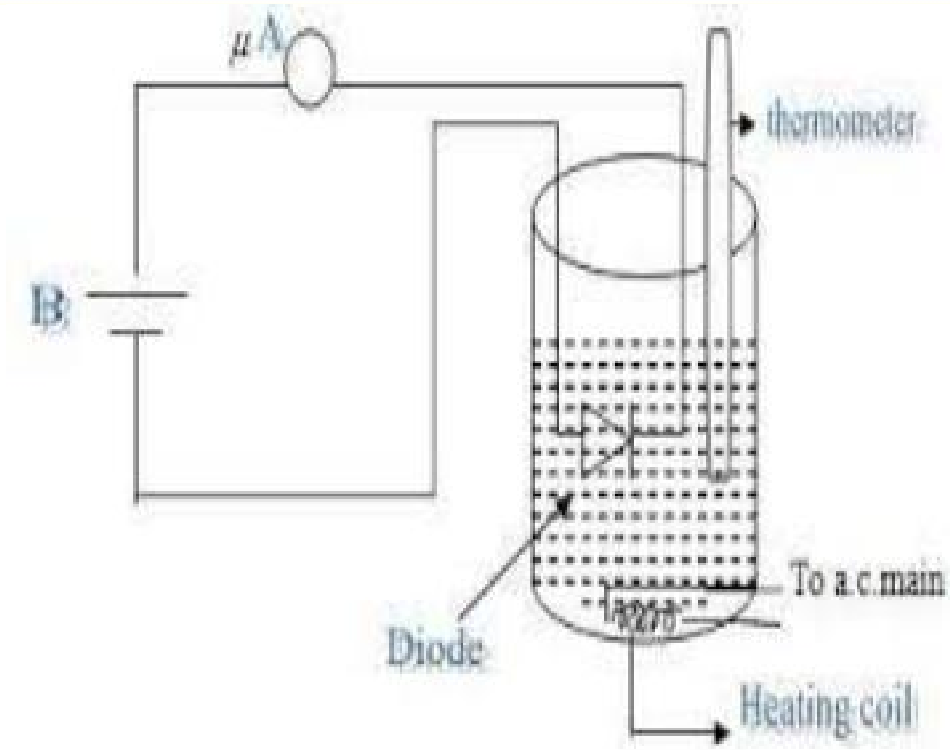
I_s is reverse saturation current

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°C and the corresponding current is noted. The experiment is repeated by decreasing temperature in steps of 5°C (upto 40°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

CALCULATIONS:

S.No	Temperature		1/T (x 10^{-3})(1/K)	Reverse bias current (I_s) μA	ln I_s μA
	t^0(C)	T(K)			

Taking 1/ T along X-axis and lnIs along Y-axis, plot a graph between ln Is and 1/T for three different voltages. The graph will be a straight line as shown in above fig. Determine the slope of straight line from this graph and then calculate band gap using formula,

Band gap (Eg) = slope x 1.983 x 10^{-4} --------eV

PRECAUTIONS:

The following precautions should be taken while performing the experiment:

1. The diode must be reverse biased.
2. Do not exceed the temperature of the oven above 100°C to avoid over heating of the diode.
3. The voltmeter and ammeter reading should initially be at zero mark.
4. Bulb of the thermometer should be inserted well in the oven.
5. Readings of microammeter should be taken when the temperature is decreasing.
6. Readings of current and temperature must be taken simultaneously.

RESULT:

The energy band gap of a given semiconductor E_g = ----------- e V.

Observations from Virtual Lab (If applicable):

Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	Define an intrinsic semiconductor?	CO1	Understand
2	Distinguish between an N-type semiconductor and a P-type semiconductor	CO1	Remember
3	Explain the formation of P-N junction in a diode.	CO1	Remember
4	What is the depletion layer in P-N junction?	CO1	Remember
5	Explain conduction band and valence band in an intrinsic semiconductor.	CO1	Remember
6	Define energy gap in an intrinsic semiconductor.	CO1	Remember
7	What is forward bias and reverse bias?	CO1	Remember
8	Explain the formation of covalent bonds in an intrinsic semiconductor.	CO1	Remember
9	Write the applications of P-N junction diode.	CO1	Remember
10	What are the units of resistance?	CO1	Remember
11	Define an electric circuit.	CO1	Remember
12	Define ohms law.	CO1	Remember
13	Charge is defined as.	CO1	Remember
14	What are majority and minority charge carriers in a n-type semiconductor?	CO1	Remember
15	What is meant by forward biasing?	CO1	Remember
16	What is meant by reverse biasing?	CO1	Remember
17	Explain ohm's law.	CO1	Remember
18	What are the units for current?	CO1	Remember
19	Define an electric circuit.	CO1	Remember
20	On what factors energy gap depends.		

Note :Each experiment should contain Minimum 20 Viva Questions

EXPERIMENT 4

SOL GEL METHOD

Aim: Iron Oxide Nanoparticles Synthesis – (Fe_3O_4) by Co-precipitation Method.

Materials:

Chemicals

All the chemicals were of reagent grade and used without further purification.

- Ferric chloride hexahydrate ($FeCl_3 \cdot 6H_2O$)
- Ferrous chloride ($FeCl_2$ $4H_2O$) or sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$)
- Sodium hydroxide (NaOH) or 25% Ammonium Hydroxide Solution (NH_4OH)
- Deionized water

Glassware and others

- Glass Beakers (100 ml) – 2 no.s
- Round Bottom Flask 250 ml – 1 no.
- Magnetic Stirrer
- Magnets.
- Filter papers

Preparation steps:

Iron Source: Solution of Ferric chloride hexahydrate ($FeCl_3$ $6H_2O$) and ferrous chloride ($FeCl_2$ $4H_2O$) or ferrous sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$) were prepared with molar ratio 2:1.

Sodium hydroxide (1 M, 50 ml) or 25% Ammonium Hydroxide Solution (~ 50 ml) was added drop wise into the iron source under vigorous stirring.

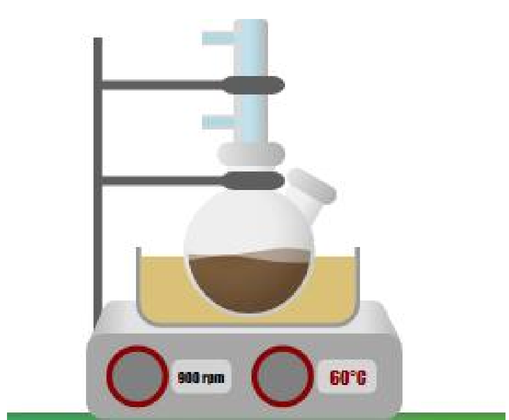
A black precipitate of magnetite (**Fe_3O_4**) was obtained instantly.

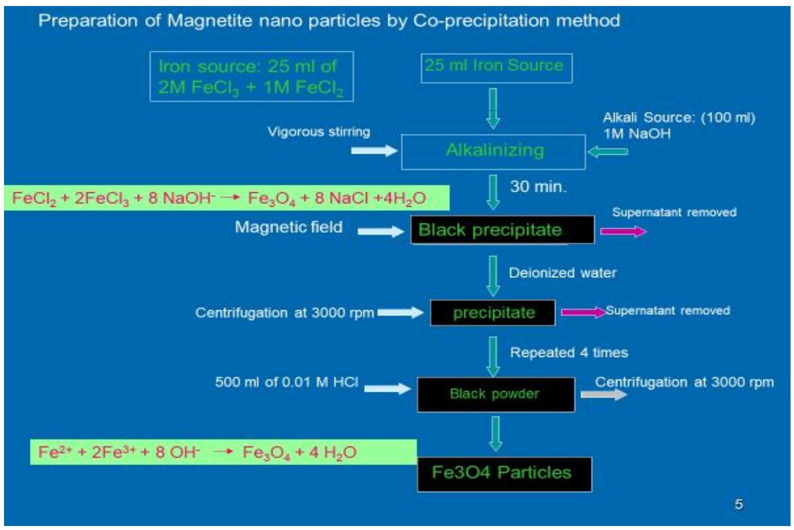
The precipitate was isolated in the magnetic field and the supernatant was removed from the precipitate by decantation.

Deoxygenated distilled water was added to the precipitate and the solution decanted using magnetic field.

After repeating this decanted procedure, filter out the black color powder.

Result: Black color powder indicated the formation of Fe_3O_4 Nanoparticles.





Safety Precautions

Use of Personal Protective Equipment (PPE): Always wear appropriate PPE, including gloves, goggles, and lab coats, to protect against exposure to chemicals and nanoparticles during synthesis.

Ventilation: Conduct the synthesis in a well-ventilated area or under a fume hood to avoid inhalation of any fumes or dust generated during the process.

Chemical Handling: Handle all chemicals, such as iron salts (e.g., FeCl3, FeCl2, FeSO4), with care. Follow Material Safety Data Sheets (MSDS) for information on hazards and safe handling practices.

Waste Disposal: Dispose of chemical waste according to local regulations.

Observations from Virtual Lab (If applicable):
Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is a sol-gel process?	CO1	Understand
2	What are the primary steps involved in the sol-gel method?	CO1	Remember
3	Explain the difference between a sol and a gel.	CO1	Remember
4	What are the advantages of the sol-gel method for preparing nanomaterials?	CO1	Remember
5	Can you explain the hydrolysis and condensation reactions involved in the sol-gel process?	CO1	Remember
6	How does the sol-gel method allow for uniform doping of materials at the molecular level?	CO1	Remember
7	What is the importance of molecular-level mixing in the sol-gel method?	CO1	Remember
8	What are some common applications of materials synthesized via the sol-gel method?	CO1	Remember
9	How can you characterize the final product of a sol-gel process?	CO1	Remember
10	What is a potential problem when synthesizing specific materials and how can it be solved?	CO1	Remember
11	Can the sol-gel method be used to create aerogels or xerogels?	CO1	Remember
12	How is sol prepared?	CO1	Remember
13	What is aerogel?	CO1	Remember
14	What are the applications of sol-gel method?	CO1	Remember
15	What are materials used in sol-gel method?	CO1	Remember
16	How is black precipitate formed?	CO1	Remember
17	Mention the synthesis methods used in nanomaterials.	CO1	Remember
18	What are nanomaterials?	CO1	Remember
19	Give examples of nano materials in 3 dimensions.		
20	What is meant by nano technology?		

EXPERIMENT 5

B-H CURVE

AIM: To draw B-H curve between the magnetizing field (H) and magnetic induction (B) of specimen and to find coercivity (H_c), Remanence (B_r) and Hysteresis loss.

APPARATUS: Deflection magnetometer (DM), A wooden bench with sliding magnetizing coil (Solenoid) and compensating coil, DC power supply, Rheostat, Commutator, Plug key, Iron rod specimen & Ammeter.

PROCEDURE:

1) Remove all magnets/ magnetizing materials from the vicinity.

2) Keep the deflection magnetometer in Tan A position, so that the arms are in the East and West direction. Aluminum pointer is made parallel to the arms of Deflection Magnetometer. Set the Aluminum pointer to read 0-0 and make the circuit connections as shown in the circuit diagram

3) Without placing the specimen rod in solenoid, close the circuit and increase the current gradually up to 3 amps.

4) Place the un magnetized specimen in solenoid and switch on the power supply.

5) Remove two opposite keys in commutator.

6) With minimum current note the readings at two ends of aluminum pointer in DM without parallel error as θ_1 and θ_2.

7) Increase the current by using Rheostat in steps of 0.25 amps till maximum current is reached. At each step note the readings of DM in Tabular column1.

8) Now decrease the current from maximum value in steps of 0.25 amps till it reaches minimum current and note down the readings of DM in Table column 2.

9) Change the positions of keys in commutator so that the direction of current flow gets reversed.

10) Repeat the whole process of increasing and decreasing current and note down the readings in Tabular column 3 & 4.

11) Again, reverse the current by changing the positions of keys in commutator.

12) Now increase the current and note down the readings of DM in Tabular Column 5.

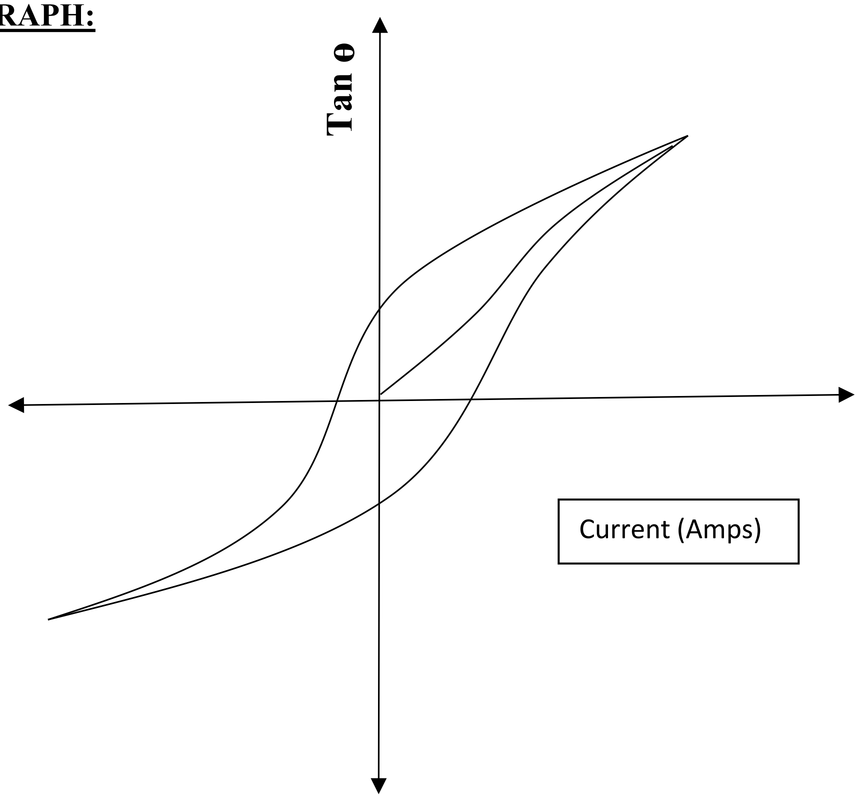
13) The relationship between the Magnetic field (H), magnetization (I) and magnetic Induction (B) is given by $B = \mu_o (H + I)$.

14) Plot the graph Current in amps on X-axis Vs Tanθ on Y-axis.

15) From the graph calculate the following parameters using the formula given below:

i) Coercivity (H_c) = K_2. OA amps/meter.

IDEAL GRAPH:



TABULAR COLUMN 1: FORWARD DIRECTION: INCREASING CURRENT

Sl. No	Current (I) in Amps	Deflection Θ_1	Deflection Θ_2	Mean θ	Tan θ

TABULAR COLUMN 2: FORWARD DIRECTION: DECREASING CURRENT

Sl. No	Current (I) in Amps	Deflection Θ_1	Deflection Θ_2	Mean θ	Tan θ

TABULAR COLUMN 3: REVERSE DIRECTION: INCREASING CURRENT

Sl. No	Current (I) in Amps	Deflection Θ_1	Deflection Θ_2	Mean θ	Tan θ

TABULAR COLUMN 4: REVERSE DIRECTION: DECREASING CURRENT

Sl. No	Current (I) in Amps	Deflection Θ_1	Deflection Θ_2	Mean θ	Tan θ

TABULAR COLUMN 5: FORWARD DIRECTION: INCREASING CURRENT

RESULT:

BH Curve of Ferro magnetic material is studied.

Observations from Virtual Lab (If applicable):

Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is BH Curve	CO1	Understand
2	What are Soft magnetic materials	CO1	Remember
3	What are Hard magnetic materials	CO1	Remember
4	Draw the BH curve	CO1	Remember
5	What are the applications of Ferro magnetic materials	CO1	Remember
6	What is Retentivity?	CO1	Remember
7	What is Coercivity?	CO1	Remember
8	Define Magnetic Induction?	CO1	Remember
9	Define Magnetic flux density?	CO1	Remember
10	What is Magnetic Intensity?	CO1	Remember
11	What are different magnetic material?	CO1	Remember
12	What are the properties of soft Magnetic materials	CO1	Remember
13	What are the properties of Hard Magnetic materials	CO1	Remember
14	What is meant by Hysteresis loss?	CO1	Remember
15	What is the unit of magnetic Induction?	CO1	Remember
16	What is the unit of Relative Permeability?	CO1	Remember
17	What is the magnetic Susceptibility?	CO1	Remember
18	What is the Meant by Tangent Law ?	CO1	Remember
19	Give examples of magnetic materials.		
20	What is meant by magnetic Dipole?		

EXPERIMENT 6

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 and 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

$$\mathbf{B} = \frac{\mu_o n i a^2}{2(x^2+a^2)^{\frac{3}{2}}} \text{Tesla} \_\_\_\_\_\_\_\_ \qquad (1)$$

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

$\mu_o = 4\pi \times 10^{-7}$ Henry/meter

n is number of turns in the coil =

i is the current through the coil =

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

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

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,

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

Where B_e is 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.

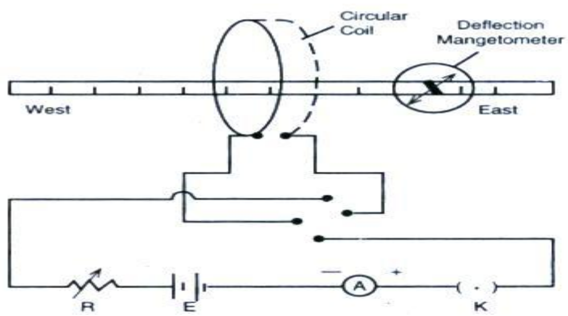


Figure 2 : *Arrangement for the measurement of magnetic field along the axis of a current carrying coil*

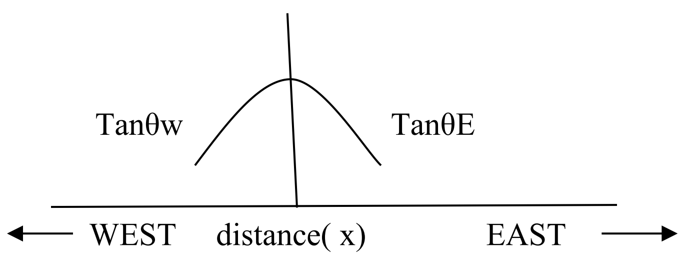
The deflections before and after reversal of current are noted when d = 0. The readings are noted in Table 1. The magnetometer is moved towards East along the axis of the coil in steps of 5 cm at a time. At each position, the key is closed and the deflections before and after reversal of current is noted. The mean deflection be denoted as $\boldsymbol{\theta}_E$. 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 $\boldsymbol{\theta}_W$.

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 Tanθ_E and Tanθ_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= __ amps. Number of the turns in the coil n = _________

Radius of the coil (in m) a = _______ m, μ_o= 4πx10^{-7} Henry/meter

B_e = 0.39x10^{-4} Tesla

Table 1 :

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						$\theta = \frac{\theta_e + \theta_w}{2}$	Tanθ	B = $B_e$tanθ	$B = \frac{\mu_o n i a^2}{2(x^2+a^2)^{\frac{3}{2}}}$
		θ_1	θ_2	θ_3	θ_4	Meanθe	Tanθe	θ_1	θ_2	θ_3	θ_4	Meanθw	Tanθw				

TABLE 2 :

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

RESULT: Magnetic field induction at several points have been determined with the help the circular current carrying coil and it is observed that the experimental and theoretical values are approximately same.

Observations from Virtual Lab (If applicable):
Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	Define electric field.	CO1	Understand
2	What is permeability?	CO1	Remember
3	Define magnetic meridian & magnetic field.	CO1	Remember
4	What is the use of an ammeter?	CO1	Remember
5	Define the magnetic field of induction and give its units.	CO1	Remember
6	State Biot-savarts law.	CO1	Remember
7	What is deflection magnetometer?	CO1	Remember
8	What is tangent law?	CO1	Remember
9	What is the difference between magnetic induction & earth's magnetic field?	CO1	Remember
10	What is a commutator?	CO1	Remember

11	What do you observe in this experiment?	CO1	Remember
12	What are the properties of soft Magnetic materials	CO1	Remember
13	What are the properties of Hard Magnetic materials	CO1	Remember
14	What is meant by Hysteresis loss?	CO1	Remember
15	What is tangent galvanometer?	CO1	Remember
16	What is the unit of Relative Permeability?	CO1	Remember
17	What is the magnetic Susceptibility?	CO1	Remember
18	What is the Meant by Tangent Law ?	CO1	Remember
19	Give examples of magnetic materials.	CO1	Remember
20	Explain Magnetic levitation.	CO1	Remember

EXPERIMENT 7

DIELECTRIC CONSTANT

AIM: To find the Dielectric constant of solids.

APPARATUS:

The experiment set consists of:

1. Parallel Plate Capacitors (Brass discs) 2no's-large, 2no's-small

2. Capacitance meter

3. Dielectric materials: Plane glass, Tinted glass, Plywood & PZT

THEORY:

DIELECTRIC CONSTANT

The dielectric constant is the ratio of the permittivity of a substance to the permittivity of free space. It is an expression of the extent to which a material concentrates electric flux, and is the electrical equivalent of relative magnetic permeability.

As the dielectric constant increases, the electric flux density increases, if all other factors remain unchanged. This enables objects of a given size, such as sets of metal plates, to hold their electric charge for long periods of time, and/or to hold large quantities of charge. Materials with high dielectric constants are useful in the manufacture of high-value capacitors.

A high dielectric constant, in and of itself, is not necessarily desirable. Generally, substances with high dielectric constants break down more easily when subjected to intense electric fields, than do materials with low dielectric constants. For example, dry air has a low dielectric constant, but it makes an excellent dielectric material for capacitors used in high-power radio-frequency (RF) transmitters. Even if air does undergo dielectric breakdown (a condition in which the dielectric suddenly begins to conduct (current), the breakdown is not permanent. When the excessive electric field is removed, air returns to its normal dielectric state. Solid dielectric substances such as polyethylene or glass, however, can sustain permanent damage.

DIELECTRIC MATERIAL

A dielectric material is a substance that is a poor conductor of electricity, but an efficient supporter of field's. If the flow of current between opposite electric charge poles is kept to a minimum while the electrostatic lines of flux are not impeded or interrupted, an electrostatic field can store energy. This property is useful in capacitors especially at radio frequencies. Dielectric materials are also used in the construction of radio-frequency transmission lines. In practice, most dielectric materials are solid. Examples include porcelain (ceramic), mica, glass, plastics, and the oxides of various metals. Some liquids and gases can serve as good dielectric materials. Dry air is an excellent dielectric, and is used in variable capacitors and some types of transmission lines. Distilled water is a fair dielectric. A vacuum is an exceptionally efficient dielectric.

An important property of a dielectric is its ability to support an electrostatic field while dissipating minimal energy in the form of heat. The lower the *dielectric loss* (the proportion of energy lost as heat), the more effective is a dielectric material. Another consideration is the *dielectric constant*, the extent to which a substance concentrates the electrostatic lines of flux. Substances with a low dielectric constant include a perfect vacuum, dry air, and most pure, dry gases such as helium and nitrogen. Materials with moderate dielectric constants include ceramics, distilled water, paper, mica, polyethylene, and glass. Metal oxides, in general, have high dielectric constants.

The prime asset of high-dielectric-constant substances, such as aluminum oxide, is the fact that they make possible the manufacture of high-value capacitors with small physical volume. But these materials are generally not able to withstand electrostatic fields as intense as low dielectric constant substances such as air. If the voltage across a dielectric material becomes too great that is, if the electrostatic field becomes too intense the material will suddenly begin to conduct current. This phenomenon is called *dielectric breakdown*. In components that use gases or liquids as the dielectric medium, this condition reverses itself if the voltage decreases below the critical point. But in components containing solid dielectrics, dielectric breakdown usually results in permanent damage.

Various substances have dielectric constants ε_r greater than 1. These substances are generally called dielectric materials, or simply dielectrics. Commonly used dielectrics include glass, paper, mica, various ceramics, polyethylene, and certain metal oxides. Dielectrics are used in capacitors and transmission lines in alternating current (AC), audio frequency (AF), and radio frequency (RF) applications.

PARALLEL PLATE CAPACITOR:

The most common capacitor consists of two parallel plates. The capacitance of a parallel plate capacitor depends on the area of the plates *A* and their separation *d*. According to Gauss's law, the electric field between the two plates is:

$$E = \frac{Q}{\varepsilon_0 A} \quad \Rightarrow \quad Ed = V = \frac{Qd}{\varepsilon_0 A}$$

Since the capacitance is defined by one can see that capacitance is:

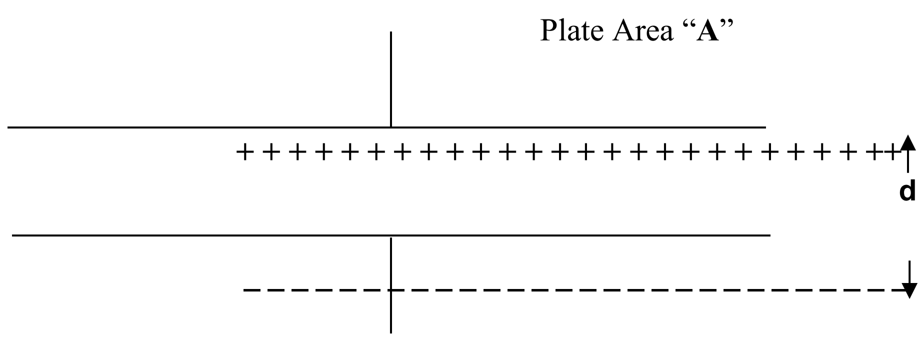
$$C = \frac{\varepsilon_0 A}{d}$$

$$C = \frac{\varepsilon A}{d} = \frac{\kappa \varepsilon_0 A}{d}$$

Thus you get the most capacitance when the plates are large and close together. A large capacitance means that the capacitor stores a large amount of charge.

If a dielectric material is inserted between the plates, the microscopic dipole moments of the material will shield the charges on the plates and alter the relation. Materials have a permeability e which is given by the relative permeability k, e=ke$_0$. The capacitance is thus given by:

All materials have a relative permeability, k greater than unity, so the capacitance can be increased by inserting a dielectric. Sometimes is referred to as the dielectric constant of the material. The electric field causes some fraction of the dipoles in the material to orient themselves along the E-field as opposed to the usual random orientation. This effectively, appears as if negative charge is lined up against the positive plate, and the positive charge against the negative plate as shown in the fig(1).



The capacitance of the flat, parallel metallic plates of area "A" separation "d" is given by the expression above.

Where

$\varepsilon_0 = 8.854 \times 10^{-12}$ Farads/meter is permittivity of space

K= Relative permittivity of the dielectric material between the parallel plates (Dielectric constant)

K=1 for free space, K>1 for all media & approximately 1 for air.

PROCEDURE:

1. Place the dielectric material say glass in between the brass discs.

2. Measure the capacitance across the parallel plate capacitors with the help of capacitance meter provided.

3. Calculate the dielectric constant of that particular material using the formula given below in the calculation.

4. Repeat the steps 1 to 3 for other Dielectric material & calculate their respective Dielectric constant.

5. For PZT use smaller disc set up & repeat the steps 1 to 3.

CALCULATIONS:

$$\text{Capacitance} = \frac{K \times \varepsilon_0 \times \text{Area (A)}}{\text{Separation (d)}}$$

Therefore

$$K = \frac{\text{Capacitance(C)} \times \text{Separation (d)}}{\varepsilon_0 \times \text{Area (A)}}$$

Where

C= Capacitance measured across the parallel plate capacitor with the dielectric material

$\varepsilon_o = 8.854 \times 10^{-12}$ Farads/meter is permittivity of space

K= Dielectric Constant (Relative permittivity of the dielectric material between the parallel plate)

K=1 for free space, K>1 for all media & approximately 1 for air.

d= Thickness of the sample

A= Area of the parallel plate capacitor= πr^2

Radius of the parallel plate capacitor (Large) = 3.75cms

Radius of the parallel plate capacitor (Small) = 1.15cms

Result: The Dielctric constant of a given material = -----------

Observations from Virtual Lab (If applicable):
Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is Dielectric constant?	CO1	Understand
2	What is dielectric?	CO1	Remember
3	What is the difference between dielectric and insulator?		Remember
4	What is a ferro electric material?	CO1	Remember
5	What is meant by loss angle and dielectric loss?	CO1	Remember
6	What are the properties exhibited by a ferro electric material?	CO1	Remember
7	What is curie temperature?	CO1	Remember
8	What is dielectric strength?	CO1	Remember
9	What is dielectric breakdown?	CO1	Remember
10	What are the applications of ferroelectric material	CO1	Remember

11		CO1	Remember
12	What are the properties of Piezo electric materials	CO1	Remember
13	What are the properties of Pyro Magnetic materials	CO1	Remember
14	What is meant by Hysteresis loss?	CO1	Remember
15	What is the use of galvanometer?	CO1	Remember
16	What is the unit of Relative Permittivity?	CO1	Remember
17	What is the Electric Susceptibility?	CO1	Remember
18	What is the Meant by Tangent Law ?	CO1	Remember
19	Give examples of Dielectric materials.	CO1	Remember
20	Explain Electric Susceptibility.	CO1	Remember

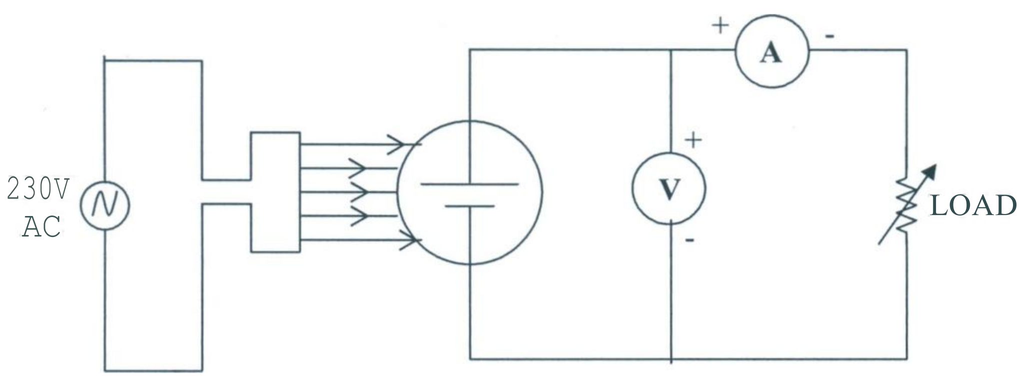
EXPERIMENT 8

SOLAR CELL

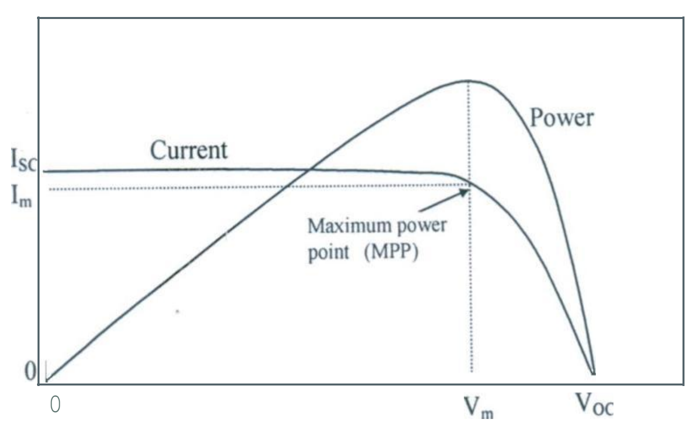
AIM: To Study the V-I and P-I characteristics of a Solar cell.

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:

S.NO	Voltage (V) (V)	Current (I) (mA)	Power (V x I)W

Short circuit current value I_{sc}= --------------

Open Circuit Voltage V_{oc}= ---------------

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

Observations from Virtual Lab (If applicable):
Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is solar cell?	CO1	Understand
2	Mention the other name of solar cell?	CO1	Remember
3	What is the principle of solar cell?	CO1	Remember
4	Draw the schematic symbol of solar cell.	CO1	Remember
5	Define semiconductor.	CO1	Remember
6	What are the types of semiconductors?	CO1	Remember
7	Explain extrinsic semiconductor.	CO1	Remember
8	What are the types of semiconductors?	CO1	Remember
9	What type of impurities is present in intrinsic semiconductor?	CO1	Remember
10	What type of impurities is present in extrinsic semiconductor?	CO1	Remember
11	What is the difference between solar cell and a photodiode?	CO1	Remember
12	What are the types of semiconductor materials used for solar cell?	CO1	Remember
13	How can be a PN junction is formed.	CO1	Remember
14	Define intrinsic semiconductor.	CO1	Remember
15	What is the meaning of valence and conduction band in semiconductor?	CO1	Remember

16	How is the Fermi energy level in a semiconductor defined.	CO1	Remember
17	Give some practical uses of the solar cell.	CO1	Remember
18	Define direct band gap semiconductor.	CO1	Remember
19	What is the depletion region?	CO1	Remember
20	Define energy gap.	CO1	Remember

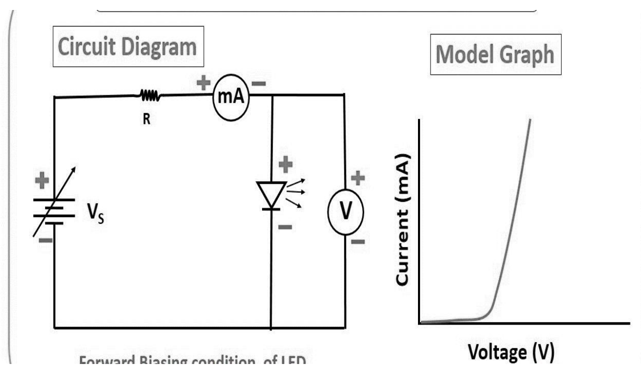
EXPERIMENT 9

V-I CHARACTERISTICS OF LASER & DIFFRACTION GRATING

AIM:

a) To Study the V-I characteristics of Laser.

APPARATUS: Laser trainer kit, digital multimeter.



PROCEDURE FOR V-I CHARACTERISTICS OF A LASER:

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

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

3.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.

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

5.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.

6.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.

7.For P-I values note down the Power values by increasing the I value.

V-I VALUES OF LASER:

S.no	V_L(mv)	I_L(mA)

PRECAUTIONS:

1.Make sure that the volt meter is measuring the voltage across the Laser only.

2.Increase the power supply very slowly until laser just starts to glow.

3.Continosly monitor the current so that it do not exceed the maximum current, with this the damage of the Laser with high current can be avoided.

RESULT:

V-I characteristics of LASER diodes are studied and Verified.

b) DETERMINATION OF THE WAVELENGTH OF LASER SOURCE USING A DIFFRACTION GRATING

AIM:
To determine the wavelength of the laser source using a plane diffraction grating

APPARATUS:
A laser source, a plane diffraction grating, meter scale.

FORMULA: $\lambda = \frac{Sin\theta}{N.n}$

Where λ = Wavelength of laser source of light
θ = Angle of diffraction
N = No. Of lines per cm on the grating = xxx lines/2.54 cm = xxxx lines/cm
n = Order of the spectrum

$$Sin\theta = \frac{Y_n}{\sqrt{(D^2+{Y_n}^2)}}$$

Where, y_n = linear separation of diffraction maxima from the central maxima
D = distance between the grating and the screen

THEORY:

The light emitted by conventional light source such as Na lamp, Hg vapor lamp is incoherent i.e., it spreads out more (or) less uniformly in all directions. But a laser beam is highly intense and directional than that of any ordinary source of light. However, the laser beam diverges slightly due to the diffraction effects. The optical frequencies of the diffraction effect the optical frequencies of lasers are exactly large (1.5 to 100 Hz)

PROCEDURE:

The laser source, whose wavelength is to be determined is mounted horizontally on an optical bench such that light emitted from the laser source is incident normally on the grating. The position of the bench s adjusted, so that a red spot observed on the screen. The central bright red spot corresponds to the central maxima and the other spots correspond to the 1^{st}, 2^{nd} ,3^{rd} …. on either side of central maxima. The grating s placed at a distance (D) from the screen, and then the laser separation 'Y_n' between the central maxima and 1^{st} order maxima on either – sides measured with a scale. The experiment is changing the distance between the grating and screen. For different values and in each case the linear separation is noted.

The Sine of the angle of the diffraction θ is calculated by using formula $\text{Sin}\theta = \frac{Y_n}{\sqrt{(D^2+Y_n{}^2)}}$

Finally the wavelength of given laser source is calculated by using the formula

$$\lambda = \frac{Sin\theta}{N.n}$$

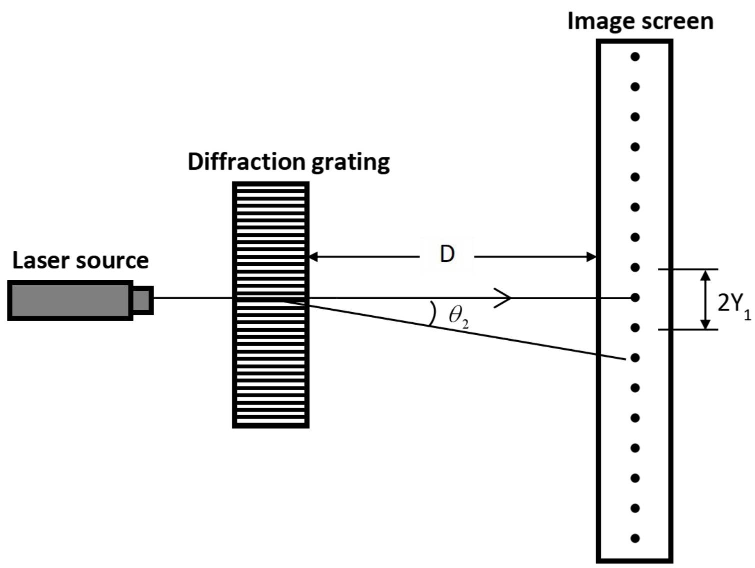
Where, N = No. of lines per cm on the grating

n = Order of the spectrum

PRECAUTIONS:

1. Laser light source should be switched off after taking observations
2. The grating should be placed on the optical bench, so the incident light emitted b the laser should be incident normally on it.
3. The grating and the screen should be at same light.

4. The separation between the central maxima and first, second, third order maxima should be measured accurately.



S.No	Distance b/w grating and screen (D) cm	Order of the spectrum (n)	Linear separation		Mean $y_n = \frac{(a+b)}{2}$	$\sin\theta = \frac{Y_n}{\sqrt{(D^2+Y_n^2)}}$	$\lambda = \frac{\sin\theta}{N.n}$
			Left (a) cm	Right (b) cm			

Result:

a) VI characteristics of Laser studied.

b) The wavelength of given Laser source is = -----------.

Observations from Virtual Lab (If applicable):
Results from Virtual Lab (If applicable):
Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	What is n-type semiconductors?	CO1	Understand
2	What is p-type semiconductors?	CO1	Remember
3	Define conduction and valence band in a semiconductor?	CO1	Remember
4	What are Laser materials and give some examples.	CO1	Remember
5	What is the basic mechanism of Laser?	CO1	Remember
6	What are the input and output energies of Laser?	CO1	Remember
7	What are the majority charge carriers in a p-type semiconductor?	CO1	Remember
8	What are the majority charge carriers in a n-type semiconductor?	CO1	Remember
9	What are different types of lasers?	CO1	Remember
10	What is laser? Explain?	CO1	Remember
11	What is the difference between laser and conventional light?	CO1	Remember
12	What is stimulated emission?	CO1	Remember
13	Write the characteristics of laser.	CO1	Remember
14	What are the applications of laser in industry, research?	CO1	Remember
15	What are the different types of semiconductors?	CO1	Remember

16	How is a PN junction formed?	CO1	Remember
17	Explain ohm's law.	CO1	Remember
18	What are the units for current?	CO1	Remember
19	Define an electric circuit.	CO1	Remember
20	Give an example of a solid state laser.	CO1	Remember

EXPERIMENT 10

BENDING LOSSES AND NUMERICAL APERTURE OF AN OPTICAL FIBER

a)AIM :

To determine the Numerical aperture (NA) and acceptance angle (θ_a) of a given optical fibre.

APPARATUS :

LED source, NA jig and optical fiber.

THEORY :

Numerical aperture of an optical fiber is a measure of how much light can be collected by the optical fiber. It is the product of refractive index of the incident medium and the Sine of the Θ_a.

$$NA = n_i . \sin\theta_a, \; n_i \text{ for air is } 1$$

$$NA = \sin\theta_a$$

$\theta_a = \sin^{-1}$ (NA)

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

$$NA = \sqrt{\frac{n_1^2 - n_2^2}{n_0}}$$

Where, n_1 = refractive index of core

n_2 = refractive index of cladding

n_0 = refractive index of the medium where optical fiber is installed

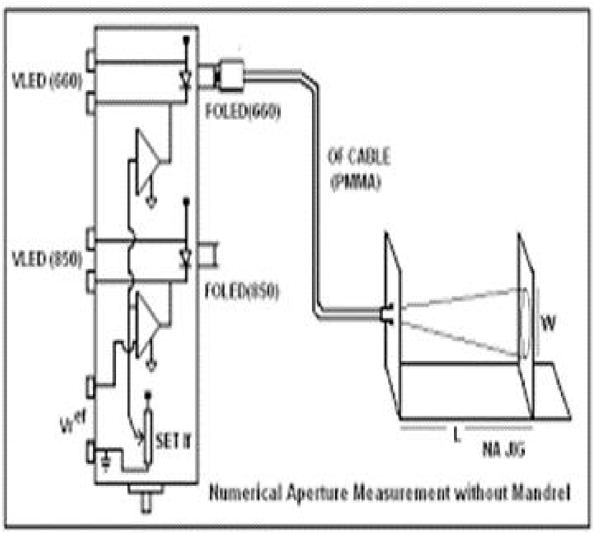
EXPERIMENTAL FORMULA : $NA = \frac{W}{\sqrt{4L^2 + W^2}}$

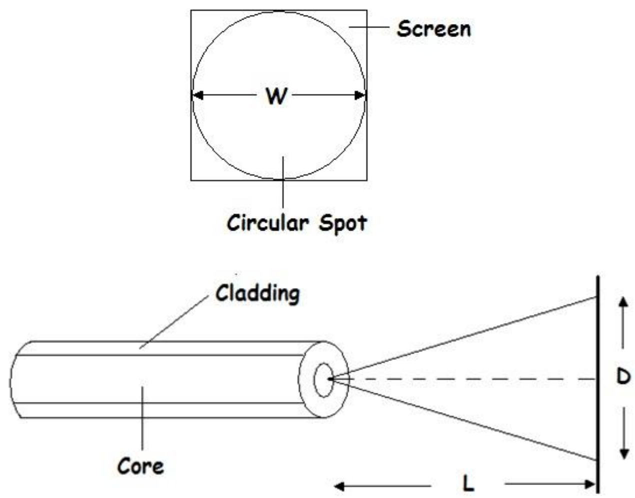
$$\theta_a = Sin^{-1}(NA)$$

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

W = diameter of the light falling on the screen.

NA MEASUREMENT SCHEME OF DIAGRAM :





PROCEDURE :

The schematic diagram of the numerical aperture measurement system is shown above and itself explanatory.

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

Step1:-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 25 mm diameter) vertically at a suitable distance to make the red spot from the emitting fibre coincide with the 10 mm circle.

ANOTHER METHOD :

In this method the experiment set up for the NA 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 NA 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.

TABLE :

S.NO	Distance of the screen (L) mm	Diameter of the circle (W) mm	NA	Θ_a degrees

RESULT: Numerical aperture of the fiber cable NA ___________

Acceptance angle of the fiber cable is Θ_a ____________

b) BENDING LOSSES OF OPTICAL FIBRE

AIM: To determine the bending losses in optical fiber due to the macro bending and also to determine the transmission losses.

APPARATUS: Optical fiber trainer module, optical fiber cables of different lengths, mandrel.

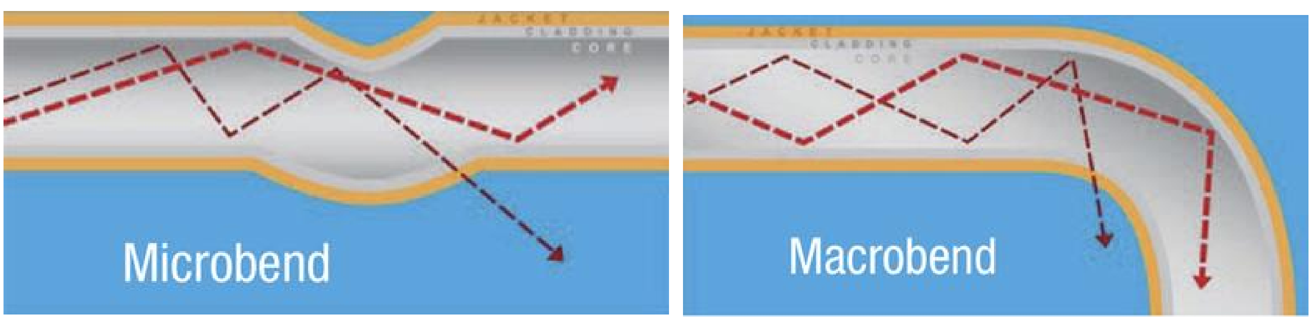
THEORY: The transmission loss or attenuation of an optical fiber is perhaps the most important characteristics of the fiber. Attenuation results primarily from absorption and scattering of light. Attenuation also results from a number of effects like, fiber joints, Improper cleaving and also splicing due to axial displacement and mismatch of core diameters of fibers. But here, we study the attenuation due to macro bending and transmission losses in fibers.

Loss of optical power = -$10/L \log P_0/p_f$ dB/m

Where P_0 power launched in to the fiber

P_f = power reached at the end of fiber.

L = Length of the given optical fiber.



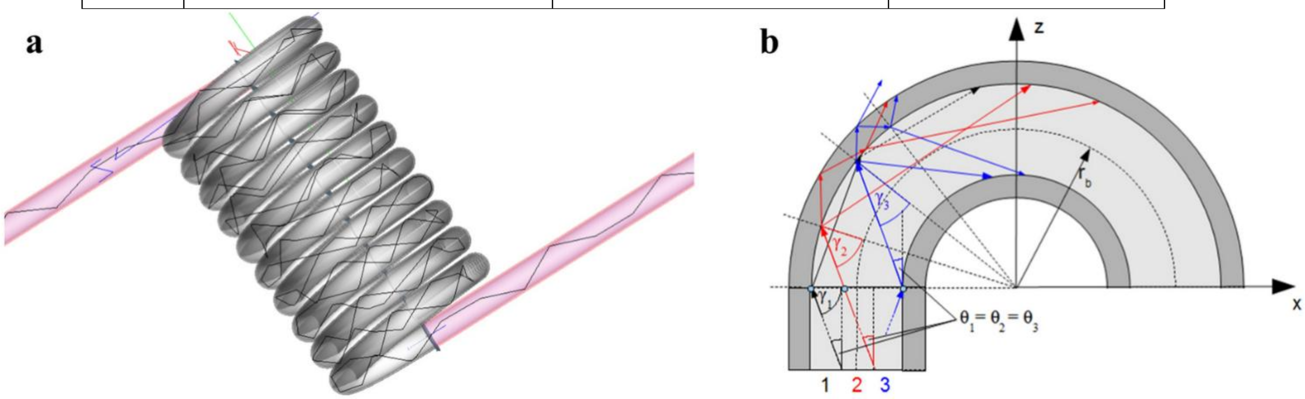
Bending losses

PROCEEDURE: To determine the bending losses:

1. Connect the one end to the 1m long optical fiber to the output end of the LED and the other end to the photo detector. switch on the power.
2. Turn the SET P_0 knob clockwise a little. Insert the leads of the dB meter at the output terminals of the optical power meter circuit and then note the output power in the dB meter.
3. Without disturbing the SET P_0 knob with one turn of OFC on the mandrel and measure the output power, in the Db meter, as described above. Note the readings in the table 1.
4. Repeat the 2&3 by increasing SET P_0 knob and measure the corresponding p_{F1} and p_{F2} values and note in Table 1. The loss due to bending of the OFC= p_{F1}- p_{F2}.

Table 1:

S.No.	Output power without bending (p_{F1}) dB	Output power with bending (p_{F2}) dB	Loss= p_{F1}- p_{F2}



Bending losses

To measure Attenuation Losses:

- ✓ Connect one end of the 1m long OFC to the output end of the LED and the other end to the photo detector (PIN diode) and switch on the power.
- ✓ Repeat the second step by increasing SET P_0 knob and measure the corresponding (P_{F1}) values for five different of P_0 and note in Table 2.
- ✓ Repeat steps 1 through 3 by connecting 5m long OFC and note the readings P_{F2} in table 2.
- ✓ Calculate the loss in each OFC by using the formulae shown in Table 2.
- ✓ The loss in a particular cable plus the loss due to in-line adopter and the loss due to inline adopter is about 1.0 Db. Therefore, the loss in each fiber is obtained.

Table 2: To determine the transmission loss in cables

Length of cable-1 = -----------------------m.

Length of cable-2 = -----------------------m.

S.No.	Output pwer in cable -1	Output pwer in cable -1	Output power in combined cable	Loss in cable-1=P_{f3}-	Loss in cable-2=P_{f3}-

	(P_{f1}) dB	(P_{f2}) dB	(P_{f3}) dB	P_{f2} (dB)	P_{f1} (dB)

Result: Loss in Cable ---

Observations from Virtual Lab (If applicable):

Results from Virtual Lab (If applicable):

Validation of the Results :

VIVA QUESTIONS

S.No	Question	CO	Blooms Taxonomy
1	Define Numerical aperture.	CO1	Understand
2	What are the parts of optical fiber?	CO1	Remember
3	On what principle does an optical fiber works.	CO1	Remember
4	What is meant by attenuation in optical fibers?	CO1	Remember
5	Mention the different types of optical fibers are.	CO1	Remember
6	Define step index optical fiber .	CO1	Remember
7	Define graded index optical fiber.	CO1	Remember
8	What are the types of losses in optical fiber?	CO1	Remember
9	What is total internal reflection?	CO1	Remember
10	What is critical angle?	CO1	Remember
11	Write the formula for Numerical Aperature.	CO1	Remember

12	Define acceptance angle of an optical fiber	CO1	Remember
13	Define snells law.	CO1	Remember
14	Write the formula for Numerical aperature in terms of fractional refractive index change.	CO1	Remember
15	Write the applications of optical fibers.	CO1	Remember
16	Write applications of optical fibers in medicine .	CO1	Remember
17	What is meant by scattering loss?	CO1	Remember
18	Write the unit for losses in fibers.	CO1	Remember
19	What is meant by intermodal dispersion?	CO1	Remember
20	What are the different components of fiber optic communication system?	CO1	Remember

Note :Each experiment should contain Minimum 20 Viva Questions