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Bridging the Industry–Academia Gap Through Experiential Learning in Analog Electronics Education

[1]Remya Jayachandran, [1]Salila Hegde
[1]The National Institute of Engineering, Mysore, Karnataka, India 570008.
[1]remyajayachandran@nie.ac.in, [2]salilahegde@nie.ac.in

***Abstract*— Experiential learning in the area of Electronics and Communication Engineering Education provides a hands-on approach that fosters active engagement and practical skill development among students. This TLP methodology emphasizes learning through practical implementation of real-world applications, enabling students to bridge the gap between theoretical knowledge and application. In this work, the experiential learning methodology adopted for the third-semester Electronics and Communication Engineering students for the core subject Analog Electronics is detailed. The pre-requisite for this course is Basic Electronics in which students were trained to design and analyze the basic circuits with certain exposure to practical learning. Students pursuing Electronics and Communication engineering often encounter various challenges in comprehending the subject matter. Analog electronics involves abstract concepts such as amplifiers, filters, oscillators and semiconductor devices, which can be challenging for them to grasp without hands-on experience. The theoretical foundation of Analog electronics often involves complex mathematical analysis, including differential equations, Fourier analysis, and Laplace transforms, which can be daunting for students. Students may struggle to understand the practical relevance and real-world applications of theory concepts, leading to a lack of motivation and engagement. Troubleshooting and debugging analog circuits require a deep understanding of the underlying principles and students may face difficulties in identifying and rectifying errors. Addressing these challenges through experiential learning and practical implementation can greatly enhance students' understanding of the fundamental course Analog electronics.**

***Keywords*— Active learning, Analog electronics, Design project, Effective assessment, Engineering Education, Experiential learning**

***JEET Category*—Research**

I. INTRODUCTION

At the start of their career, teachers often lack specialized training to effectively teach professional courses. Subsequently, they develop the necessary skills over time through experience. This learning curve can impact students' interest and engagement with professional courses, often leading to ineffective learning. Consequently, many students perceive these courses as difficult, which sometimes results in heightened academic stress, depression, or even course discontinuation. Analog Electronics, a foundational core course in electrical and electronics engineering, is particularly challenging for students. It introduces the basics of electronic devices and circuit analysis, forming a prerequisite for more advanced subjects like VLSI Design, Signal Process, which is critical for the industry. A general survey of first-year students reveals difficulty in understanding circuit analysis during the Basic Electronics course—a prerequisite for Analog Electronics in their second year. This lack of a strong foundation hampers their ability to excel in higher-level courses, contributing to the observed skill gap in VLSI Design engineers, a high-demand specialization in today's job market. The COVID-19 pandemic exacerbated these challenges. Students were primarily taught through online classes, which proved less effective for hands-on subjects like Analog Electronics that require extensive circuit analysis and interaction. The shift to online learning significantly impacted academic performance and employability. For example, the 2019–2023 undergraduate batches saw a pass percentage of 60% in Analog Electronics. Subsequent batches (2020–2024 and 2021–2025) resumed offline classes in their third semester but showed only a marginal increase in pass percentages (10–20%), largely due to insufficient foundational knowledge. Although additional Teaching and Learning Processes (TLP) like problem sheets, quizzes, and open-book tests were introduced, conventional methods remained dominant, with limited emphasis on active and experiential learning. As a result, the potential to substantially improve student outcomes remains untapped.

Post-COVID, there has been a noticeable decline in students' focus and interest in hardwork. Additionally, many students today are raised in financially secure households, with access to greater comforts compared to previous generations. This upbringing may reduce their drive to face challenges and strive in academic pursuits. These factors pose a significant challenge for educators in capturing students' attention and ensuring they understand the subject matter effectively. To address these challenges, it has become imperative for teachers to adopt innovative teaching and learning methods beyond traditional approaches. Such techniques are essential

Remya Jayachandran
The National Institute of Engineering, Mysore, Karnataka, India 570008
remyajayachandran@nie.ac.in

to actively engage students in the classroom and enhance their learning experience. This paper highlights the authors' efforts to bridge these gaps through diverse pedagogical strategies, with a special emphasis on experiential learning to make the learning process more interactive and engaging.

II. Literature survey

A lecture may be considered as a base tool to facilitate learning for students. Even though traditional lecture has several advantages, if the professor cannot appropriately adjust classes every advantage may turn out to be a disadvantage as per Wankat and Oreovicz (2015). If not done properly, or misused (which can be easily done), the lecture becomes a highly inadequate teaching technique. There are several disadvantages of traditional lecturing, one of which is boredom for students. They also explain techniques for professors to be good performers in the class and techniques for good presentation also. Active learning is necessary as a large percentage of students have at most attention span of 15 minutes (Heywood, J. 2005). Students want less lecturing and more engineering applications and examples ((Pomales-García and Liu, 2007). They also want more interaction and the chance to work examples in class. This would change the lecture format into an even more active course. Students can be made to get involved in a lecture class by employing different teaching and learning (TLP) methods. One method is to have a group of volunteers who meet regularly with the professor to provide feedback (Svinicki and McKeachie, 2014). In this method, students are required to pay attention and give feedback on what they have learned. To make this method effective by regularly giving short pre- or post-lecture quizzes. One way to do this is to conduct a quiz during the last ten minutes of class s (Gray and Madson, 2007; Peck, 1979). Asking questions in a class and its advantages are well explained by Hyman(1982).Building interpersonal rapport with students make them feel comfortable in class and they believe faculty is supportive (Daly et al., 2012). Guest Lectures from an industrial perspective can be valuable in any engineering class and not just in design courses. Engineers from industry can give an industrial flavor that most professors cannot duplicate (Borns, 1989). Hence even if a lecturer may be new to teaching, by adopting above mentioned activities, class can turn out to be good.

An extensive review of research by Felder et al. (2000) showed conclusively that the following eight methods improved instruction in engineering: (a) use instructional objectives, (b) teach inductively (c) show material is relevant, (d) balance concrete and abstract information, (e) use active learning, (f) use cooperative group learning, (g) make tests challenging but fair and (h) show concern about student learning. Most of the active learning methods are highly effective than lecture for learning higher-level cognitive objectives (Prince, 2004) and mastery methods is superior for the lower-level objectives (Bloom, 1968, 1984). The extensive meta-analysis by Freeman et al. (2014) showed that learners in active learning classes had better test scores and were less likely to fail than students in lecture classes. Active learning was effective for all class sizes although classes with less than 50 students had the largest effects. Active learning will also tend to reduce cheating because there are often numerous lowstake assessments (Lang, 2013; see Section 12.2). Seeing real instrument or manufacturing operations provides students with a concrete, visual, and often tactile learning experience. Hence field visits and local trips to campus facilities or at the research centre of university will give a useful step-up for many courses (Davis, 2009). Problem-Based Learning (PBL) uses realistic problems to structure student learning of new material (Du et al., 2009). Cooperative group learning involves students, which leads to learning. It also helps learners learn how to work in groups, which helps satisfy the ABET criterion and has been proven to result in superior performance in the top three levels of Bloom's taxonomy. In cooperative group learning, students work together, do homework, complete projects, and prepare for tests (Goldstein 1982). Many engineers contend that designing is the heart of engineering. All the mathematics, physics, chemistry, and engineering science courses are the background for what makes engineering different from applied mathematics or the physical sciences. The engineering design experience should be developed and integrated throughout the curriculum (Jones, J.B. 1991).

Problem-Based Learning (PBL) has been increasingly adopted in engineering education to enhance student engagement and improve learning outcomes, particularly in courses like Analog Electronics. A study at Palestine Polytechnic University examined the impact of PBL on students' achievement in an Analog Electronics course (Arman, A., 2019). The findings indicated that students exposed to PBL demonstrated significant improvements in their understanding and application of analog electronics concepts. They developed better research skills, collaborated more effectively in groups, and gained greater confidence in practical applications. Similarly, research conducted at Walter Sisulu University of Technology in South Africa compared PBL with traditional lecturing methods in a first-year Analog Electronics course (Podges, J. M, 2014). The study found that while PBL students showed enhanced practical understanding and positive attitudes towards learning, there were no significant differences in overall learning outcomes compared to the traditional approach. Project-Based Learning (PjBL), a subset of PBL, has also been applied in Analog Electronics education. A study presented at the International Conference on Education Innovation and Social Science detailed the implementation of PjBL in an Analog Electronic Technology course (Fang, J., 2017). Students engaged in designing audio power amplifier circuits, which enhanced their practical skills and understanding of theoretical concepts. The hands-on project fostered enthusiasm and improved learning outcomes. Effective Strategies for Project-Based Learning of Practical Electronics and Integrated circuit design are detailed in literature with different methodologies (Mohd-Yasin, F.

(2021). Yang, X. (2021). Hussain, A. A.(2024), Escribano, L.,(2024), Kataria, D(2024)), Jayachandran R(2026). These papers mainly focus on hybrid learning and various teaching methodologies for teaching Circuit branch courses. From this literature survey, it is evident that active-based learning along with practical learning can help students to understand engineering courses in a better way. This will enhance the confidence level of the pupil in technical interviews and get them placed in the core companies. Next section depicts the methodology followed to incorporate experiential learning along with the traditional teaching methods.

This paper is organized as follows: Section III elaborates on the teaching and learning methodologies employed for the Analog Electronics course in the 3rd semester of UG engineering programs. Section IV discusses the impact of experiential learning on students' skills and understanding. Section V examines the effects of the implemented Teaching-Learning Process (TLP) on student outcomes. Finally, Section VI explores the future scope of this approach and presents the conclusion.

III. Methodology

The third-semester students of the Electronics and Communication Engineering program have been chosen to implement experiential learning approach for the Analog Electronics course. The course duration is from November 20th to March 15th 2024. Total number of students are 136 and they are divided into two sections; section A and B. The class is a mixture of students of different caliber as they are admitted to UG program based on KCET ranking with general merit and reservation class students and management quota. And due to the rise in IT companies and high salaried jobs top ranking students mostly opted IT related Engineering programmers (Maryum J. 2024). Due to recent job trends in IT section many colleges have increased their intake for IT related UG programs (Nikita Duggal, 2024). This has resulted in a large section of top-ranking students opting for Computer science engineering and allied branches. And hence the students taking admission to electronics by their own interest is seldom less compared to total students. And also, they have lesser ranking in their qualifying entrance test due to which many of them lack analytical skills too.

Figure 1 is the cut off ranking of admissions for AY 2022-2023 (2022-2026 batches) and AY 2023-2024 (2023-2027 batches). The students admitted in AY 2023-2024, the highest ranking students are less compared to the 2022 batch. The methodology adopted for one batch may not be effective for their junior batch. It is important that the faculty should be aware about ranking of the students to get an idea about the student group.

UG Course	Quota	Sub-Quota	Cut-off rank 2022-23		Cut-off rank 2023-24	
			Highest	Least	Highest	Least
Electronics & Communication Engineering	KEA	Aided	2451	9893	5084	9201
		Unaided	10095	12720	8942	10764
	Comed-K	Unaided	6618	25640	7623	10770

Fig. 1. Cutoff ranking of admissions for Electronics & Communication Engineering in AY 2022-23, AY 2023-24 at a Tier I Institute of Southern Karnataka

One more challenge is teaching the lateral entry (diploma students) and change of branch students. Lateral entry (LE) students get admission to 3rd semester of Engineering based on their Diploma CET ranking. Change of branch (C.O.B.) students is often from non-circuit branches like Mechanical and Civil Engineering. And to add to the difficulty their start of attending class is delayed due to the delay in their admission process. For LE students, they lack Engineering Mathematics knowledge as they do not study in their diploma curriculum; they find it more difficult to understand the subject. Hence the TLP to be implemented must take care of all these challenges.

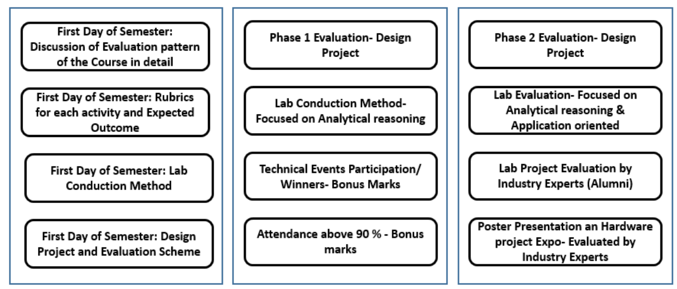

Fig. 2. Methodology introduced in TLP for the Circuit Design Courses – Basic Electronics, Analog Circuits and Linear Integrated Circuits

Electronics and communication Engineering has vivid subjects requiring good knowledge of Engineering Mathematics, Analytical and problem-solving skill, design and practical implementation of systems and circuits which demand the learners to be intellectual, hardworking and dedicated. The course Analog Electronics is of five credits course which has five theory modules of three credits and a LAB course of two credits. The course syllabus has MOSFETs working, MOSFET amplifiers DC and AC analysis, MOSFET applications like amplifiers and oscillators and analysis, Frequency response of amplifiers, Power electronics systems such as power amplifiers, power electronics devices like SCR, TRIAC and DIAC characteristics. And the number of classes allotted for this course is 40 hours which is practically not possible to teach entire syllabus effectively. This is another challenge. And this is one of the main subjects which form the basement for most of higher semester subjects and also for getting jobs in core companies and to take PG entrance exams like GATE.

The authors are Professors with a doctorate degree in the Electronics and Communication domain and have expertise in the said course with prior teaching experience of the subject and industry experience. In addition to that, the Professors have certification from IIEECP and NPTEL TLP in engineering education. Both the professors with senior professors in the department discussed how to teach effectively the subject to increase the quality of knowledge in

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students. As per the committee discussion different experiential learning methods and financial budgets are planned to conduct activities which are detailed in coming sessions.

Fig. 3. Active learning - Analog Design Contest conducted by fourth year students for second year students

The methodology introduced in Circuits Design subjects is shown in Fig. 2. The lesson plan is prepared well in advance considering the LAB experiments to be conducted and extra classes slot is allotted in timetable. Social media platforms – WhatsApp groups and LMS - Moodle accounts are created section wise to share the learning materials, and academic notifications. Syllabus of the course, abridged lesson plan and semester calendar of events is shared to students in these platforms prior to the start of classes.

A. PjBL Methodology for AY 2022-2023 batch

In the first class, students were briefed on the course structure, assessment methods, and the experiential learning approach. To encourage participation, incentives like bonus marks were offered for top performers and full attendance. Internal tests emphasized numerical problems to strengthen analytical skills. The evaluation pattern is shown in Table I, and outstanding students received up to 5 bonus marks added to their internal scores. Figure 3 highlights student participation in an analog circuit design contest organized by final-year students. This initiative, tied to bonus incentives, helped boost second-year students' confidence and engagement in technical activities. Kolb's Experiential Learning Theory suggests that effective learning occurs through a continuous cycle of experience, reflection, conceptualization, and experimentation. This cycle helps individuals learn by directly engaging in experiences, reflecting on them, abstracting concepts from those reflections, and then actively experimenting with those concepts.

To enhance the continuous evaluation of the Analog Circuits course, an experiential learning approach was introduced in progressive stages. The objectives of this Teaching and Learning Process (TLP) extend beyond improving course outcomes and academic results to:

1. To enhance the analytical skill of the students in circuit design
2. To get to know the various BJT, MOSFET circuits used in various applications which are beyond the syllabus.
3. To understand the design concepts and apply the theoretical knowledge in circuit design
4. To encourage the students to design their own circuit for the given requirements.
5. To upgrade the technical presentation and communication skill.

TABLE I
EVALUATION PATTERN FOR AY 2022-2023

CIE Activities	Marks	Pattern
Test 1	25	Blooms level, L4 – 5 %, L3 – 60 %, L2-30%, L1 – 5%
Test 2	25	Blooms level, L4 – 5 %, L3 – 65 %, L2-25%, L1 – 10%
Quiz	20	Quiz 1- Surprise test -25%, Quiz 2- Open book test – 50 %, Quiz 3- Multiple choice – 25 %
Experiential Learning	30	Hardware Project
Bonus* Marks	5	Eligibility Criteria- Anyone given below 1. Participation in technical events (external) 2. Solving L4 level questions in exam 3. Solving L4 level problems in class 4. More than 90% attendance (only for students who have test1 + test2 > 15 marks) *Bonus Maximum marks – 5 marks
Award and Recognition with Cash Prize/ Memento		1. Best Performer 2. 100% attendance

In the first stage, students visited a PCB design company in Mysore for hands-on industry exposure, interacting with professionals and observing real-world processes. Faculty and staff accompanied students in small groups to ensure focused learning. After the visit, a technical quiz was conducted, and student feedback was collected to assess the visit's effectiveness. Students also submitted structured reports summarizing their learning experience. In the second stage, a technical talk on "Emerging Devices – FinFET" was delivered by a VLSI expert and college alumnus working at Intel India. The session covered FinFET fundamentals, design challenges, and industry trends. Students engaged in discussions, gaining insights into core technical skills and industry expectations. A follow-up quiz and feedback collection were conducted to evaluate the session’s effectiveness. These activities took place after the first internal test.

In the third stage, students undertook an Analog Circuit Design Project based on existing circuits using FET or BJT components. Guidelines, rubrics, and report formats were provided in December 2023, with a 45-day completion timeline. Groups of 2–4 students were formed with balanced

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academic performance (50% with CGPA ≥ 6, 50% < 6). The project was carried out in structured phases shown in Figure 4, with periodic evaluations to monitor progress. This phase complemented prior activities by combining industry exposure, expert input, and hands-on application to enhance learning in Analog Circuits.

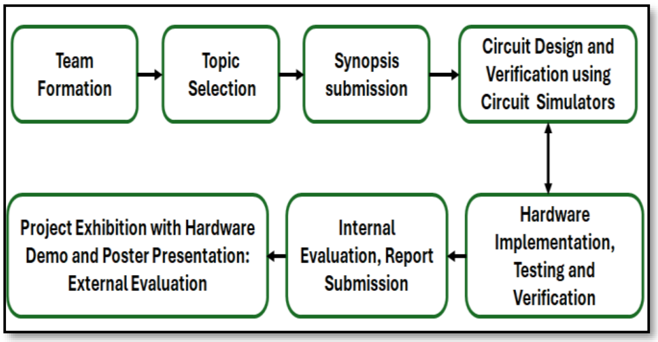
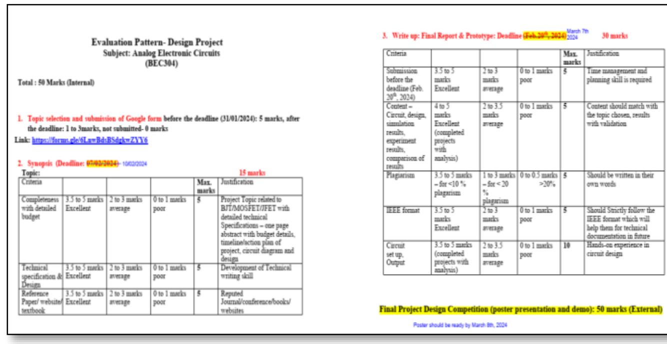


Fig. 4: Various stages of Analog Design Project Execution

An effective assessment rubric was designed to evaluate the project systematically. During the first phase, students were given one week to form teams and select their project topics. This phase accounted for 10% of the total marks, with a 2% deduction for late submissions. With a clear understanding of the evaluation criteria, all students submitted their team details and topics on time. In the second phase, students submitted a project synopsis using a standardized template and assessment rubric provided in advance to ensure consistency and clarity. Figure 5 outlines the evaluation criteria. Students had two weeks to complete the synopsis, and marks were announced within a week of the submission deadline. The third phase involved continuous evaluation of circuit simulation and hardware implementation. Each group was assessed individually on their understanding of circuit analysis and functionality. Clear deadlines and prior access to rubrics supported effective planning and execution. Figure 6 displays a sample project report in IEEE format, helping students build technical writing skills early in their academic journey. The final phase featured a Project Exhibition and Poster Presentation, evaluated by industry experts from companies like Texas Instruments, Siemens, and CISCO, along with senior internal faculty. This gave students valuable exposure to industry expectations and opportunities to engage with professionals and senior peers. Winning teams received cash prizes, boosting motivation. Feedback was collected to assess the initiative's impact. Figures 7, Fig. 8, and Fig.9 illustrate the evaluation sheet, student posters, and project rubrics respectively



Evaluation Pattern- Design Project
Subject: Analog Electronic Circuits
(BEC304)

Total : 50 Marks (Internal)

1. **Topic selection and submission of Google form before the deadline (31/01/2024): 5 marks, after the deadline: 1 to 3marks, not submitted- 0 marks**

Link: https://forms.gle/6LawBdsBSdgkwZYY6

2. **Synopsis (Deadline: ~~07/02/2024~~)** - 10/02/2024

Topic: **15 marks**

Criteria				Max. marks	Justification
Completeness with detailed budget	3.5 to 5 marks Excellent	2 to 3 marks average	0 to 1 marks poor	5	Project Topic related to BJT/MOSFET/JFET with detailed technical Specifications – one page abstract with budget details, timeline/action plan of project, circuit diagram and design
Technical specification & Design	3.5 to 5 marks Excellent	2 to 3 marks average	0 to 1 marks poor	5	Development of Technical writing skill
Reference Paper/ website/ textbook	3.5 to 5 marks Excellent	2 to 3 marks average	0 to 1 marks poor	5	Reputed Journal/conference/books/ websites

3. **Write up: Final Report & Prototype: Deadline ~~(Feb.20th, 2024)~~** March 7th 2024 **30 marks**

Criteria				Max. marks	Justification
Submission before the deadline (Feb. 20th, 2024)	3.5 to 5 marks Excellent	2 to 3 marks average	0 to 1 marks poor	5	Time management and planning skill is required
Content – Circuit, design, simulation results, experiment results, comparison of results	4 to 5 marks Excellent (completed projects with analysis)	2 to 3.5 marks average	0 to 1 marks poor	5	Content should match with the topic chosen, results with validation
Plagiarism	3.5 to 5 marks – for <10 % plagarism	1 to 3 marks – for < 20 % plagarism	0 to 0.5 marks >20%	5	Should be written in their own words
IEEE format	3.5 to 5 marks Excellent	2 to 3 marks average	0 to 1 marks poor	5	Should Strictly follow the IEEE format which will help them for technical documentation in future
Circuit set up, Output	3.5 to 5 marks (completed projects with analysis)	2 to 3.5 marks average	0 to 1 marks poor	10	Hands-on experience in circuit design

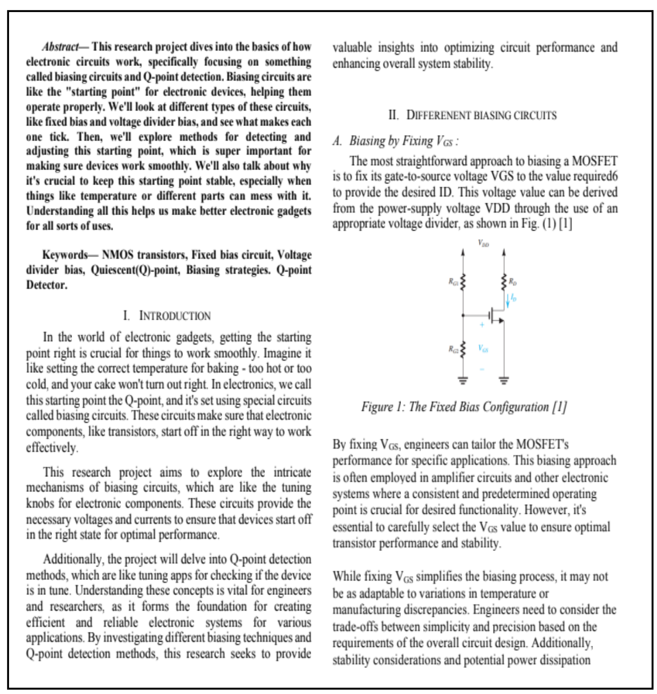
Final Project Design Competition (poster presentation and demo): 50 marks (External)

Poster should be ready by March 8th, 2024

Fig. 5. Effective Assessment: Detailed Rubrics for design project evaluation

The final phase featured a Project Exhibition and Poster Presentation, evaluated by industry experts from companies like Texas Instruments, Siemens, and CISCO, along with senior internal faculty. This gave students valuable exposure to industry expectations and opportunities to engage with professionals and senior peers. Winning teams received cash prizes, boosting motivation. Feedback was collected to assess the initiative's impact. Figures 6–8 illustrate the evaluation sheet, student posters, and project rubrics

To measure the effectiveness of this experiential learning approach, the outcomes were compared with results from previous batches. Specifically, student performance from the 2020–2024 and 2021–2025 batches was analyzed against that of the 2022–2026 batches. This comparative analysis offered valuable insights into the improvements in student accomplishments and highlighted the success of the proposed learning methodology.



***Abstract*— This research project dives into the basics of how electronic circuits work, specifically focusing on something called biasing circuits and Q-point detection. Biasing circuits are like the "starting point" for electronic devices, helping them operate properly. We'll look at different types of these circuits, like fixed bias and voltage divider bias, and see what makes each one tick. Then, we'll explore methods for detecting and adjusting this starting point, which is super important for making sure devices work smoothly. We'll also talk about why it's crucial to keep this starting point stable, especially when things like temperature or different parts can mess with it. Understanding all this helps us make better electronic gadgets for all sorts of uses.**

Keywords— NMOS transistors, Fixed bias circuit, Voltage divider bias, Quiescent(Q)-point, Biasing strategies. Q-point Detector.

I. INTRODUCTION

In the world of electronic gadgets, getting the starting point right is crucial for things to work smoothly. Imagine it like setting the correct temperature for baking - too hot or too cold, and your cake won't turn out right. In electronics, we call this starting point the Q-point, and it's set using special circuits called biasing circuits. These circuits make sure that electronic components, like transistors, start off in the right way to work effectively.

This research project aims to explore the intricate mechanisms of biasing circuits, which are like the tuning knobs for electronic components. These circuits provide the necessary voltages and currents to ensure that devices start off in the right state for optimal performance.

Additionally, the project will delve into Q-point detection methods, which are like tuning apps for checking if the device is in tune. Understanding these concepts is vital for engineers and researchers, as it forms the foundation for creating efficient and reliable electronic systems for various applications. By investigating different biasing techniques and Q-point detection methods, this research seeks to provide valuable insights into optimizing circuit performance and enhancing overall system stability.

II. DIFFERENENT BIASING CIRCUITS

A. Biasing by Fixing V_{GS} :

The most straightforward approach to biasing a MOSFET is to fix its gate-to-source voltage VGS to the value required6 to provide the desired ID. This voltage value can be derived from the power-supply voltage VDD through the use of an appropriate voltage divider, as shown in Fig. (1) [1]

Figure 1: The Fixed Bias Configuration [1]

By fixing V_{GS}, engineers can tailor the MOSFET's performance for specific applications. This biasing approach is often employed in amplifier circuits and other electronic systems where a consistent and predetermined operating point is crucial for desired functionality. However, it's essential to carefully select the V_{GS} value to ensure optimal transistor performance and stability.

While fixing V_{GS} simplifies the biasing process, it may not be as adaptable to variations in temperature or manufacturing discrepancies. Engineers need to consider the trade-offs between simplicity and precision based on the requirements of the overall circuit design. Additionally, stability considerations and potential power dissipation

Fig. 6. Technical Paper written by students of third semester in the given format.

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Batch No.	Name	USN	Project Title	Synopsis and analysis (50)	Report (30)	Result (20)	Internal total(100)	External (50+50)	Total(200)	Theory CIE(30)	LAB TEST CIE(10)
1	Adhrutha S M		Automatic Water Level Detection and Motor control	48	29	20	97	100	197	29.55	9.85
	B S Pranav			40	29	20	89	100	189	28.35	9.45
	Anthony Lanson			45	29	20	94	100	194	29.1	9.7
	Sharada P Bhagwath			40	29	20	89	94	183	27.45	9.15
2	Karthik MN		Object detection and motor actuatuion using LDR Sensor	46	27	20	93	85	178	26.7	8.9
	Bheema kashyapa			46	27	20	93	85	178	26.7	8.9
	Bhargav			43	26	20	89	85	174	26.1	8.7
	Amogh H			42	26	20	88	85	173	25.95	8.65
	Deepu.M		Design and mplementation of Half subtractor using NOR gate	45	26	20	91	88	179	26.85	8.95
	Hamsa Bhaskar B			45	26	20	91	88	179	26.85	8.95
	Kadaburu Matam Spandhana			45	26	20	91	80	171	25.65	8.55

Fig. 7. Sample project evaluation sheet

All third-semester students took Analog Electronics after completing Basic Electronics in the previous semester. Their progress in circuit debugging and design was closely monitored. A hands-on approach, including live demonstrations of topics like power amplifiers, significantly improved their analytical skills. Experiments using audio amplifiers and the NI ELVIS Kit at the IDEA Lab shown in Fig. 10 and Fig. 11 respectively, enabled students to build, interface, and accurately measure circuits via PC software. Carefully planned teaching methods ensured effective learning while accommodating students' overall academic workload.

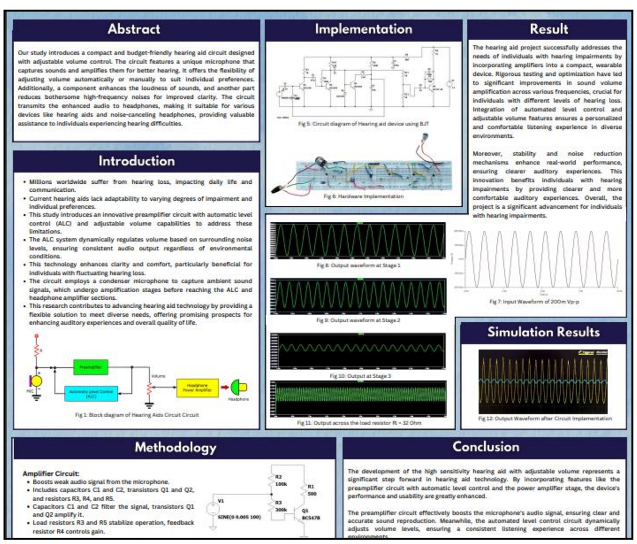

Fig. 8. Sample poster by students

Group No:

Department of Electronics & Communication Engineering

Analog Electronics Design Project Evaluation 2023-24

Title of the project:

Date:

Semester:

1. Student Name:

USN:

Indicators	Outstanding (10)	Excellent (8 to 9)	Good (7)	Average (5 to 6)	Poor (1 to 4)	Total
Circuit Design Explanation, Applications						
Results and Analysis of the project						
Poster content						
Project demo and explanation in detail						
Overall presentation						
					Grand Total	

Fig. 9. Rubrics for External Project evaluation

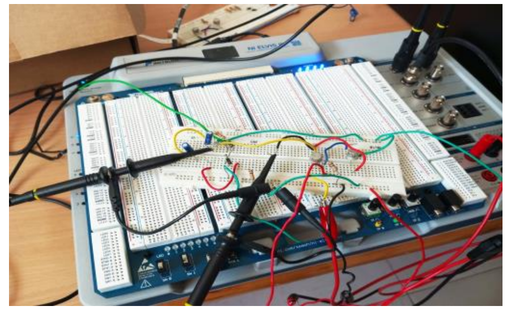

Fig. 10. Circuit implementation using NI ELVIS-KIT

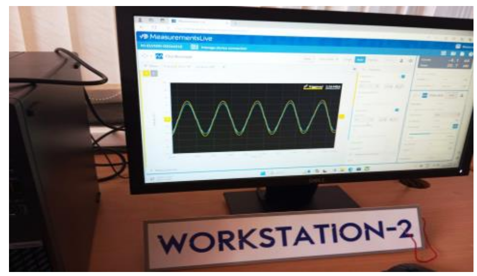

Fig. 11. Input and output waveforms of the circuit shown in PC

The 2022–2026 ECE batch was the first to experience a structured experiential learning approach in Analog Electronics, leading to increased student interest in analog projects and contests. Active learning techniques, bonus marks for participation and attendance, and various support measures—such as open-book tests, extra classes, and tiered problem sheets—were implemented to enhance engagement and understanding. Faculty availability for doubt-clearing further strengthened student-faculty interaction. Previous batches (2019–2025) received numerical problem sheets, but lacked a systematic experiential learning framework. The 2021–2025 batch, in particular, showed performance decline due to the impact of COVID-19 and the NEP curriculum changes, which affected their foundational skills. In contrast, the 2021–2026 batch participated in technical conferences and poster presentations, while the 2020–2024 batch received advanced problem-solving assignments and revision sessions.

B. PjBL methodology adopted for AY 2023-2024

As shown in Fig. 1, the 2023 ECE batch had lower admission rankings (5000–12,000) compared to the 2022 batch. Many students from the 2023 cohort, affected by the COVID-19 pandemic, faced challenges in foundational subjects. To address this, courses like Basic Electronics and Innovation and Design Thinking were introduced in the second semester to build problem-solving skills and connect theory to real-life applications. The batch consists of 140 students divided alphabetically into Sections A and B. Experiential learning was implemented in Section A for Basic Electronics, while Section B followed a conventional approach. Exams for both sections included 90% numerical questions to strengthen analytical skills.

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At the beginning of the second semester, the complete evaluation pattern was discussed in detail with the students. The Test 1 and Test 2 exams were conducted, focusing heavily on numerical problems (90%), aligned with Level 3 Bloom's taxonomy. As anticipated, only 30% of students passed Test 1 on Basic Electronics, but by Test 2, the pass rate increased to 50%, demonstrating that students were adapting to the new methodologies. Active learning was introduced in the tutorial sessions, paired with hands-on lab work that was not part of the official syllabus. These sessions allowed students to relate theoretical concepts to practical applications. For example, topics such as diode characterization and DC power supply design were explored. In addition, students were encouraged to use Virtual Labs and the LTSpice simulator for analyzing basic circuits. Despite the challenge of many students lacking foundational knowledge, the active learning methods helped them step outside their comfort zones. To further reinforce their learning, basic analog circuit design projects were assigned to teams. The evaluation involved both demonstrations and viva assessments. The final results for the Basic Electronics course showed: Two students scored above 90 marks, about 12% of students scored in the 70–90 range, 40% of students scored below 70 marks. The overall pass percentage for the final exam was 85%, with Bloom's levels distribution as follows:

- Level 4(L4): 20 marks
- Level 3(L3): 40 marks
- Level 2(L2): 40 marks

In the third semester, Section A adopted a project-based experiential learning approach, while Section B followed traditional methods. A new activity, a Digital Poster Presentation on active and passive components, was introduced to enhance students' understanding of technical specifications and datasheet interpretation. This mid-semester event also contributed to quiz scores and was evaluated by industry and academic experts using defined rubrics shown in Fig. 13. The assessment focused on component identification, technical understanding, software use, creativity, presentation skills, and teamwork, helping students build essential skills for future applications.

In the second stage, students visited a Mysore-based industry specializing in product testing and characterization, gaining hands-on exposure to testing equipment, quality procedures, and design practices. They later completed a quiz and submitted a technical write-up summarizing their learning. In the third stage, students undertook an Analog Circuit Design Project with a 60-day timeline. Guidelines, rubrics, and formats were shared in advance. Teams of 2–4 students were formed with a balanced mix of academic performance. Fifth-semester students served as mentors, and PCB design was made a mandatory component. Mentoring played a key role in project evaluation.

DECCTEROUS

Dated: 30 / 11 /2024

"DECCTEROUS"- Integrated Circuit Design Club

Team Name:

Indicators	Outstanding (9-10)	Excellent (7 to 8)	Good (5 to 6)	Average (3 to 4)	Poor (0 to 2)	Total
Poster Navigation						
Content						
Use case examples						
Datasheets, Pictures, Components list						
Overall Presentation						
Evaluator Name: Signature:					Total (50)	

Question Answer Session:

Sl.No	Student Name	USN	Viva (25)	Component Identification (10)	Involvement in Poster Design (15)	Total (50)

Fig. 12. Evaluation Pattern for the Poster Competition on Active & Passive electronic Components

Analog Circuit Design Project Internal evaluation conducted from 9/12/2024 to 12/12/2024

Team No.	Team Members	Topic	Internal marks (50)	Mentor
1	Kavya, Amulya D, Pooja R K, Priyanka	Noise limiter	30	Ansh Vinod
2	Harshitha B M	2 Bit Half Adder using BJT	40	
3	Mourya P, Nandan B, M P Hemanth Kumar	Automatic night light	33	Adrutha
4	Govinda V M, K R Mruthyumjaya, Daivik , Karthik K P	555 Timer in Astable mode using BJTs	30	Mehul
5	Nidhishree, Madeena Bi, Kavya G, Hemashree	Hearing Aid	25	Ansh Vinod

Fig.13. Sample sheet -Internal Evaluation marks

TABLE III
EVALUATION SCHEME

CIE Activities	Marks	Pattern
Test 1	25	Blooms level, L4 – 5 %, L3 – 60 %, L2- 35%
Test 2	25	Blooms level, L4 – 5 %, L3 – 65 %, L2- 35%
Quiz	20	Quiz 1- Technical events -35%, Quiz 2- Open book test – 50 %, Quiz 3- Multiple choice – 05 %
Experiential Learning	30	Hardware Project Industry Visit Digital Poster
Bonus* Marks	5	Eligibility Criteria- Anyone given below • Participation in technical events (external) • Solving L4 level questions in exam • Solving L4 level problems in class • More than 90% attendance (only for students who have test1 + test2 > 15 marks) *Bonus Maximum marks – 5 marks
Award and Recognition with Cash Prize/ Memento/ Books		3. Best Performer 4. 100% attendance

The evaluation process followed the same structure as in the

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previous year, with Phase I conducted in the first week of November 2024, and Phase II in the first week of December 2024. During these phases, students were continuously assessed on the simulation and hardware implementation of their projects, with a specific emphasis on developing analytical skills. At the end of the project, students were required to submit the final technical report in standard IEEE format, including detailed analysis and results. Fig. 13 presents the a sample sheet of the internal evaluation of the project. The marks are consolidated including the mentor feedback. The evaluation rubrics were updated accordingly to align with the added focus on PCB design and technical content.

To enhance the analytical skills of students, a new methodology was introduced in the Analog Circuit Lab. Instead of just following a predefined experiment, students were required to select a design problem relevant to the experiment during the lab sessions, design the circuit, and analyze the results. Each lab team worked with unique design parameters, and continuous evaluation was conducted through viva assessments. This approach significantly improved the students' analytical thinking skills. However, Section B faced some challenges, as this analytical approach had not been implemented during their second semester. The impact of experiential learning became evident when comparing the performance of Section A (who adopted the methodology) with the overall performance of Section B students. Students underwent rigorous round of explaining circuit analysis of their design project.

In the first phase their mentors asked questions on circuit and it's behaviour which made them to understand and prepare it further. In the second phase their respective faculty in charge conducted in depth analysis test of their project. This helped improving their knowledge further. The final phase of the Design Project — "The Analog Showdown" — a project exhibition and evaluation, was held in the third week of December 2024. The exhibition was evaluated by external examiners, who were alumni of the college currently working in prominent industries such as Texas Instruments, Siemens, AMD, Morphing Machines, and Schneider Electric, along with internal examiners who are circuit experts within the department. As part of this phase, a keynote session on "The Big Picture of Electronics and Communication Engineering – A Project Based Learning Approach" was organized for students, led by an experienced industry expert. This session proved to be eye-opening and provided valuable insights for the students. The project evaluation allowed students to interact with professionals and alumni, learning about the skill sets necessary for entering the core domains. Additionally, the mentorship provided by the fifth-semester students was beneficial for both groups. The fifth-semester students were able to reinforce their fundamentals, while the third-semester students received structured guidance. The winners of the exhibition were recognized and awarded cash prizes, and feedback was collected from students to assess the impact and effectiveness of the experiential learning process. The success of these modified methodologies was evident in the final lab exam of Analog Electronics, where Level 4 (L4) questions were included, demonstrating the students' ability to tackle higher-order problems. Section A students, who underwent experiential learning for both Basic Electronics and Analog Electronics over two consecutive semesters, outperformed the B Section students. The impact of project-based learning in circuit-related courses was clearly evident in the result analysis. While Section B students initially faced challenges, they showed significant improvement by the end of the semester. The experiential learning process helped all students understand the critical importance of analytical skills in the circuit domain and how these skills are essential for securing jobs in core industries. The A section students showed active participations in technical events like circuit hackathon, IEEE activities, Electronics components poster design competition, Student research symposium, Technical treasure hunt etc. with respect to B section students. The demo set up of the one of the top projects in the exhibition- ANALOG showdown is shown in Fig. 14. The students were able to demonstrate the theoretical concepts in the project demonstration with real world applications. The evaluation pattern for the projects is shown in Fig. 15. The statistics of student participation in Technical events after introducing the TLP method is shown in Fig.16.

Fig. 14. Analog Project Demo set up for final evaluation by third semester students AY 2023-24

DECCTEROUS

Dated: 21 / 12 /2024

"DECCTEROUS"- Integrated Circuit Design Club

Project Title:

Criteria	Excellent (9-10)	Very good (7-8)	Good (5-6)	Average (3-4)	Poor (2-1)	Total
Mentoring						
User-Centric Focus						
Problem Definition						
Ideation Quality (Design)						
Prototyping and Testing (PCB)						
Feasibility and Viability (Challenges)						
Alignment with Objectives						
Collaborative Effort (Team work)						
Result Analysis (Detailed Analysis)						
Final Report (Hardcopy)						
Total						

Question Answer Session:

Sl.No	Student Name	USN	Viva (25)	Circuit Analysis skill (10)	Involvement in circuit design (15)	Total (50)

Fig. 15. Evaluation pattern for Analog Design Project

Section	Student Participation				
	SRS 2024	IEEE events	IC Dsign club activities	Poster Presentation	Circuit Hackathons/Treasure hunt/ Quiz
A (No. of students-71)	40	30	40	71	30
B (No. of students-72)	0	35	40	12	40

Fig. 16. Student Participation in various technical events hosted by different colleges as well as our institute

Feedback received from students:

"From this design project I understood how to put my theoretical knowledge into real time application and develop my technical skill, and to face all the questions which will be asked, develop self confidence"

"*The event was too good. The events conducted by the IC design club are always special because, it straight away relates to our branch topics and the skills required to the core companies. The questions and needs of the judges were same as of that questions asked by Professors in the labs. I just felt how they can be so magical!! I have mainly learnt the importance of having complete grip on the concept and applying it practically."*

Feedback from Alumni who were evaluators of Digital Poster Presentation & The Analog Showdown

"It's really appreciable to see the students at this semester itself know how to read the datasheet and identify the components for the project design. Student's explanation of the circuit design and the analysis has improvised a lot compared to previous year"

"Really amazing to hear the technical explanation the students have given for their circuit project. From a third semester student it is really great. Most of the students have a good confidence level, justification skill, analytical skill which shows they are in right track. If they continue, we can expect great engineers from this institute"

IV. Results and Discussions

In this section, the quantitative and qualitative results of the 3rd semester students in the Analog Electronics course are compared with the performance of previous batches. Figure 12 presents the pass percentage and the highest marks scored out of 100 by students from different batches in the 3rd semester of the course. Due to the integration of theory and practical concepts, the pass percentage increased to 90%. Additionally, over 90% of the students were able to answer the question on FinFET, which was the subject of the technical talk held earlier, showing that students were well-versed in recent developments in FinFET technology. Though there is a slight decrease in the highest marks, this can be attributed to the fact that the exam questions were aligned with NBA (National Board of Accreditation) standards, encompassing multiple Bloom's Taxonomy levels and application-based questions. Nevertheless, this shift led to a qualitative improvement in overall student performance.

It's important to note that the 2023-2024 batch final exam results are not included at this point, as their exams have not yet taken place. A few observations when comparing the 2023-2024 batch (which is currently active) with the 2022-2023 batch are as follows: The 2023-2024 batch is more engaged in participating in competitions and shows strong presentation skills. However, they seem to be more reliant on tools like ChatGPT and, as a result, display weaker technical and analytical skills. This batch also shows more interest in coding rather than hardware, which is impacting their overall development in core technical subjects like Analog Electronics.

In particular, Section B students of the 2023-2024 batch performed poorly when compared to Section A. The lack of analytical skill development in Basic Electronics, due to traditional teaching methods that focused heavily on theory based learning rather than a problem-solving approach, contributed to this discrepancy in performance. The percentage of different modes of TLP is shown in figure 13. It is clearly visible that experiential and active learning for the batch 2022-2026 is effectively implemented to higher percentage. This graph also shows that offline classes are much more effective than online classes for analytical subjects. There has been a significant rise in the analytical skills of the 2022-2026 batch compared to earlier batches, improvement in pass percentage and their affinity towards the analog domain has notably increased, as shown in Fig. 17, Fig. 18 and Fig.19 respectively. This represents a major qualitative improvement, as the industry increasingly seeks candidates with integrated knowledge of both circuits and analysis. Additionally, the number of Analog circuit projects has significantly increased, with a total of 39 projects carried out by students, marking a key achievement. According to evaluators, there has been a drastic improvement in the skills and qualities of students in this batch compared to prior years. Another area of improvement is in technical presentation and documentation. All batches successfully prepared impressive posters and delivered strong presentations. Students also learned paper writing skills in the IEEE format, which will prove valuable for publishing in journals and conferences in the future. For the 2023-2024 batch, evaluators were particularly impressed with the students' explanation level, project execution, and overall presentation. Additionally, students demonstrated the ability to explain the technical details of individual components in depth. This marked a significant improvement in the students' technical proficiency. The evaluators who assessed both the 2022-2023 and 2023-2024 batch projects observed a notable difference. They noted that the students of the 2023-2024 batch were able to explain topics in detail, with a stronger understanding of the fundamentals compared to the previous batch. This feedback affirms the positive impact of the project-based learning system. Figure 19 highlights another qualitative improvement observed in the students. An increasing number of students have actively participated in technical activities such as project exhibitions, IEEE events, and student club activities. These opportunities have notably boosted the confidence of many students, especially those who previously struggled with performance anxiety or were more timid. Project presentations, in particular, have played a significant role in helping these students overcome their apprehensions, showcasing an impressive growth in their self-assurance and ability to engage in technical discussions.

V. IMPACT ANALYSIS

The proposed methodology facilitated interactive discussions and knowledge-sharing sessions between students and faculty, focusing on emerging technologies. It underscored the importance of having strong fundamentals in IC design, which is crucial for students aiming for employment in core industries. The method also provided valuable insights on how to effectively analyze circuit designs and tackle the challenges associated with them. This approach has increased the visibility and reputation of our department, as evidenced by the active participation of students. Several project groups took advantage of the PCB design facility at the AICTE Idea LAB, successfully designing their circuits on PCB themselves—an impact of the industrial visit. A sample PCB designed by the students is shown in Figure 20.

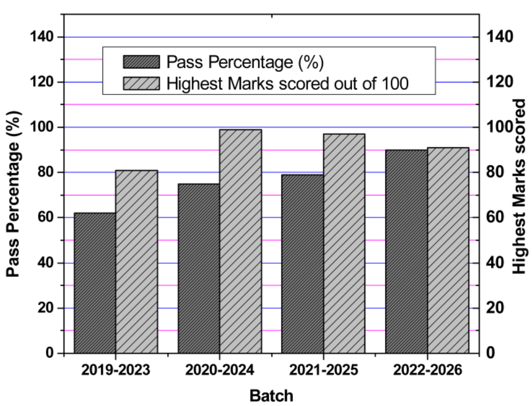

Fig. 17. Pass percentage and highest marks for the course Analog Electronics

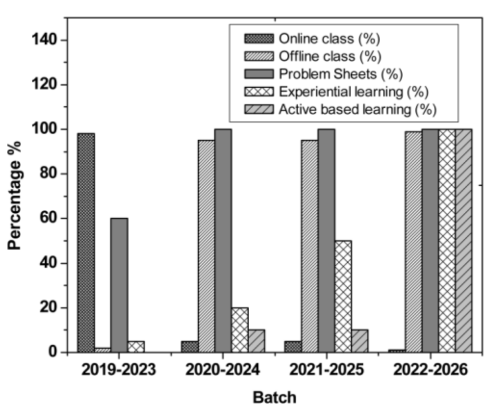

Fig. 18. Improvement in Experiential and active learning percentage in each academic year

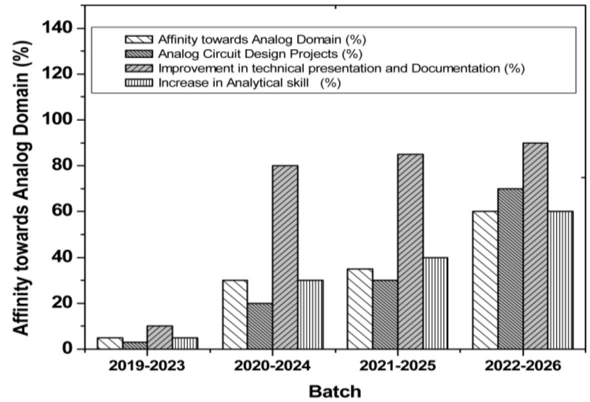

Fig. 19. Improvement in Affinity towards analog domain, analog design projects, technical presentation and documentation skills and analytical skill in circuit design

Experts provided constructive feedback, offering suggestions for improving the projects to address their limitations. Some students acted on these suggestions, enhancing their circuits, which are now on the path to being transformed into viable products. Notably, one of the design projects from the 2022-2026 batch—the "Automatic Water Level Detector and Motor Control"—won first place during the project evaluation. The students took the expert feedback seriously, refining their circuit to overcome its initial shortcomings and ensuring its satisfactory performance. Furthermore, they are now progressing towards applying for a patent, which could result in a cost-effective product that serves underserved communities. This initiative has led to a shift in the students' attitude toward practical implementation of their studies, leading to a deeper understanding of the subject. Moreover, the project has fostered stronger connections between the department and alumni, facilitating enhanced engagement. The outcome has effectively utilized available resources and department funds, significantly improving student skills in communication, documentation, project management, and teamwork.

As part of the Teaching-Learning Cycle (TLC), the slow learners and timid students of the 2022-2026 batch were encouraged to deliver lectures on selected topics in front of the class. This initiative had a significant impact on their learning experience, as it helped them realize the importance of thoroughly analyzing and understanding concepts in order to present them confidently. Additionally, it allowed these students to practice answering queries, further enhancing their comprehension and communication skills. For many, this exercise also served as a way to gradually overcome their stage fear, increasing their confidence and participation in future discussions.

For AY 2023-24, Section A (71 students) was made as study group where the experiential learning is adopted and Section B (71 students) as control group where conventional lab conduction methods were followed. Before exposing the study group participants to the new methodology, both the groups were exposed to pretest. At the end of intervention of each innovative methods, post-test was given to the study as well as control group participants. Evaluation is done using

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Kirkpatrick's Evaluation Model. Effectiveness of intervention was evaluated by class average normalized gain (g),

$$g = \frac{[\%\, posttest\ score - \%\, pretest\ score]}{[100 - \%\, pretest\ score]} \qquad (1)$$

Class-average normalized gain (g) of 0.3, i.e., 30% was considered as statistically significant as per Hake's criteria for effectiveness of an educational intervention. The pretest and post test analysis is conducted for Analog circuits lab in lab cycles- Module1 (Basic experiments- characterization of devices), Module2 (Basic Circuit analysis), Module3 (Circuit Designs), Module4 (Application level). Figure 20 presents the pre-test score comparison and Fig. 21 presents the post test score analysis for control group and study group computed using Eq. 1.

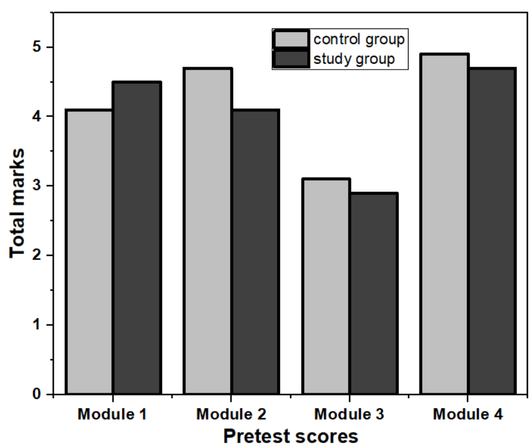

Fig. 20. Mean pre-test score of control group and study group for different modules

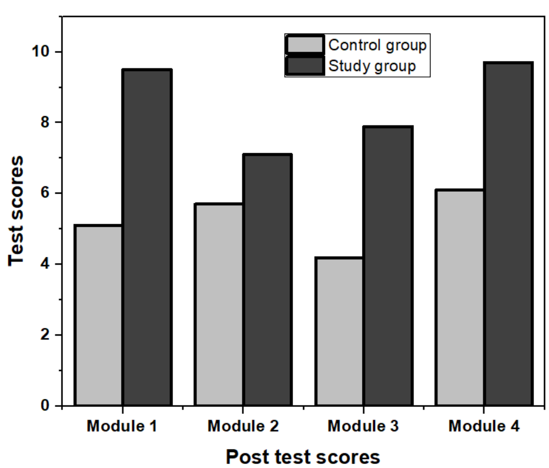

Fig. 21. Mean pre-test score of control group and study group for different modules

The pre-/post-test analysis shows significant improvement in posttest score. Class average normalized gain for study group is more than 0.8 (80%) by adopting experiential learning method in circuits lab conduction while for study group, the class average normalized gain is around 0.5 (50 %) which means moderately effective. This showed that experiential learning in the form of interactive lab conduction using different techniques was highly effective which complies with Kolb's Experiential Learning Theory. These activities boosted up their self-learning ability, analytical skills, and enhanced their problem solving skill and self confidence in the field of Analog Circuit design.

Inspired by the experiential learning activities, students from the 2023-2024 batch took the initiative to form an "IC Design Club" in the department. The club was inaugurated on 6th July 2024 at the college campus. Its primary objective is to foster continuous knowledge upgradation in the field of Integrated Circuit (IC) Design. The students believe that the club has the potential to make significant contributions not only to the institution but also to society. Figure 22 showcases the creative logo and name devised by a collaboration of 4th and 2nd semester students of the ECE department during the Academic Year 2023-24. Currently these students are in the fifth semester and more than 20% students opted Analog Circuit Project as their Minor Project. One of the team secured third prize in Analog Circuit Design category in the 24 hour Circuit Hackathon competition organized by IEEE. This is one of the remarkable achievements from this batch. Five students were selected for Fellowship scheme with stipend offer for ten months to carry out the R&D project. Experiential learning methods have transformed the student capability to work on real–life application projects.

For the 2023-2024 batch, the upgraded methodology of Experiential Learning helped the students gain a deeper understanding of the subject matter, and it provided them insight into why faculty members incorporated various learning strategies. The changes in the teaching pedagogy are made with respect to the feedback from previous batch as well as the project evaluators suggestions. To ensure the students were actively engaged, several activities were organized, such as open book exams, quizzes, fun-based learning events like treasure hunts, technical crosswords, circuit debugging, circuit building etc. These activities not only kept the students engaged but also enhanced their technical skills. Despite the batch's comparatively lower ranking compared to the 2022-2023 admitted batches, their performance showed remarkable progress. However, there is still room for improvement, particularly in focus, reading technical articles, and enhancing problem-solving skills. One more significant impact is that the professors handling this course could learn and share many aspects of subject and other important skills too. More than anything it has given authors satisfaction as the result has proved to meet objectives. Students today need educators who are more than just instructors—they need leaders and role models. The professor not only teaches but inspires students to think beyond limits, aspire higher, and achieve extraordinary success. As of now, the students of this batch has won many technical competitions, more than 30% students participated in various technical events and also represented the institute. Few students have submitted technical articles in International

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conference. The outcome of the experiential learning methodology in Analog Electronics will be reflected in their higher semester subjects. Circuit analysis is fundamental in understanding, designing, and troubleshooting electrical circuits, making it one of the most critical skills for electrical engineering students, particularly in fields like Analog Electronics. The students were able to appreciate the beauty of the semiconductor devices and the circuits in this course through PjBL.

Fig. 22. IC design club logo and name

VI. Challenges Encountered and Mitigation Strategies

The primary challenge in implementing the new teaching methodology for the Analog Electronics subject was helping students adapt to the new approach. In addition, the evaluation schemes of other subjects are relatively liberal, which makes students less motivated to actively participate in the prescribed activities. Another significant challenge is that on-campus placements in the core ECE domain are fewer compared to the software sector. As a result, many ECE students are placed in IT companies rather than core ECE roles, leading to reduced motivation among students to prioritize learning core subjects. The introduction of the new TLP method has brought about a remarkable change by promoting activity-based learning. This approach has enabled students to apply theoretical concepts to practical applications effectively. The impact of the new learning method becomes more evident in the higher semesters. Students who were part of the IC Design student club were selected by core ECE companies, more than five technical articles were published by the same batch, two patents were filed in circuit-related areas, Best Project awards were received, and students actively participated in the Smart India Hackathon and various technical projects.

TABLE IV
OUTCOME OF EXPERIENTIAL LEARNING

No. of students got placement in ECE Core Domain		
AY 2021-2025	AY 2022-26	AY 2023-27
10	30	NA
No. of students got internship in ECE core Domain		
40	50	20
No. of students got funding for their Projects		
3	20	30
No. of students published technical articles		
2	10	5

Table IV summarizes the outcomes of the innovative experiential learning practices implemented in circuit-related courses. Students from Academic Year (AY) 2021–2025 are currently employed in industry. In this cohort, only ten students were members of the IC Design Club, and a structured experiential learning component had not yet been formally introduced. However, during their third semester in the Analog Electronics course and laboratory, students undertook an innovative poster design activity on the evolution of transistors, organized in commemoration of the 75th anniversary of the transistor's invention. This activity provided exposure to diverse transistor architectures and enhanced students' awareness of key contributors to transistor development. Students from AY 2022–2026 are presently in their final semester, and the placement process is ongoing. Notably, a significant proportion of students placed in core electronics domains belong to the IC Design Club initiated by the department. The integration of experiential learning strategies and hands-on training sessions contributed to strengthening students' conceptual understanding of circuit fundamentals. Consequently, students demonstrated improved confidence and competence during technical interviews.

Industry feedback collected after the interview process further validates these outcomes. One recruiting expert remarked:

"There is a significant improvement in student performance compared to previous recruitment cycles and students from other institutions. This year, the selection process was particularly challenging due to the overall quality of candidates. The students demonstrated strong fundamentals in circuit concepts, and their résumés reflected active involvement in the IC Design Club. We appreciate the faculty's efforts in aligning student training with industry requirements."

Feedback received from alumni who served on the recruitment committee further corroborates the effectiveness of the experiential learning approach. One alumnus noted:

"A majority of the shortlisted candidates were members of the IC Design Club, and several of them had been evaluated by me earlier during the third-semester project expo. Their participation in these activities significantly strengthened their conceptual understanding and enhanced their interview performance. The faculty's efforts to equip students with industry-relevant technical skills are clearly evident. The experiential learning methodologies and best practices adopted in circuit-related courses are highly effective and could be extended to other subjects."

Students from AY-2023-27 are currently in sixth semester, their placements not yet started. In this batch 40 % students are from IC Design club and they have experienced the TLP process in a different way with open book exams, poster presentation, project expos, paper presentations, hackathons, funded projects etc. This batch is trained in a different way. The outcome is visible in Table IV.

VII. FUTURE SCOPE AND CONCLUSION

In 4th semester students have course Linear integrated circuits which is based on Analog electronics. Similar improvements can be achieved in that subject also as that also need mathematical and analytical skills for 2023-2024 admitted batch. It is observed that many students are still in their comfort zone and not ready to come out of it. To overcome that subject related topics may be given for students to prepare and present in class under the supervision and guidance of faculty and analytical skill evaluation should be conducted in lab as well as in theory. Students can further improve their projects by considering the suggestions from examiners and present their work in conferences at other colleges/universities and journals. Few more projects may be converted into low cost products by availing facility in Idea LAB of the college which can be a step for "Make in INDIA". The project outcome of 2022-2023 admitted batch is one of the analog project was improvised with the guidance of the faculty mentor and filed patent for that idea. Working with specialized tools and equipment, such as oscilloscopes, function generators, and multi meters, can present a learning curve for students, especially in terms of practical application. Integrating theoretical knowledge with practical design skills to create functional analog circuits can be challenging for students, particularly in understanding the trade-offs between theory and real-world constraints. By immersing students in hands-on projects, simulations, and interactive activities, experiential learning cultivates critical thinking, problem-solving abilities, and teamwork skills essential for success in the dynamic field of Electronics and Communication Engineering. This sets the stage for exploring the significance and impact of experiential learning in shaping the future engineers in this specialized discipline.

APPENDIX

A. Feedback 2022-2026 batch- Sample set

Timestamp	Full Name	USN	PO1: By participating in analog circuit design project evaluation & poster presentation, are you able to apply the knowledge of engineering fundamentals in analyzing the analog circuits	PO2: By participating in analog circuit design project evaluation & poster presentation, are you able to analyze and identify the issues to considered while implementing the circuit	PO3: By participating in analog circuit design project evaluation & poster presentation, are you able to Design an Electronics and Communication system, component or process as per needs and specifications within realistic	PO4: By participating in analog circuit design project evaluation & poster presentation are you able to Design and verify the experimental results to analyze and interpret data.	PO5: By participating in analog circuit design project evaluation & poster presentation, Are you able to use various simulation softwares for testing the design and use the equipments to test your project prototype?	PO7: By participating in analog circuit design project evaluation & poster presentation, are you able to Understand societal and environmental impacts of engineering problems and provide sustainable solutions for the same.	PO8: By participating in analog circuit design project evaluation & poster presentation, to Practice appropriate professional responsibilities and ethics.	PO9: By participating in analog circuit design project evaluation & poster presentation, Are you able to Involve in Team work function effectively as an individual and as a member or leader in diverse teams	PO10: By participating in analog circuit design project evaluation & poster presentation, are you able to communicate effectively with the engineering community and with society at large such as being able to	PO11: By participating in analog circuit design project evaluation & poster presentation are you able to Adopt engineering and managerial skills in project environment.	PO12: By participating in analog circuit design project evaluation & poster presentation, are you able to develop confidence for self education, leading to life long learning in the context of overchanging technology	PSO1: By participating in analog circuit design project evaluation & poster presentation, are you able to do Mapping theoretical knowledge to real-world applications in areas like Communication, Embedded systems, Signal	PSO2: By participating in analog circuit design project evaluation & poster presentation are you able to know about the various non-ideal effects in the analog circuit design	PSO3: By participating in analog circuit design project evaluation & poster presentation are you able to understand the fundamentals required to get in career and able to Pursue higher education, research or entrepreneurs
12:12:14 PM	Mehul Jhunjhunwala	4NI22EC050	4	4	4	4	5	4	4	4	4	4	4	4	(Strongly Agree	4
12:12:21 PM	Ansh Vinod Patil	4NI22EC010	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	4	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	4	4
12:12:33 PM	Karthik MN	4ni22ec035	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:12:46 PM	Ayush Salecha	4NI22EC015	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:12:52 PM	Jayesh Gidwani	4NI22EC032	4	4	(Strongly Agree	4	5	(Strongly Agree	4	(Strongly Agree	(Strongly Agree	4	(Strongly Agree	4	4	5 (Strongly Agree)
12:12:57 PM	Disha L	4NI22EC028	4	5 (Strongly Agree)	(Strongly Agree	4	5	4	4	(Strongly Agree	(Strongly Agree	4	4	4	3	4
12:13:12 PM	D Dhanush	4NI22EC023	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:13:24 PM	Adithya S	4NI22EC003	4	4	(Strongly Agree	4	5	4	4	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	4	3	4
12:13:36 PM	DHANARAJ.R	4NI22EC027	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	(Strongly Agree	4	5 (Strongly Agree)
12:13:39 PM	ANUSHA K G	4NI22EC012	4	5 (Strongly Agree)	4	4	5	4	(Strongly Agree	4	(Strongly Agree	(Strongly Agree	4	4	(Strongly Agree	4
12:13:40 PM	Deekshith P	4NI22EC025	4	5 (Strongly Agree)	(Strongly Agree	4	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4
12:14:01 PM	Bhavna R	4NI22EC019	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:14:03 PM	CHANDAN J	4NI23EC402	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:14:04 PM	Pannaga Kalkur	4NI22EC058	4	4	4	4	5	4	4	4	4	4	4	4	4	5 (Strongly Agree)
12:14:07 PM	M N Varshini	4NI22EC044	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:14:16 PM	Nandeesh M	4NI23EC406	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	(Strongly Agree	4	5 (Strongly Agree)
12:14:21 PM	Gopinath R	4NI23EC404	4	4	4	4	5	4	4	4	4	4	4	4	4	4
12:14:21 PM	Milana G	4NI22EC051	4	4	4	4	5	4	4	(Strongly Agree	3	4	4	4	3	4
12:14:31 PM	Adhrutha S M	4NI22EC002	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:14:43 PM	Nishchal PR	4NI22EC56	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:14:58 PM	Lohith.R	4NI22EC130	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4
12:15:04 PM	DEEPU M	4NI22EC026	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:16:11 PM	Aishwarya K	4NI22EC004	5 (Strongly Agree)	5 (Strongly Agree)	4	4	5	(Strongly Agree	4	4	(Strongly Agree	4	4	4	4	4
12:16:17 PM	Hamsa Bhaskar. B	4NI22EC029	5 (Strongly Agree)	5 (Strongly Agree)	4	4	5	(Strongly Agree	4	(Strongly Agree	(Strongly Agree	4	(Strongly Agree	4	4	4
12:17:10 PM	Anthany Lanson S	4NI22EC011	5 (Strongly Agree)	5 (Strongly Agree)	4	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	5 (Strongly Agree)
12:17:42 PM	MALLAPPA BAGOJI	4NI22EC046	4	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	4	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	4	(Strongly Agree	5 (Strongly Agree)
12:18:59 PM	Manasa Mukund	4NI22EC047	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:21:36 PM	Pooja M N	4NI22EC061	5 (Strongly Agree)	5 (Strongly Agree)	(Strongly Agree	(Strongly Agree	5	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	(Strongly Agree	5 (Strongly Agree)
12:22:18 PM	PREKSHA GM	4NI22EC068	4	4	3	3	5	4	(Strongly Agree	4	(Strongly Agree	4	4	3	4	4

B. Feedback 2023-2027 batch- Sample

Project Title	Have yo	1. What is hardware debugging?	2. What is your takeaway of this keynote session?	3. Write in your own words why Project based learning is very important	4. Would you like to have such talk	5. How do you rate the keynote address?	6. What are the different development steps in making a product?	Is	Are	How	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	1. Write in your own words about your view " Doing design projects in academics is important to bridge the gap between theory and practical"	2. Write in your own words How conducting lab experiments in a systematic way and making you write the inference in your own words help in your professional development?
Battery eliminator	No										4	5	5	5	5	5	5	4	5	4	4	4	4	4	3	Doing design projects in	Conducting lab experiments
Design and Implementation of Half Subtractor using discrete components	Yes	Hardware debugging is the process of identifying and fixing issues or errors in a hardware circuit or system. It involves using tools and techniques to analyze circuit behavior, locate faults, and ensure the system operates as intended	The keynote session emphasized the importance of practical experience in circuit design and the value of a systematic approach to problem-solving during product development.	Project-based learning allows students to apply theoretical knowledge in real-world scenarios, enhancing their problem-solving skills, creativity, and teamwork. It bridges the gap between academic concepts and industry practices, preparing students for professional challenges	Yes	5	Developing a product involves identifying a problem or need, followed by designing and creating a prototype. The prototype is tested and debugged to ensure functionality and quality. Based on feedback, the product is refined and prepared for large-scale manufacturing. Finally, the product is launched, with ongoing updates and	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Design projects in academics are essential because they help students apply theoretical knowledge to real-world problems. This hands-on experience enhances understanding and builds critical thinking and problem-solving skills. It prepares students for industry challenges by teaching them to design, test, and refine solutions, thereby bridging the gap between classroom learning and practical applications.	Conducting lab experiments systematically develops discipli attention to detail, and a structured approach to problem solving. Writing inferences in ow own words enhances comprehension, communication and analytical skills. These practices prepare students for professional roles by fostering clear understanding of concepts and the ability to present finding effectively.
Headset/ Loudspeaker convert	No										5	4	4	4	5	4	5	5	4	4	5	5	5	5	4	It is important we are learning more in practical sessions	Doing Lab experiments step bh step we are learning how to han the components and how to analyze the circuit
Simple crystal tester	Yes	Hardware debugging is the process of identifying and fixing issues in electronic components using tools like multimeters and oscilloscopes.	To focus on our skills and to understand whatever we learn clearly and to work in labs and do circuit analysis as much as possible	To learn the analysis,to learn clearly about the components,to build circuits by our own..	Yes	5	1. Idea Generation 2. Research 3. Design 4. Development 5. Launch	4	5	5	5	5	5	5	5	5	4	4	4	5	5	5	5	4	5	We can implement and connect whatever we have learnt in theory with practical	Labs are really helpful as we can learn things practically
Automatic Night light	No										5	4	4	4	5	4	4	4	5	5	5	5	5	5	5	Will help us to understand the practical working	It will help us to understand the working of the components
Headset Or Loudspeaker Converter	Yes	Hardware debugging is the process of identifying and fixing problems with the physical	Want to spend time in lab be good at practical	We learned new things which are required and analyzed the circuit with different	Yes	5	Idea generation, product development , design and testing, hardware debugging, marketing	5	5	5	4	3	5	4	4	5	4	4	3	2	4	3	3	4	4	project is more important which develps our skill and teach real environment	Yes by spending more time in la we get more knowledge about th components

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