DESIGN AND IMPLEMENTATION OF AN AI-ASSISTED MODULAR WEB-ORIENTED LEARNING MANAGEMENT SYSTEM (LMS)

A Methodology report submitted in
partial fulfilment of requirements for the degree of

Bachelor of Technology

In

Computer Engineering

By

Ashish Sunar (22CSEC09)

Aakansh Rai (22CSEC25)

Ayush Chettri (22CSEC34)

Under the supervision of

Mr. Asish Shakya

Assistant Professor

Department of Computer Engineering

DEPARTMENT OF COMPUTER ENGINEERING

SIKKIM INSTITUTE OF SCIENCE & TECHNOLOGY

(An affiliated college of Central University)

2025

ABSTRACT

Learning Management Systems (LMS) are very important in modern education. They help colleges deliver content, manage courses, and improve communication between teachers and students. But our college does not have any LMS, which makes managing academic work difficult and time-consuming. Most existing LMS platforms also lack smart features that make learning easier and more engaging.

This project aims to create an LMS for our college with three main features: attendance management, role-based access control, and an AI-powered chatbot. The attendance feature will help track student participation in real time and reduce manual work. Role-based access will make sure teachers, students, and admins get the tools they need. The AI chatbot will act as a virtual assistant, giving 24/7 support and guiding users through the system.

By introducing this LMS, we will solve the problem of not having a digital learning system in our college. It will make learning easier, save time, and create a smarter and more interactive academic environment.

***Keywords**: Learning Management System (LMS), digital classroom, attendance management, role-based access control, AI-powered chatbot, virtual assistant.*

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In today's world, technology plays a big role in education. Schools, colleges, and universities use digital tools to make learning easier and more organized. One of the most important tools is the Learning Management System (LMS). An LMS helps share study materials, manage courses, communicate with students, and track academic progress. But our college does not have an LMS, which makes managing classes and communication difficult. Also, many existing LMS platforms do not have smart features that can make learning better and more interactive

This project aims to build a smart and efficient LMS for our college. The goal is to improve how students, teachers, and administrators manage academic activities. The proposed LMS will include three main features: attendance management, role-based access control, and an AI-powered chatbot

The attendance feature will allow teachers to record attendance automatically and in real time. This will save time, reduce errors, and help track student participation easily

The role-based access feature will make sure each user: student, teacher, or administrator, gets access only to what they need. For example, students can see their classes and grades, teachers can manage lessons, and administrators can manage the whole system. This will make the platform organized and secure

Finally, the AI-powered chatbot will act as a virtual assistant. It will be available all the time to answer questions, help users navigate the system, and provide academic support. This will make the LMS more user-friendly and interactive.

By adding these smart features in one system, this LMS will help solve the problem of not having a digital learning platform in our college. It will make learning smoother, reduce teachers' workload, and give better support to students.

1.1 LITERATURE SURVEY

Table 1.1.1 Literature Survey 1

1.	**Name of Paper**	Learning Management System (LMS) Research during 1991-2021: How Technology Affects Education.
	Journal Name	International Journal of Emerging Technologies in Learning (iJET)
	Published Date	July 2022
	Authors	Binar Kurnia Prahani, Jauharoti Alfin, Ah. Zakki Fuad, Hanandita Veda Saphira, Eko Hariyono, Nadi Suprapto
	Findings	• LMS research has increased significantly over three decades. • E-learning and technology integration are major trends in education. • The USA, China, and Malaysia lead in LMS-related research.
	Research Gap	• Limited work on AI-powered LMS solutions. • Lack of modular and flexible system architectures. • Few studies on personalization and adaptive learning features.
	Relevance with our work	• This project focuses on AI-assisted LMS design, addressing personalization gaps. • Emphasizes modular and web-oriented architecture, which current studies lack. • Supports innovation in making LMS adaptive and intelligent for better learning outcomes.

Table 1.1.2 Literature Survey 2

2.	**Name of Paper**	Development of Learning Management Systems and Effects in Education: A Comprehensive Review
	Journal Name	International Journal of Novel Research and Development (IJNRD)
	Published Date	May 2024
	Authors	Saksham Saxena, Deepti Sharma, Lokesh Saxen, Aayush Singh, Dr. Vrinda Sachdeva
	Findings	• LMS design is rooted in learning theories, emphasizing social learning, experiential learning, and cognitive alignment in digital platforms. • Research highlights that user experience, accessibility, and ease of use are crucial factors influencing LMS adoption.
	Research Gap	• Limited research addresses how LMS can overcome the digital divide and ensure accessibility for marginalized learners. • Trends like AI and mobile learning are discussed, empirical evidence on their effectiveness within LMS remains sparse.
	Relevance with our work	• This project builds up online learning environment with compatibility. • By addressing limitations in inclusivity and adaptability, this project extends LMS research with intelligent, AI-assisted support for diverse learners.

Table 1.1.3 Literature Survey 3

3.	**Name of Paper**	Learning Management System (LMS) among University Students: Does It Work?
	Journal Name	International Journal of e-Education, e-Business, e-Management, and e-Learning (IJEEEE)
	Published Date	June 2013
	Authors	Nor Azura Adzharuddin, Lee Hwei Ling
	Findings	• LMS improves communication between students and lecturers beyond classroom settings. • Provides access to course materials and interactive features (forums, discussions). • Technical issues and underutilization of interactive features are common barriers.
	Research Gap	• Limited research on adaptive and customizable LMS features. • Lack of real-time engagement tools like AI chat or personalized recommendations. • Insufficient integration of analytics for student performance tracking.
	Relevance with our work	• This project addresses gaps by implementing AI-assisted modular LMS. • Focuses on real-time interaction, adaptive learning, and better engagement. • Provides a customizable and scalable architecture beyond traditional LMS designs.

Table 1.1.4 Literature Survey 4

4.	**Name of Paper**	Learning Management Systems in Education: Research and Challenges
	Journal Name	*Book Chapter in* Handbook of Research on Redesigning Teaching, Learning, and Assessment in the Digital Era
	Published Date	June 2022
	Authors	Albérico Manuel Rosário, Joana Carmo Dias
	Findings	• LMS technologies revolutionize education by managing learning materials, tracking performance, and improving interactions in education. • Adoption of LMS has grown significantly, with most higher education institutions globally integrating some form of LMS. • Emphasis placed on the need to understand user requirements (students, teachers, administrators) to ensure effectiveness of LMS design.
	Research Gap	• Many studies focus on adoption trends but fewer provide solutions for adaptability. • Few frameworks address long-term sustainability and compatibility into LMS.
	Relevance with our work	• The emphasis on tailoring LMS to user needs complements this project's AI-driven personalization features. • This project extends the identified opportunities by embedding intelligence and modularity into LMS frameworks.

Table 1.1.5 Literature Survey 5

5.	**Name of Paper**	Learning Management Systems for Higher Education: A Brief Comparison
	Journal Name	Discover Education
	Published Date	May 2024
	Authors	Lisseth Sanchez, Jefferson Penarreta, Xavier Soria Poma
	Findings	• Compared popular LMS platforms like Moodle, Blackboard, and Canvas for higher education. • Moodle is widely adopted due to open-source flexibility. • Key evaluation factors: cost, usability, scalability, and integration capabilities.
	Research Gap	• Lack of AI-driven personalization and predictive analytics in current LMS. • Minimal focus on modular web-based architectures for adaptability. • Limited work on enhanced engagement tools beyond traditional features.
	Relevance with our work	• This project offers AI-assisted modular design, overcoming personalization and scalability limitations. • Incorporates analytics and adaptive features to improve engagement and usability.

Table 1.1.6 Literature Survey 6

6.	**Name of Paper**	Learning Management System
	Journal Name	International Journal of Business and Social Science
	Published Date	June 2012
	Authors	Farshad Mahnegar
	Findings	• Distance learning evolved through stages: correspondence, multimedia, telematic teaching, and Internet-based learning. • Internet and web technologies are the backbone of modern virtual learning environments. • LMS platforms provide tools for managing courses, learners, and assessments.
	Research Gap	• Limited integration of AI-based adaptive learning in LMS systems. • Minimal research on automating personalization and engagement analytics. • Lack of flexible modular architecture for scalable learning solutions.
	Relevance with our work	• This project aims to incorporate personalization and modular design, addressing flexibility issues. • Enhances intelligent engagement tools and scalability for future educational trends.

Table 1.1.7 Literature Survey 7

7.	**Name of Paper**	Learning Management Systems (LMS) and E-Learning Management: An Integrative Review and Research Agenda
	Journal Name	Journal of Information Systems and Technology Management (JISTEM)
	Published Date	May–August 2016
	Authors	Paulo Cristiano de Oliveira, Cristiano Jose Castro de Almeida Cunha, Marina Keiko Nakayama
	Findings	• Although LMSs are now a standard tool in education, most applications focus on content delivery rather than broader e-learning management. • LMSs are insufficient in terms of coordination and strategic administrative functions.
	Research Gap	• There is a lack of empirical research focused on how LMS platforms can support strategic and managerial aspects. • The role of LMSs in providing institution-wide oversight, such as monitoring performance remains largely unexamined.
	Relevance with our work	• This project addresses this gap by integrating real-time attendance monitoring. • This project address better administrative functions and management by providing role-based access.

Table 1.1.8 Literature Survey 8

8.	**Name of Paper**	Web-based Learning Management System Considerations for Higher Education
	Journal Name	Learning and Performance Quarterly
	Published Date	2013
	Authors	Chih-Hung Chung, Laura A. Pasquini, Chang E. Koh
	Findings	• Successful LMS adoption requires considering usability, scalability, and integration with institutional systems. • Key factors include learner engagement, course design, and content accessibility. • Emphasizes security and data privacy as critical aspects in LMS deployment.
	Research Gap	• Limited focus on AI-based personalization and predictive analytics. • Lack of flexible modular architectures for future-ready LMS design. • Minimal research on real-time data analytics for engagement monitoring.
	Relevance with our work	• This project addresses these gaps by enabling adaptive learning, scalability, and advanced analytics. • Ensures data-driven personalization and improved user experience, aligning with modern LMS requirements.

Table 1.1.9 Literature Survey 9

9.	**Name of Paper**	The Analysis of a Learning Management System from a Design and Development Perspective
	Journal Name	International Journal of Information and Education Technology
	Published Date	April 2022
	Authors	Abdallah Ahmed Hassan Alia
	Findings	• Integration of Learning Management Systems (LMS) with Course Management Systems (CMS) significantly reduces manual workload. • Automatic synchronization of user accounts, sessions, and course data improves accuracy and saves time. • The proposed Learning Integration Course model demonstrated faster performance compared to traditional CSV/manual processes.
	Research Gap	• Limited exploration of LMS integration in large-scale • Scalability and adaptability of integration frameworks for emerging educational technologies remain underexplored.
	Relevance with our work	• The paper emphasizes collaboration and interaction, which complements this project's AI-assisted features for learner engagement. • By addressing the gaps in scalability and automation, this project extends this work towards a more intelligent, web-oriented LMS.

Table 1.1.10 Literature Survey 10

10.	**Name of Paper**	Design And Development E-Learning System by Learning Management System (LMS) In Vocational Education
	Journal Name	International Journal of Scientific & Technology Research
	Published Date	January 2020
	Authors	Rabiman Rabiman, Muhammad Nurtanto, Nur Kholifah
	Findings	• Traditional classroom methods face limitations such as lack of repetition, time constraints, and limited knowledge transfer. • LMS-based e-learning systems were developed using the Hannafin and Peck model (needs analysis, design, development, implementation). • LMS implementation improved learning quality, student engagement, and self-reflection, especially in vocational training contexts.
	Research Gap	• Focus was mainly on vocational education; limited generalization to modular LMS frameworks. • The system lacked advancement and not deeply integrated with adaptive features.
	Relevance with our work	• Highlights the importance of structured design models (needs analysis → design → implementation), which can guide this modular LMS development. • This AI-assisted features can extend beyond what this study achieved, by automating content delivery and providing AI for learner support

1.2 PROBLEM DEFINITION

1. **No Existing LMS in College:** SIST currently does not have any Learning Management System, making it difficult to manage classes, share study materials, and track student performance in an organized way.
2. **Lack of Role-Based Access Control:** Many systems do not provide fine-grained access controls for different roles (e.g., students, teachers, admins), causing confusion and data mismanagement.
3. **Weak Attendance Systems:** Attendance is often manually tracked or easily manipulated.
4. **No On-Demand Support**: Students often need help outside class hours, but most LMS platforms do not provide a 24x7 support system or AI assistant to answer common queries.

1.3 OBJECTIVES

1. **Develop an LMS for college**
   - Develop an LMS that provides a digital platform for teaching, learning, and communication.
2. **Develop Role-Based Access Control (RBAC)**
   - Create a permission-based access system for different user roles (e.g., student, teacher, admin) with specific content and feature visibility.
3. **Integrate an attendance management system**
   - Attendance management system within the LMS to enable real-time tracking, reduce manual errors, and generate accurate attendance reports.
4. **Integrate a 24x7 AI Chatbot for Academic Help**
   - Deploy an intelligent chatbot that can assist students with course-related queries, FAQs and navigation help at any time.

CHAPTER 2

METHODOLOGY

2.1 METHODOLOGY

This section outlines the step-by-step approach adopted to develop the Learning Management System (LMS). The methodology follows the Iterative Waterfall Model**,** which ensures structured development with opportunities for feedback and refinement. The Iterative Waterfall allows feedback loops between stages, enabling improvements at each phase without restarting the entire process.

2.1.1 Requirement Analysis

- **Identify core users:** Admin, Teacher, Student.
- **Define features:**
    1. User authentication & role management.
    2. Course creation & management.
    3. Assignment upload & submission.
    4. Attendance management.
- **Deliverable:** Software Requirement Specification (SRS).

2.1.2 System Design

- **Architecture:**
    1. **Frontend:** React.js for dynamic UI.
    2. **Backend:** Node.js with Express for API handling.
    3. **Database:** PostgreSQL for relational data.
- **Design activities:**
    1. Create ER diagrams for database schema.
    2. Design UI wireframes for dashboards and course pages.
- **Deliverable:** System Design Document**.**

2.1.3 Development

- **Frontend:**
    1. Build responsive UI using React.js.
    2. Use React Router for navigation.
    3. Integrate Axios for API communication.

- **Backend:**
    1. Implement RESTful APIs using Node.js and Express.
    2. Integrate JWT for authentication.
- **Database:**
    1. Design normalized schema for courses, users, submissions.
    2. Use Sequelize/Prisma ORM for queries.
- **Deliverable:** Working modules stored in GitHub [www.github.com/ayushchettri/my-lms].

2.1.4 Testing

- **Unit Testing:**
    1. Launch React components using npm.
    2. Validate Node.js routes using Postman.
    3. Validate React components and Node.js routes.
- **Integration Testing:** Ensure proper communication between frontend and backend.
- **System Testing:** Verify overall LMS workflow.
- **User Acceptance Testing:** Conduct trials with real users.
- **Deliverable:** Test reports and bug fixes.

2.1.5 Deployment

- **Frontend:** Deploy React app on Vercel.
- **Backend:** Deploy Node.js app on Heroku/.
- **Database:** PostgreSQL hosted on AWS RDS.
- Implement CI/CD pipelines for automated updates.
- **Deliverable:** Live LMS URL.

2.1.6 Maintenance

- Bug fixes.
- Features updates.
- **Deliverable:** Updated and better versions.

2.1.7 Tools and Technologies

- **Frontend:** React.js
- **Backend:** Node.js (Express.js)
- **Database:** PostgreSQL
- **Design Tools:** Figma for UI/UX
- **Version Control:** GitHub
- **Deployment:** Vercel, Heroku, AWS

2.2 SYSTEM DESIGN

2.2.1 Iterative Waterfall Model Diagram

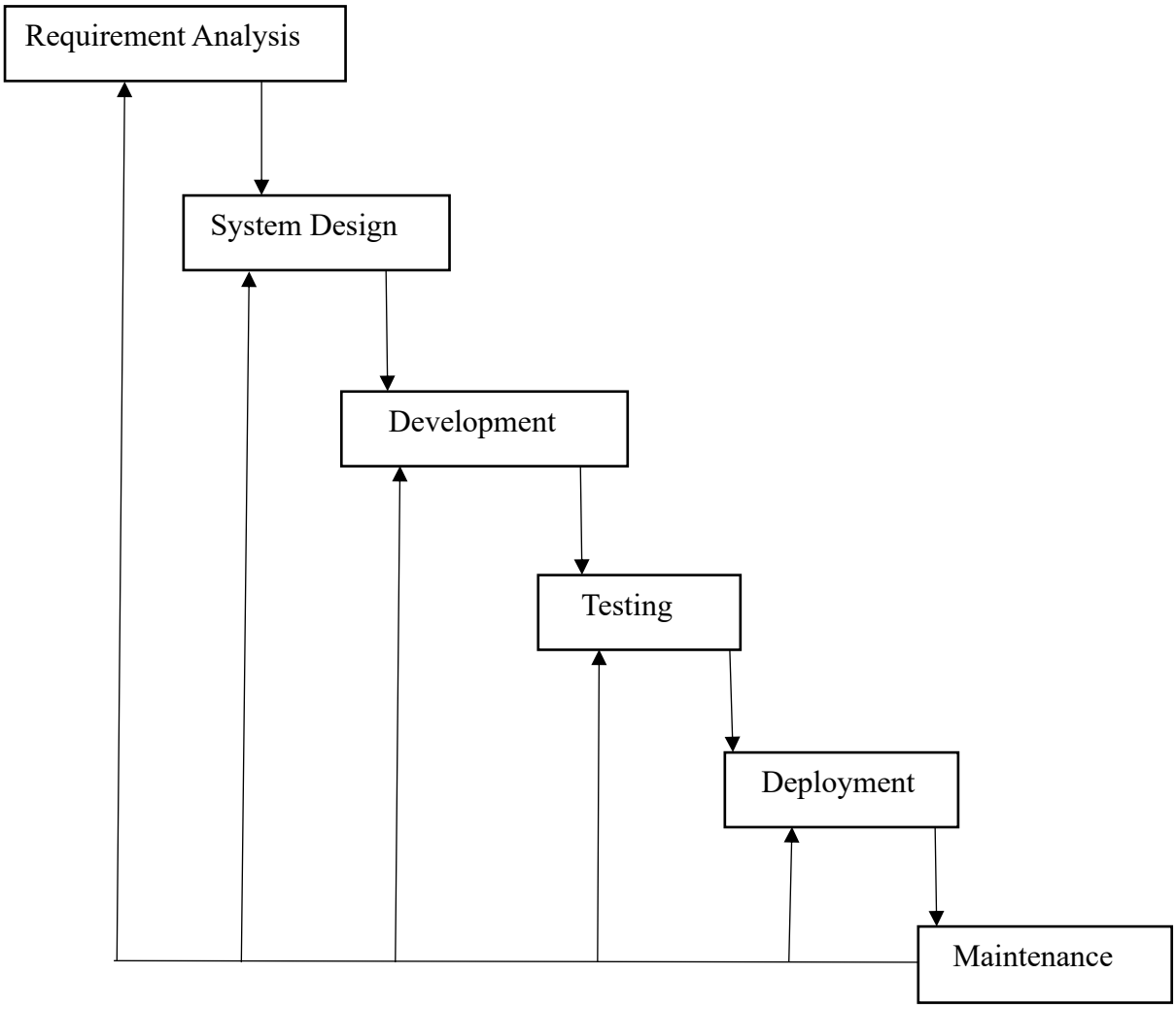

Fig. 2.2.1: Iterative Waterfall Model Diagram

2.2.2 System Flow

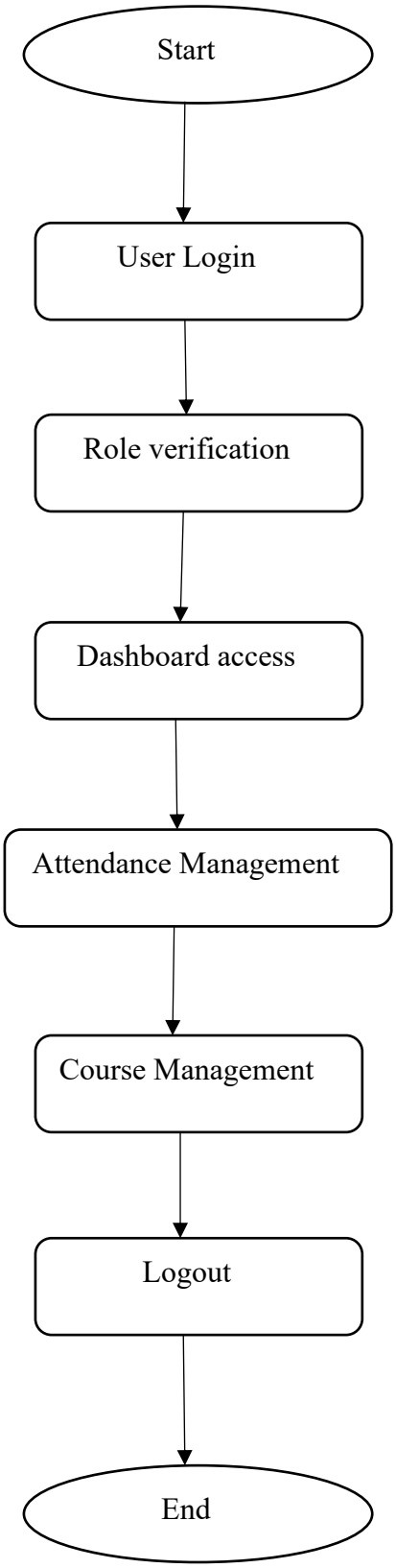

Fig. 2.2.2: System Flow Diagram

2.2.3 Use Case Diagram

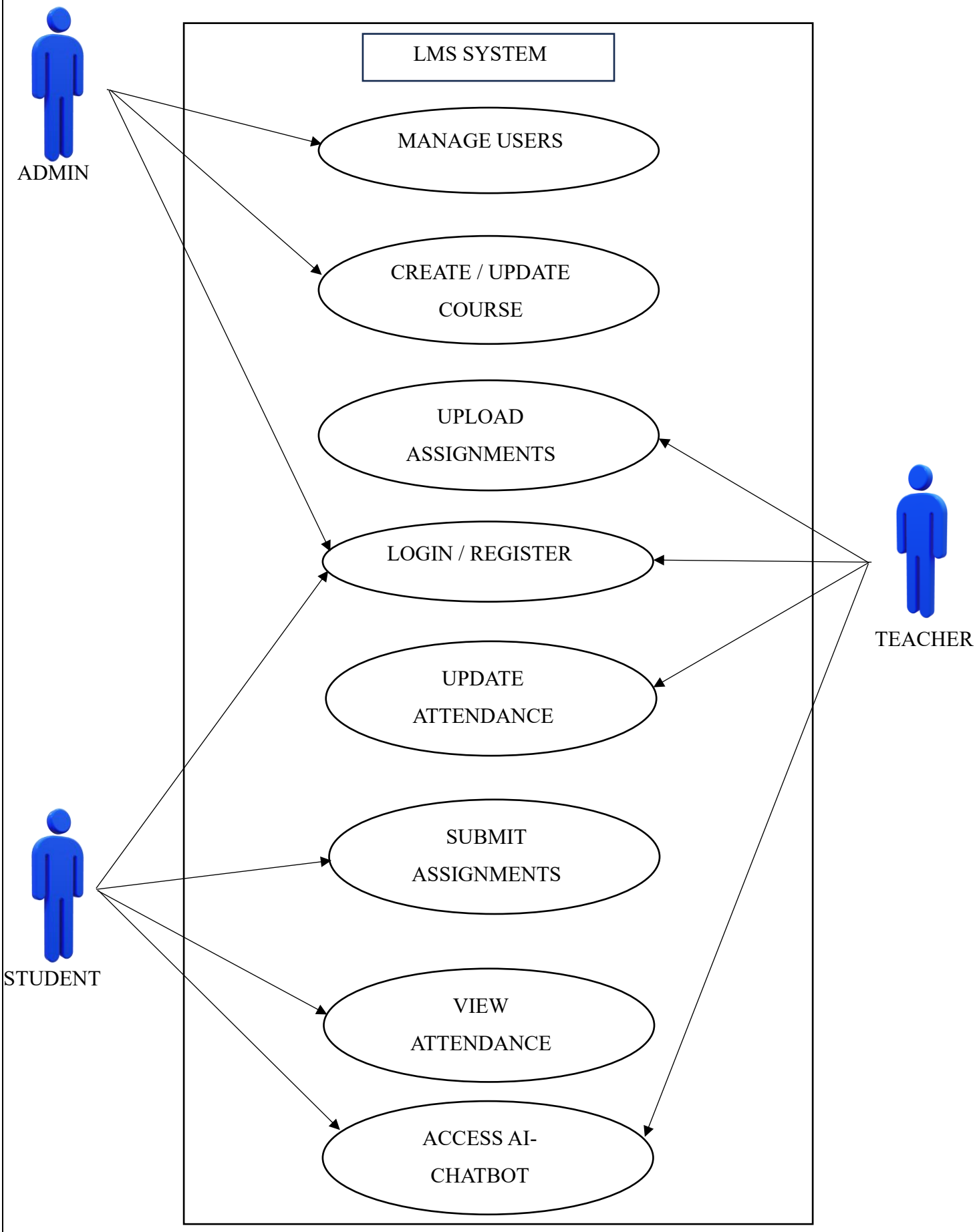

Fig. 2.2.3: Use Case Diagram

2.2.4 Data Flow Diagram

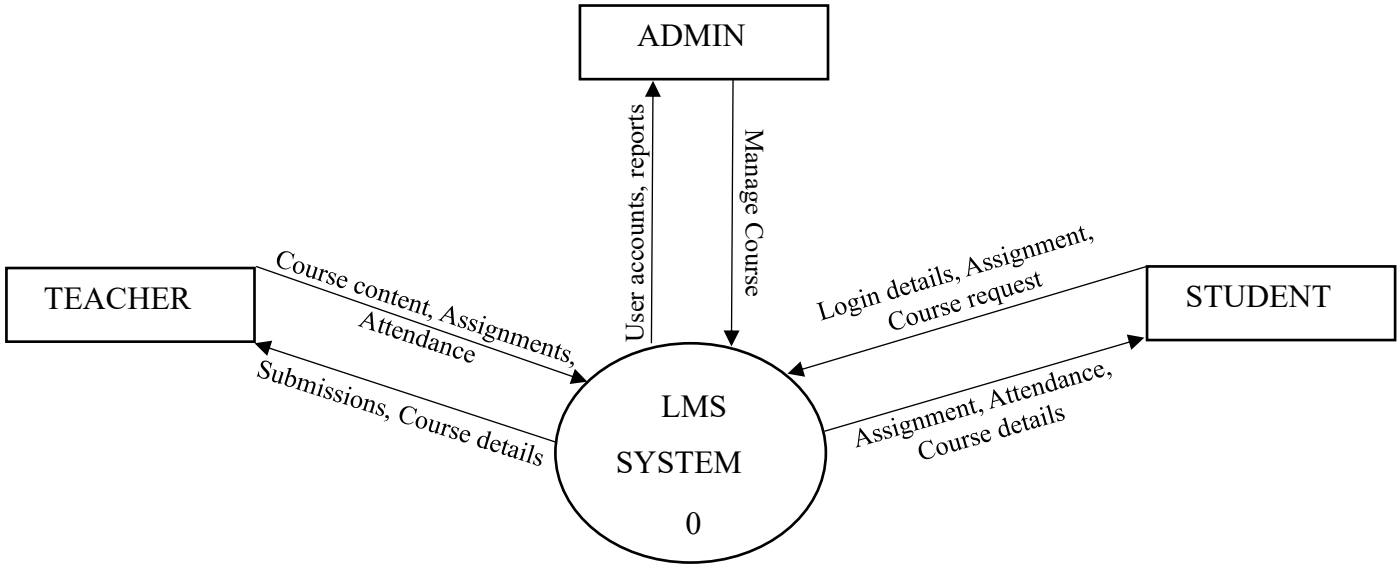

Fig. 2.2.4: Data Flow Diagram- Level 0

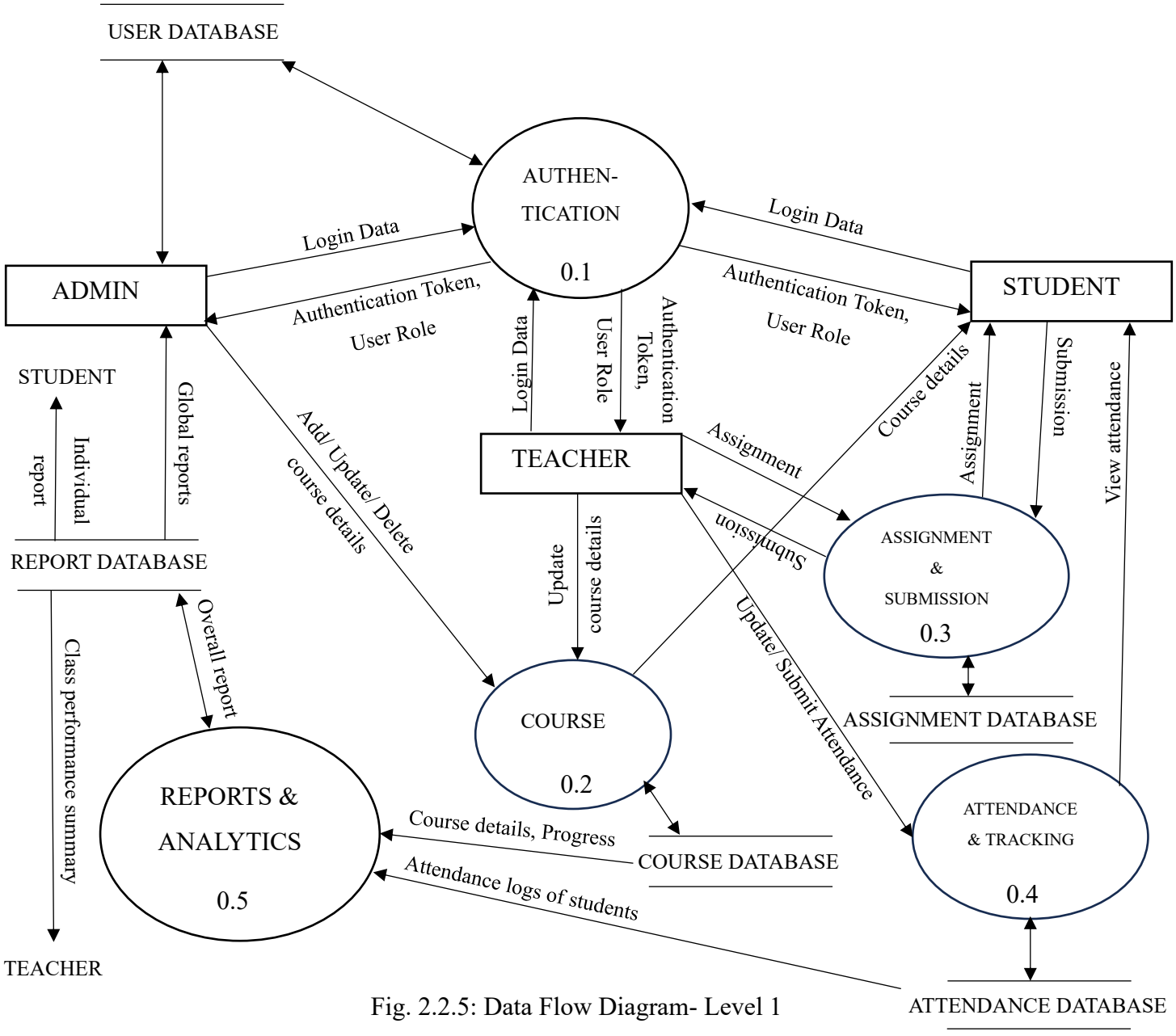

Fig. 2.2.5: Data Flow Diagram- Level 1

2.2.5 System Architecture Diagram

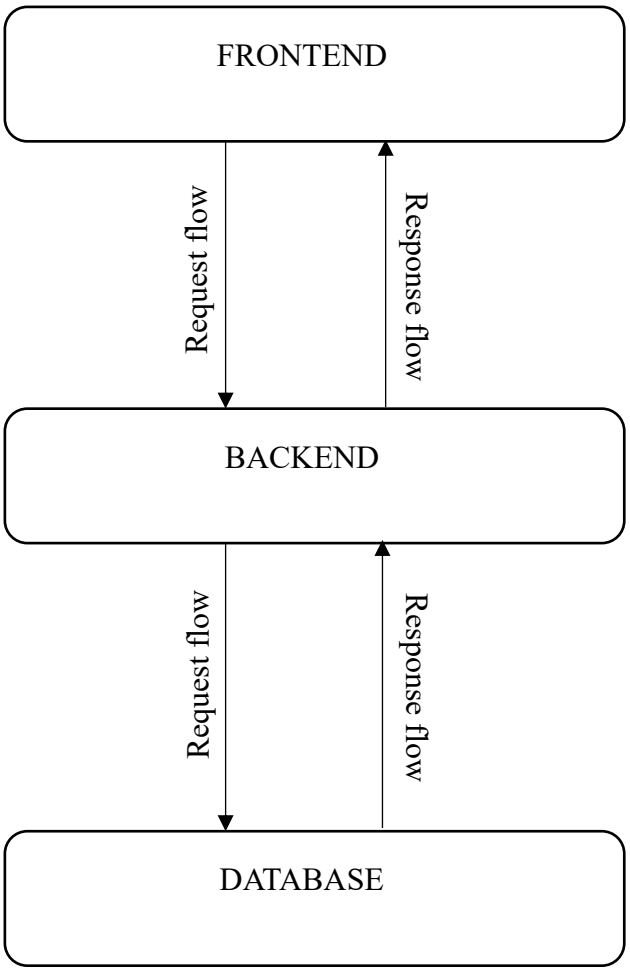

Fig. 2.2.6: System Architecture Diagram

CHAPTER 3
PLANNING

3.1 GANTT CHART

ACTIVITIES/ DURATION	MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
FEASIBILITY STUDY																												
LITERATURE SURVEY																												
PROBLEM IDENTIFICATION																												
REQUIREMENT ANALYSIS																												
DESIGN																												
IMPLEMENTATION																												
TESTING																												
DOCUMENTATION																												

Proposed Activity

Achieved Activity

Fig. 3.1: Gantt Chart

REFERENCES

[1] Prahani, B. K., Alfin, J., Fuad, A. Z., Saphira, H. V., Hariyono, E., & Suprapto, N. (2022). Learning management system (LMS) research during 1991–2021: How technology affects education. International Journal of Emerging Technologies in Learning (iJET), 17(17), 182–199. https://doi.org/10.3991/ijet.v17i17.30763

[2] Saxena, S., Sharma, D., Saxena, L., Singh, A., & Sachdeva, V. (2024). Development of learning management systems and effects in education: A comprehensive review. International Journal of Novel Research and Development (IJNRD), 9(5), 250–256.

[3] Adzharuddin, N. A., & Ling, L. H. (2013). Learning management system (LMS) among university students: Does it work? International Journal of e-Education, e-Business, e-Management, and e-Learning, 3(3), 248–252. https://doi.org/10.7763/IJEEEE.2013.V3.233

[4] Rosário, A. M., & Dias, J. C. (2022). Learning management systems in education: Research and challenges. In Handbook of research on redesigning teaching, learning, and assessment in the digital era (pp. 32–47). IGI Global. https://doi.org/10.4018/978-1-6684-4706-2.ch003

[5] Sanchez, L., Penarreta, J., & Poma, X. S. (2024). Learning management systems for higher education: A brief comparison. Discover Education, 3, Article 58. https://doi.org/10.1007/s44217-024-00143-5

[6] Mahnegar, F. (2012). Learning management system. International Journal of Business and Social Science, 3(12, Special Issue), 144–150.

[7] de Oliveira, P. C., de Almeida Cunha, C. J. C., & Nakayama, M. K. (2016). Learning management systems (LMS) and e-learning management: An integrative review and research agenda. JISTEM – Journal of Information Systems and Technology Management, 13(2), 157–180. https://doi.org/10.4301/S1807-17752016000200001

[8] Chung, C.-H., Pasquini, L. A., & Koh, C. E. (2013). Web-based Learning Management System Considerations for Higher Education. Learning and Performance Quarterly, 1(4), 24–37

[9] Alia, A. A. H. (2022). The analysis of a learning management system from a design and development perspective. International Journal of Information and Education Technology, 12(4), 280–289. https://doi.org/10.18178/ijiet.2022.12.4.1616

[10] Rabiman, R., Nurtanto, M., & Kholifah, N. (2020). Design and development of E-learning system by learning management system (LMS) in vocational education. International Journal of Scientific & Technology Research, 9(1), 1059–1063.