STRUCTURED DATA MANAGEMENT IN AI-LMS USING MYSQL

A PROJECT REPORT

Submitted by

DHIVYA V	**510421104025**
KAVIYA SRI V	**510421104046**
KAYALVIZHI K	**510421104047**
KOMATHI R	**510421104050**

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE ENGINEERING

ARUNAI ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION)

TIRUVANNAMALAI

MAY 2025

BONAFIDE CERTIFICATE




Certified that this project report titled**"STRUCTURED DATA MANAGEMENT IN AI-LMS USING MYSQL"** is the bonafide work of "DHIVYA V(510421104025), KAVIYA SRI V(510421104046), KAYALVIZHI K(510421104047), KOMATHI R(510421104050)" who carried out the project work under my supervision **.**

SIGNATURE OF SUPERVISOR
Mrs.V.UMADEVI, M.E.,
Assistant Professor,
Computer Science Engineering,
Arunai Engineering College,
Tiruvannamalai-606 603

SIGNATURE OF HOD
Mrs.V.UMADEVI, M.E.,
Assistant Professor,
Computer Science Engineering,
Arunai Engineering College,
Tiruvannamalai-606 603

INTERNAL EXAMINER **EXTERNAL EXAMINER**

CERTIFICATE OF EVALUATION

COLLEGE : 5104 - ARUNAI ENGINEERING COLLEGE
BRANCH : B.E.COMPUTER SCIENCE AND ENGINEERING
SEMESTER : VIII (2021 – 2025)
SUBJECT CODE & NAME : CS3811 PROJECT WORK

NAME OF THE STUDENTS	REGISTER NUMBER	TITLE OF THE PROJECT	NAME OF SUPERVISOR WITH DESIGNATION
DHIVYA V KAVIYA SRI V KAYALVIZHI K KOMATHI R	510421104025 510421104046 510421104047 510421104050	STRUCTURED DATA MANAGEMENT IN AI-LMS USING MYSQL	Mrs.V.UMADEVI,M.E,Assistant professor,Computer Science & Engineering

The report of the **PROJECT WORK** submitted for the fulfilment of Bachelor of Engineering degree in **COMPUTER SCIENCE AND ENGINEERING** of Anna University was evaluated and confirmed to be reports of the work done by the above students.

SIGNATURE OF SUPERVISOR
Mrs.V.UMADEVI, M.E.,
Assistant Professor,
Computer Science Engineering,
Arunai Engineering College,
Tiruvannamalai-606 603.

SIGNATURE OF HOD
Mrs.V.UMADEVI, M.E.,
Assistant Professor,
Computer Science Engineering,
Arunai Engineering College,
Tiruvannamalai-606 603.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

It is our duty to thank the GOD Almighty and my beloved parents and teachers for their persistent blessing and constant encouragement to reach this level of what we are today.

A project of this nature needs co-operation and support from many for successful completion. In this regard I am fortune to express my heartfelt thanks to our beloved Founder Chairman **Mr.E.V.VELU,**Chair Person **Mrs.SANKARI VELU** and **Er.E.V.KUMARAN M.E.,** Vice Chair Person ,for providing necessary facilities with high-class environment throughout the course.

We take the privilege of expressing our sincere thanks to our belove principal **Dr.C.ELANCHEZHIYAN M.E.,Ph.D.,** for granting permission to undertake the project and we also express our heartfelt thanks to our Registrar **Dr.R.SATHIYASEELAN M.E.,Ph.D.,** for their advice in accomplishing this project work.

We are most grateful to **Mrs. V.UMADEVI,M.E.,** Head of the Department,Department of Computer Science and Enginnering ,who has given us both moral and technical support adding experience to the job we have undertaken.We are most grateful to our guide **Mrs. V.UMADEVI,M.E.,** for her astonishing guidance and encouragement for the successful completion of this project. They held us to the highest standards of quality and accuracy.

Last but not the least we would like to thank our family members ,friends, teaching and non-teaching staffs ,who has assisted us directly or indirectly throughout this project work.

ABSTRACT

The growing demand for adaptive learning environments has prompted the speedy development of Learning Management Systems (LMS) with AI integrations.This project, **"Structured Data Management in AI-LMS using MySQL,"** aims to create a scalable, secure, and efficient back-end infrastructure for an LMS system with such capabilities.The main aim is to design a properly-normalized database schema that can manage users, courses, progress tracking, transactions, and AI interactions efficiently.

The front-end, which is built with Vue.js, provides a responsive and user-friendly experience, whereas the back-end, powered by Django, takes care of authentication, authorization, content management, reporting, integration of AI features, and wallet/payment management.

One of the major features of the project is the strong database structure, supporting data integrity, security, and optimization for performance under load.Features such as AI-recommended learning, chatbot-based interactions,virtual labs,personalized learning paths, and auto-issued certificates bring a new level of richness to conventional LMS systems. One of the standout features of this LMS interface is the integration of an intelligent AI-powered chatbot. The chatbot uses the Copilot API to provide real-time assistance, answer user queries, and guide learners through their educational journey.

The end system is able to distribute dynamic, AI-driven, personalized learning content to thousands of learners reliably and securely, laying the groundwork for future scalability, mobile enablement, and high-level analytics.So, the project operates successfully within its mission of combining structured data management with smart learning systems, demonstrating applied experience of contemporary software engineering practices.

சுருக்கம்

தகவமைப்பு கற்றல் சூழல்களுக்கான வளர்ந்து வரும் தேவை, AI ஒருங்கிணைப்புகளுடன் கூடிய கற்றல் மேலாண்மை அமைப்புகளின் (LMS) விரைவான வளர்ச்சியைத் தூண்டியுள்ளது. இந்த திட்டம், "MySQL ஐப் பயன்படுத்தி AI-LMS இல் கட்டமைக்கப்பட்ட தரவு மேலாண்மை", ஒரு அளவிடக்கூடிய, பாதுகாப்பான மற்றும் திறமையான பின்-இறுதி உள்கட்டமைப்பை உருவாக்குவதை நோக்கமாகக் கொண்டுள்ளது. பயனர்கள், படிப்புகள், முன்னேற்ற கண்காணிப்பு, பரிவர்த்தனைகள் மற்றும் AI தொடர்புகளை திறமையாக நிர்வகிக்க முடியும். Vue.js உடன் கட்டமைக்கப்பட்ட முன்-இறுதி, பதிலளிக்கக்கூடிய மற்றும் பயனர் நட்பு அனுபவத்தை வழங்குகிறது, அதேசமயம் Django ஆல் இயக்கப்படும் பின்-இறுதி, அங்கீகாரம், அங்கீகாரம், உள்ளடக்க மேலாண்மை, அறிக்கையிடல், AI அம்சங்களின் ஒருங்கிணைப்பு மற்றும் பணப்பை/கட்டண மேலாண்மை ஆகியவற்றை கவனித்துக்கொள்கிறது.

திட்டத்தின் முக்கிய அம்சங்களில் ஒன்று வலுவான தரவுத்தள அமைப்பு, தரவு ஒருமைப்பாடு, பாதுகாப்பு மற்றும் சுமையின் கீழ் செயல்திறனுக்கான உகப்பாக்கம் ஆகியவற்றை ஆதரிக்கிறது.AI- பரிந்துரைக்கப்பட்ட கற்றல், சாட்போட் அடிப்படையிலான தொடர்புகள், மெய்நிகர் ஆய்வகங்கள், தனிப்பயனாக்கப்பட்ட கற்றல் பாதைகள் மற்றும் தானாக வழங்கப்பட்ட சான்றிதழ்கள் போன்ற அம்சங்கள் வழக்கமான LMS அமைப்புகளுக்கு ஒரு புதிய அளவிலான செழுமையைக் கொண்டுவருகின்றன. இந்த LMS இடைமுகத்தின் தனித்துவமான அம்சங்களில் ஒன்று, அறிவார்ந்த AI-இயக்கப்படும் சாட்பாட்டின் ஒருங்கிணைப்பு ஆகும். சாட்பாட், நிகழ்நேர உதவியை வழங்கவும், பயனர் கேள்விகளுக்கு பதிலளிக்கவும், கற்பவர்களுக்கு அவர்களின் கல்விப் பயணத்தின் மூலம் வழிகாட்டவும் Copilot API ஐப் பயன்படுத்துகிறது.

இந்த இறுதி அமைப்பு, ஆயிரக்கணக்கான கற்பவர்களுக்கு மாறும், AI-இயக்கப்படும், தனிப்பயனாக்கப்பட்ட கற்றல் உள்ளடக்கத்தை நம்பகத்தன்மையுடனும் பாதுகாப்பாகவும் விநியோகிக்க முடிகிறது, எதிர்கால அளவிடுதல், மொபைல் செயல்படுத்தல் மற்றும் உயர்நிலை பகுப்பாய்வுகளுக்கான அடித்தளத்தை அமைக்கிறது.எனவே, இந்த திட்டம் கட்டமைக்கப்பட்ட தரவு மேலாண்மையை ஸ்மார்ட் கற்றல் அமைப்புகளுடன் இணைப்பது, சமகால மென்பொருள் பொறியியல் நடைமுறைகளின் பயன்பாட்டு அனுபவத்தை வெளிப்படுத்துவது என்ற அதன் நோக்கத்திற்குள் வெற்றிகரமாக செயல்படுகிறது.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

LMS	Learning Management System
RDBMS	Relational Database Management System
SQL	Structured Query Language
AI	Artificial Intelligence
NLP	Natural Language Processing
CRUD	Create,Read,Update,Delete
ER Model	Entity-Relationship Model
ORM	Object-Relational Mapping
RBAC	Role-Based Access Control
GDPR	General Data Protection Regulation
API	Appliaction Programming Interface
DB	Database
PK	Primary Key
FK	Foreign Key
CSS	Cascading Style Sheets
API	Application Programming Interface

TABLE OF CONTENTS

CHAPTER 01

1.INTRODUCTION

1.1 Overview of Personalized Learning LMS

In the contemporary digital learning era, Learning Management Systems (LMS) are the basic platforms for delivering education in a personalized, flexible, and accessible manner. "Structured Data Management in AI-LMS using MySQL" is the project we are working on, with the goal of creating a highly efficient, artificial intelligence-driven LMS that offers user-centric learning, supported by a robust database management system.

The platform integrates

- Frontend (HTML5, CSS3, JavaScript, Vue.js),
- Backend (Python with Django ORM Framework),
- Database (MySQL)

The focus is on scalable, secure, and personalized learning delivery using efficient database structuring and management techniques.

1.2 Importance of Database in LMS

- Database is the core of the LMS system, guaranteeing:
- Smooth administration and access to user information, course materials, quizzes, credentials, and financial transactions.
- Support for AI modules in terms of storing behavior analytics and learning preferences.
- Enhanced security through normalization, indexing, constraints, and permission controls.

1.3 Objectives of the Project

- Create an AI-driven LMS with strong database support.
- Streamline course management, assessment processing, and payments.
- Implement strong user progress tracking and auto-certification.
- Use MySQL relational modeling to offer data integrity, consistency, and scalability.
- Provide real-time personalization driven by AI modules.

1.4 Scope of the Project

- The students can enroll, register, take quizzes, monitor progress, and receive certificates.
- Instructors can add and edit modules, courses, and tests.
- Admins oversee everything that users do, financial payments, AI assessment, and certification of courses.
- AI Layer tailors course suggestions based on one's learning habits.

CHAPTER 02

LITERATURE SURVEY

I.Title: Zero-Downtime Database Evolution Strategies for LMS Systems
Authors: Brown and S. Hayes
Conference: Proceedings of the International Conference on Learning Technology Innovation (ICLTI), pp. 56–64, 2024
Summary:
This paper presents strategies for updating LMS databases without interrupting service. Techniques include blue-green deployments, schema versioning, and use of feature toggles. It emphasizes transactional safety and seamless migration paths**.**
Relevance to our Project:
We adopt zero-downtime migrations and schema version control to ensure high availability and smooth updates in our LMS database.

II.Title: Role-Based Access Control Models in Multi-Tenant LMS
Authors: L. Zhang, Q. Sun, and H. Wei
Journal: International Journal of Cyber-Security and Learning, Vol. 12, No. 1, pp. 88–99, 2023
Summary:
The study investigates RBAC implementations in LMS platforms supporting multiple tenants. It outlines hierarchical roles, permission scoping, and isolation strategies to secure user actions across institutions.
Relevance to our Project:
We implement fine-grained RBAC with Django-based session control to secure user actions and preserve data integrity across roles like Admin, Instructor, and Student.

III.Title: Optimizing Query Performance in High-Load Learning Platforms
Authors: P. Singh and R. Banerjee
Journal: Information Systems Frontiers, Vol. 25, No. 2, pp. 205–218, 2023
Summary:
The authors explore methods to improve query performance in LMS environments under heavy usage. They propose adaptive indexing, query caching, and partitioning to reduce latency. The paper shows that dynamic

query rewriting based on load prediction can improve response time by up to 40%.

Relevance to our Project:

We apply these principles using composite indexes, denormalized views, and MySQL EXPLAIN plans to ensure faster access to high-demand educational content.

IV.Title: Scalable Database Architectures for Adaptive Learning Platforms

Authors: R. Kumar and A. Patel

Journal: ACM Computing Surveys (ACM Comput. Surv.), Vol. 55, No. 4, pp. 32–49, 2022

Summary:

This paper explores scalable database strategies for adaptive learning environments. It emphasizes distributed data storage, microservice-based data access layers, and use of NoSQL alongside traditional RDBMS to support dynamic content delivery and real-time analytics.

Application to Our Project:

We incorporate horizontal sharding and semi-synchronous replication in MySQL to ensure scalability. The modular schema supports adaptive AI-based learning and high-volume concurrent access.

IV.Title: AI-Enhanced Personalization Techniques in Modern LMS

Authors: Y. Li and J. Chen

Journal: Journal of Educational Data Science (J. Educ. Data Sci.), Vol. 10, No. 3, pp. 75–92, 2022

Summary:

This paper investigates how AI algorithms—particularly machine learning and natural language processing—are used to tailor content delivery, assessments, and feedback in learning management systems. It details methods for analyzing learner behavior and adapting instructional content accordingly.

Relevance to our Project:

The AI integration layer of our LMS leverages user interaction data to personalize course recommendations and module sequencing using NLP models and predictive analytics, aligning directly with the personalization strategies outlined in this work.

2.1 Traditional LMS Database Research

Early Learning Management Systems (LMS) like Moodle, Blackboard, and Canvas were dependent on legacy relational databases like MySQL and PostgreSQL.

These databases were mainly used for storing user registrations, course material, enrollment information, grades, and simple evaluations.

Even though their database structures were earlier mostly monolithic in nature — wherein a single monolithic structure used several unrelated functions, resulting in data redundancy, sluggish access, and cumbersome scalability as the number of users increased.

In classic LMS:

Every student's interaction was documented to a minimum (primarily attendance and grades).

There was no adaptive responsiveness to learner behavior or feedback.

Personalization and real-time analysis were virtually non-existent.

Consequently, conventional databases, while beneficial for static e-learning contexts, have proven inadequate in addressing the evolving requirements of dynamic, AI-driven personalized education.

2.2 Limitations of Existing LMS Platforms

Despite their success, several limitations in existing LMS platforms have been identified:

- **Static Learning Paths:** Most LMS platforms provide the same course structure for all learners, regardless of their prior knowledge or learning pace.
- **Limited Personalization:** Lack of AI-based recommendation engines restricts the ability to suggest personalized learning paths, resources, or assessments.
- **Poor Data Management:** Many systems store data in non-optimized schemas, resulting in slow performance as the database size grows.
- **Security Challenges:** Sensitive data like user credentials, wallet balances, and assessment results are sometimes insufficiently protected against breaches.
- **Inadequate Analytics:** Basic reporting is available, but real-time, AI-driven analytics and predictive insights are rare.

These limitations highlight the necessity for a more intelligent, secure, and scalable LMS backend that not only stores data efficiently but also uses AI to enhance learner engagement.

2.3 Proposed System(Role of Structured Databases in LMS)

Efficient data management is fundamental to building intelligent LMS platforms. A well-designed database enables:

- **Faster Query Response Times:** Optimized data retrieval ensures a smooth learning experience even with a large number of users.
- **Data Integrity:** Proper normalization and use of foreign keys maintain the consistency and reliability of learner data.
- **Scalability:** Modular database design ensures the system can handle future expansions like new course types, payment methods, or AI modules.
- **Security Compliance:** Structured storage of sensitive information facilitates better encryption and compliance with privacy laws like GDPR.
- **Dynamic course Recommendations:** Based on students' past performance, preferences, and areas of interest, the system will suggest courses or learning paths that align with their goals. Whether a student is excelling in a particular subject and wishes to advance further or struggling and in need of remedial courses, the system will guide them toward relevant content, improving both their engagement and educational outcomes.
- **Future-Proof Technology:**Our AI-powered LMS will be built with future scalability in mind. As technology continues to evolve, our system will be able to integrate with new tools, platforms, and learning methods.

MySQL, being a mature and reliable relational database management system, is an ideal choice for LMS platforms that require strong ACID compliance, replication support, and advanced indexing capabilities.

CHAPTER 03
SYSTEM ARCHITECTURE

3.1 TECHNLOGY STACKS:

The AI-LMS using MySQL combines several technologies to build a robust and scalable system:

Layer Technology

Front-End:HTML5, CSS3, JavaScript, Vue.js

Back-End: Python with Django Framework

Database : MySQL,Django ORM Integration

AI Integration(Future upgrade) :TensorFlow (ML models), spaCy (NLP tasks)

3.2ARCHITECTURE:

The architecture of the AI-LMS using MySQL is designed to be modular, scalable, and efficient. The system follows a client-server architecture with frontend, backend, database, and AI components. Each component is integrated to deliver a seamless and personalized learning experience.

Key Components of the System:

1.Frontend (Client-side):

User Interface (UI): Built using HTML5, CSS3, JavaScript, and Vue.js. It is the interface where users interact with the system. This includes viewing courses, tracking progress, taking quizzes, and accessing personalized recommendations.

User Interaction: Communicates with the backend through RESTful APIs to fetch and submit data.

2.Backend (Server-side):

Django Framework: The backend is powered by Django, which handles user authentication, API requests, course management, progress tracking, and wallet management.

Django REST Framework: Provides RESTful APIs for communication between frontend and backend, allowing seamless data transfer.

3.Database (MySQL):

MySQL Database: The core of the system's data storage, where all user, course, assessment, and transaction data are stored. It ensures the integrity and security of the data using normalized tables, foreign keys, and indexes.

Data Retrieval: Queries from the backend interact with the MySQL database to fetch user and course-related data.

1. **AI Modules(Future Upgrade)**

TensorFlow: Used for machine learning models that power personalized recommendations for courses and content based on user

behavior.

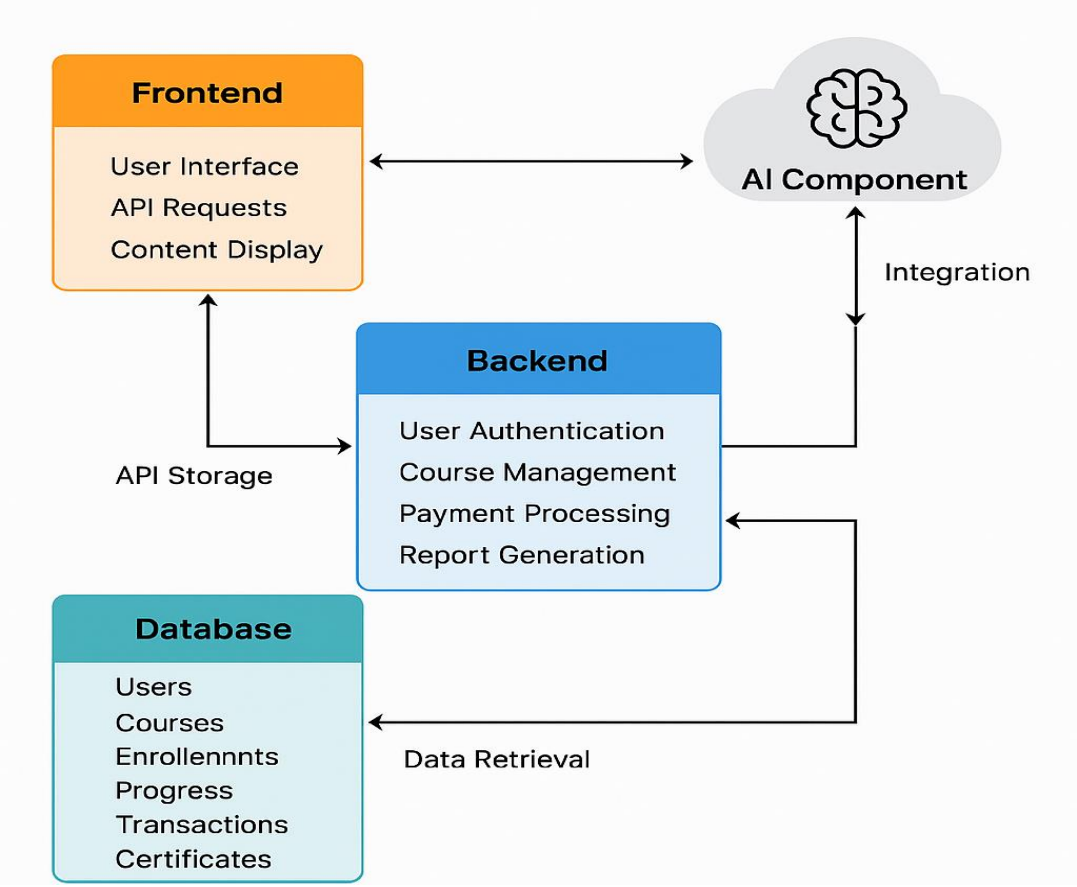
2. **Payment Gateway:**

Payment System Integration: Supports payment various gateways to manage wallet balances and transaction processing easily and securely.

3. **Admin Panel:**

Django Admin: Admins manage courses, user roles, reports, and more via Django's built-in admin panel.

3.3 BLOCK DIAGRAM:



CHAPTER 04
MODULE DESCRIPTION

4.1 FRONTEND:

The Frontend module serves as the main interface to link the users with the system. It offers a smooth, user-friendly,
and interactive interface for administrators, instructors, and students. The frontend of the LMS will be built using Vue.js 3 with the Composition API. Vue.js is a modern JavaScript framework that facilitates the development of reactive and component-based user interfaces, which is ideal for building scalable, maintainable, and high-performance applications

Roles:

The LMS platform will encompass several key functionalities to support various user roles. Students will be able to register, log in, and manage their profiles seamlessly. Instructors will have access to a dedicated dashboard that allows them to structure courses and upload content efficiently. The admin panel will enable platform-wide management, including user administration, payment verification, and course approval processes. Students will interact with a user-friendly learning interface where they can join courses, watch video lectures, download lecture materials, and participate in quizzes. Additionally, the system will feature real-time notifications for course updates, wallet balance changes, and certification alerts. To enhance the learning experience, the platform will also demonstrate AI-powered course recommendations based on each student's learning history.

Technical Highlights:

Application of Vue.js towards reactive UI as well as dynamic components.
Integration with Backend through secure RESTful APIs.

4.2 BACKEND :Django REST Framework

The Backend module forms the logic layer of the LMS system, ensuring that frontend requests are processed, validated, and responded to accordingly.

Functions:

Authentication and Authorization (Student/Instructor/Admin roles).
Course Management APIs (Create, Update, Delete, Assign Instructors).
User Progress Tracking (completion of lessons, quiz scores).
AI Engine APIs (fetch recommended courses, adaptive learning paths).
Wallet management (wallet refill, debit at registration, transaction history).
Certification generation and auto-emailing system

Technical Highlights:
Built with Django for scalability and security.
API creation with Django REST Framework.
Asynchronous tasks (for example, sending email
certificates) managed by Celery + Redis.
Security practices: API key management, SQL Injection protection, secure password storage (bcrypt hashing).

4.3 DATABASE :MySql (Structured Relational Data)

The Database Module is the core data management component of the LMS. It is responsible for storing, managing, and retrieving all the key information in high performance and reliability.

Database Structure:
Highly normalized schema (achieving Third Normal Form - 3NF).
Consistent entity relationships using Primary Keys and Foreign Keys
to provide data consistency.
Logical division into tables: Users, Courses, Modules, Lessons, Quizzes, UserProgress, Payments, Certificates, AI_Recommendations.
Roles:
The system will ensure the safe storage of personal information and user credentials, maintaining strict data privacy and security standards. All course materials, including modules, lessons, and quizzes, will be systematically captured and stored for consistent access and content management. Wallet transactions—such as top-ups, deductions, and refunds—will be accurately recorded to maintain transparency and enable user accountability. Additionally, payment and transaction records will be securely stored to facilitate auditing and financial tracking. The platform will also maintain a history of AI model predictions and user-specific course recommendations, supporting personalized learning experiences and enabling future enhancements based on past interactions.
Backup and Security Measures:
Automated database scheduled backups.
Role-based database administrator access control.
Encryption of sensitive fields (for example, payment information).
Disaster recovery configuration with off-site replication of backups.

Technical Highlights:
MySQL 8.0 for relational data storage.

4.4 AI:Copilot APIs,Tensor Flow(Future Upgrade)

The AI capabilities of the LMS will be integrated through Copilot APIs and TensorFlow for future upgrades. The integration of Copilot APIs will provide a foundation for personalized learning experiences by using AI to suggest relevant content, provide insights, and automate certain administrative tasks. Copilot's advanced machine learning models will help deliver recommendations for courses, learning resources, and even potential career paths based on user data and preferences.

For more advanced AI-driven features in the future, TensorFlow will be employed. TensorFlow is an open-source machine learning framework that supports the development of complex AI models for natural language processing, image recognition, predictive analytics, and more. TensorFlow's capabilities will be used to enhance the LMS with features like intelligent course recommendation engines, adaptive learning paths, real-time progress predictions, and automated feedback based on student behaviour and performance.

4.5 Payment Gateway: Payment Integration

The payment gateway integration is a critical component for the LMS, enabling secure transactions for course enrollments, subscription plans, and other premium features. The system will support popular payment platforms, ensuring that students can make payments easily and securely. This payment integration will be fully PCI-compliant, ensuring that all financial transactions are encrypted and handled safely.
The payment system will allow for flexibility in payment methods, supporting credit/debit cards, digital wallets, and other common online payment solutions. The system will also handle invoicing, billing cycles, and subscription management, ensuring that both students and administrators can manage payments and course access seamlessly.

4.6 SECURITY LAYER:AUTHENTICATION

Security is a critical aspect of any LMS, especially when handling sensitive user data such as personal information, grades, and payment details. The proposed LMS will have a secure authentication layer built on industry-standard practices. This will include user authentication through OAuth 2.0 or JWT (JSON Web Tokens), allowing users to securely log in and access their accounts. Two- factor authentication (2FA) will also be incorporated for added security, particularly for administrative accounts or users accessing sensitive data.

The authentication system will be designed to ensure that users only have access to the resources they are authorized to interact with, providing different levels of access for students, instructors, and administrators. The platform will also include session management and secure password storage using hashed encryption techniques, ensuring that user credentials are kept safe from unauthorized access

CHAPTER 5

DATABASE SCHEMA DESIGN

Database Schema Design is one of the most critical phases of your project because it ensures that your database structure supports all functionalities required for your LMS. Proper database design enhances system performance, scalability, data integrity, and security. The following sections provide a detailed overview of the Conceptual, Logical, and Physical designs, as well as key considerations like data types, relationships, normalization, and security.

5.1 Conceptual Database Design (ER Model)

The Conceptual Database Design defines the high-level structure of the database using the **Entity-Relationship (ER)** model. This model serves as a blueprint that identifies the core entities, their attributes, and the relationships between them. In this phase, we aim to gather all possible business requirements and represent them visually.

Entities and Relationships:

1. **Users**: The primary entity in the system. A User can be a Student, Instructor, or Admin. Each user will have unique attributes such as user_id, name, email, role, password, etc.
    - A user can enroll in one or more Courses.
    - A user has a Progress record for each course they enroll in.
2. **Courses**: A Course is the central unit of learning. Each course has details like course_id, title, description, instructor_id (which references the Instructor), and a list of modules associated with it.
    - A course can have multiple Modules and Lessons.
3. **Modules**: A Module is a sub-unit within a course. It consists of several Lessons and Quizzes.
    - A Course can contain many Modules.
4. **Lessons**: A Lesson contains educational content in the form of videos, PDFs, or articles. It is associated with a specific Module.
5. **Quizzes**: A Quiz assesses the student's knowledge after completing a Module. It includes questions, multiple choices, and answers.
6. **Payments**: Every user who subscribes to a course needs to make a payment. The Payments table stores details such as payment_id, amount, user_id, payment_date, and payment_status.
7. **Certificates**: A user earns a certificate after completing a course. The

Certificates table links users to their earned certifications, and it includes certificate_id, user_id, course_id, and date_issued.

8. **AI Recommendations**: The AI_Recommendations entity stores personalized recommendations based on a user's course progress and preferences. This data helps in suggesting new courses to a user based on their interests.

5.2 Logical Database Design (Relational Model)

In **Logical Database Design**, the goal is to transform the **ER model** into a **relational schema**. The relational schema represents the tables, columns, and relationships in a way that can be implemented in a relational database system like **MySQL**.

Tables and Relationships:

- **Users Table**: This stores user data like user_id, name, email, password_hash, and role. The user_id is the primary key.
- **Courses Table**: Each course will be represented by a row in this table. It will include the course_id, title, description, and instructor_id (foreign key linking to the Users table, specifically to an Instructor).
- **Modules Table**: This stores information about the modules within each course, such as module_id, module_title, and course_id (foreign key).
- **Lessons Table**: Each lesson is associated with a specific module, so the lessons table will have a foreign key module_id.
- **Payments Table**: The Payments table tracks user payments, including payment_id, user_id, amount, payment_date, and status.
- **Progress Table**: Tracks user progress in courses, with user_id, course_id, progress_status, and completion_date.
- **Certificates Table**: Stores issued certificates for users. Includes certificate_id, user_id, course_id, and date_issued.
- **AI_Recommendations Table**: This will contain AI-driven recommendations for users. It will include recommendation_id, user_id, course_id, reason for the recommendation.

5.3 Physical Database Design (MySQL)

Physical Database Design involves optimizing the database for performance, storage, and data retrieval. In this stage, the database schema defined in the logical design is translated into actual MySQL syntax, and performance enhancements are implemented.

Key Considerations:

- **Storage Engines**: Use **InnoDB** as the storage engine for all tables. InnoDB supports ACID-compliant transactions and foreign key constraints, ensuring data integrity.
- **Indexes**: Create indexes on frequently queried columns such as user_id, course_id, module_id, and payment_id. Indexes significantly speed up query performance by reducing the search time.
- **Foreign Keys**: Implement foreign key constraints to maintain referential integrity. For example, the Payments table should have a foreign key linking back to the Users table to ensure that payments are associated with valid users.
- **Partitioning**: For large tables like Users or Courses, use partitioning based on relevant attributes like date (e.g., partitioning Payments by month or year).
- **Caching**: Implement query caching to improve response times for frequently requested data, such as course details, user progress, and payment status.

5.4 Table Structure and Field Definitions

The following section outlines the table structure for the LMS project, defining each table's columns and specifying the data types and field definitions. These tables follow relational design principles to ensure proper data integrity and efficient data retrieval.

Table 1: Users

This table stores information about all the users of the system, which can be Students, Instructors, or Admins.

Column Name	Data Type	Constraints	Description
user_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each user
name	VARCHAR(100)	NOT NULL	Full name of the user
email	VARCHAR(100)	UNIQUE, NOT NULL	Email address (used for login)
password	VARCHAR(255)	NOT NULL	Encrypted password

Column Name	Data Type	Constraints	Description
role	ENUM('Student', 'Instructor', 'Admin')	NOT NULL	Role of the user in the system (Student, Instructor, Admin)
registration_date	DATETIME	NOT NULL	Date and time of user registration

Table 2: Courses

This table stores the courses available in the LMS. Each course is linked to an instructor.

Column Name	Data Type	Constraints	Description
course_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each course
title	VARCHAR(255)	NOT NULL	Title of the course
description	TEXT	NULL	Detailed description of the course
instructor_id	INT	FOREIGN KEY (Users.user_id)	Foreign key referencing the instructor's user_id
created_at	DATETIME	NOT NULL	Date and time when the course was created

Table 3: Modules

This table stores information about the modules within a course. Each module is linked to a specific course.

Column Name	Data Type	Constraints	Description
module_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each module
module_title	VARCHAR(255)	NOT NULL	Title of the module
course_id	INT	FOREIGN KEY (Courses.course_id)	Foreign key referencing the course
created_at	DATETIME	NOT NULL	Date and time when the module was created

Table 4: Lessons

This table stores individual lessons within each module, including lesson content**.**

Column Name	Data Type	Constraints	Description
lesson_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each lesson
lesson_title	VARCHAR	NOT NULL	Title of the lesson
lesson_content	TEXT	NULL	The actual content of the lesson (text, video, etc.)
module_id	INT	FOREIGN KEY (Modules.module_id)	Foreign key referencing the module

Table 5: Payments

This table tracks the payments made by users for course enrollment.

Column Name	Data Type	Constraints	Description
payment_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each payment
user_id	INT	FOREIGN KEY (Users.user_id)	Foreign key referencing the user who made the payment
course_id	INT	FOREIGN KEY (Courses.course_id)	Foreign key referencing the course being paid for
amount	DECIMAL(10, 2)	NOT NULL	Amount paid by the user
payment_date	DATETIME	NOT NULL	Date and time when the payment was made
status	ENUM('Pending', 'Completed', 'Failed')	NOT NULL	Status of the payment

Table 6: Progress

This table tracks the progress of users within their enrolled courses.

Column Name	Data Type	Constraints	Description
progress_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each progress record
user_id	INT	FOREIGN KEY (Users.user_id)	Foreign key referencing the user
course_id	INT	FOREIGN KEY (Courses.course_id)	Foreign key referencing the course
completion_date	DATETIME	NULL	Date and time when the course was completed
progress_status	ENUM('Not Started', 'In Progress', 'Completed')	NOT NULL	Current status of the user's progress in the course

Table 7: Certificates

This table stores the certificates issued to users for completing a course.

Column Name	Data Type	Constraints	Description
certificate_id	INT	PRIMARY KEY, AUTO_INCREMENT	Unique identifier for each certificate
user_id	INT	FOREIGN KEY (Users.user_id)	Foreign key referencing the user who earned the certificate
course_id	INT	FOREIGN KEY (Courses.course_id)	Foreign key referencing the course completed
date_issued	DATETIME	NOT NULL	Date and time when the certificate was issued

5.6 Relationships Between Entities

The relationships between entities in the LMS database help establish the links between different aspects of the system, ensuring that data is consistent and related.

- **One-to-Many Relationships**:
  - A user can enroll in many courses, but each course is associated with many users.
  - A course can have many modules, but each module belongs to a single course
- **Many-to-Many**:
  - A User can enroll in many Courses, and a Course can have many Users. This relationship is established through the junction table Progress, which contains the user_id and course_id.
- **One-to-One**:

- A User can earn only one Certificate per course, establishing a one-to-one relationship between the Certificates and the combination of user_id and course_id.

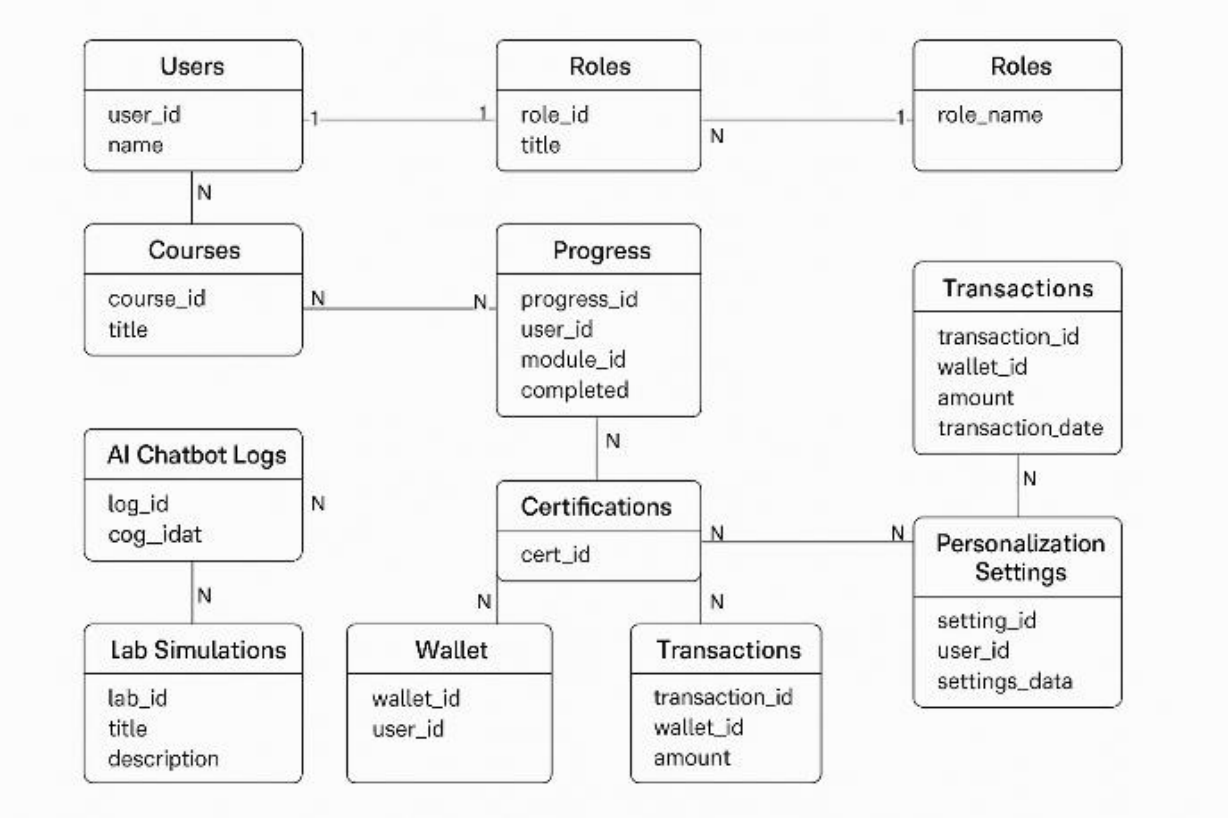
5.8 Normalization Techniques Applied

Normalization is the process of organizing data within the database to reduce redundancy and dependency. The objective is to divide the data into smaller, related tables, ensuring that each table focuses on a single theme or entity. Here's a breakdown of the **normalization** techniques applied to the database design:

1. **First Normal Form (1NF)**:
   - The database schema ensures that each column contains only atomic (indivisible) values. For example, the Lessons table does not store multiple lessons in a single column. Each lesson has its own row in the table, with distinct attributes like lesson_title, lesson_content, etc.
   - There are no repeating groups or arrays in any of the tables.
2. **Second Normal Form (2NF)**:
   - The database is free from partial dependencies. This means that all non-key columns are fully dependent on the primary key. For example, in the Modules table, the module_title and created_at depend entirely on the module_id, which is the primary key.
   - Any partial dependency, such as storing instructor information in the Courses table, has been eliminated by moving such attributes to the Users table.
3. **Third Normal Form (3NF)**:
   - The database is free from transitive dependencies. For instance, the Payments table does not store redundant user or course information, as user_id and course_id are foreign keys that link to their respective tables.
   - This ensures that no column is dependent on another non-primary key column.
4. **Boyce-Codd Normal Form (BCNF)**:
   - BCNF ensures that there are no exceptions to 3NF, i.e., all functional dependencies involve only candidate keys. The tables like Users, Courses, Modules, etc., are designed in such a way that every determinant is a candidate key.
5. **4th and 5th Normal Form (4NF and 5NF)**:

- These forms are used to eliminate multi-valued dependencies and join dependencies, which are more relevant in complex systems. In our LMS design, we have avoided these issues by breaking down data logically and storing them in related tables. For example, student progress in multiple courses is stored in the Progress table, preventing multi-valued attributes.

Database Schema Diagram



CHAPTER 6

DATABASE OPERATIONS

This chapter focuses on how the database in our AI-LMS system is actively utilized, managed, and optimized through various operations. A highly efficient and normalized database alone is not sufficient; performing effective database operations is critical for real-time system performance, scalability, and responsiveness.

6.1 CRUD Operations (Create, Read, Update, Delete)

- **Create**:
  Insertion of new data into tables like Users, Courses, Modules, Wallets, Enrollments, etc.
  Example: New user registration, new course creation.
- **Read**:
  Retrieval of data for display or decision-making.
  Example: Fetching available courses, viewing user's progress.
- **Update**:
  Modifying existing records based on user activity or administrative changes.
  Example: Updating profile details, wallet balance updates after transactions.
- **Delete**:
  Removing unnecessary or redundant data from the system to maintain database hygiene.
  Example: Deleting expired or discontinued courses.
- **Insert**:
  Insert query is used to insert the new data to the system database tables.

CRUD operations are implemented securely with validations at both backend (Django APIs) and MySQL level using constraints.

6.4 Triggers for Automation

- **Trigger-based Automation**:
  Automatic actions upon specific events in the database without manual intervention.
- **Examples**:
  - Trigger to generate a certification record automatically when course completion status becomes 100%.
  - Trigger to update wallet history table whenever a wallet transaction

occurs.

- Trigger to send AI-log updates after every module completion.

Triggers ensure that no important update or logging is missed even if the API server fails temporarily.

6.5 Indexing for Faster Data Retrieval

- **Primary Indexing**:
  Automatically created for each Primary Key (user_id, course_id, etc.).
- **Secondary Indexing**:
  Manually created indexes on important search columns like email, course_title, wallet_balance.
- **Composite Indexes**:
  For queries filtering using multiple columns together (e.g., user_id + course_id in enrollment table).

Impact of Indexing:

- Faster SELECT queries (reduced retrieval time).
- Improved overall system responsiveness.
- Efficient sorting, searching, and joins operations.

CHAPTER 7

DATABASE SECURITY AND BACKUP

Effective data security and backup strategies are critical for ensuring the confidentiality, integrity, and availability of the AI-LMS platform's data. This chapter outlines the security measures implemented and the backup mechanisms designed for reliable database protection.

7.1 Authentication and Role-Based Access Control (RBAC)

- **Authentication Mechanism**:
  - Secure login system with email and password credentials.
  - Implementation of multi-factor authentication (optional).
- **Role-Based Access Control**:
  - **Admin Role**: Full access to user management, course creation, wallet operations, and reporting tools.
  - **Instructor Role**: Access limited to course management and student progress tracking.
  - **Student Role**: Access limited to course enrollment, learning content, and wallet transactions.
  - **Database-level Access**:
    - Separate database users for application backend and administrative tasks.
    - Principle of **Least Privilege** applied to minimize risk.
- **Session Management**:
  - Token-based (JWT) or session-based authentication used for frontend-backend communication.
  - Automatic session expiry to prevent unauthorized use.

7.2 Encryption and Password Hashing Techniques

- **Password Hashing**:
  - All user passwords are hashed using **bcrypt** or **SHA-256** algorithms before storing in the database.
  - Salting techniques applied to enhance password security.
- **Sensitive Data Encryption**:
  - Sensitive fields (such as wallet balance, transactions) encrypted using server-side encryption keys.
  - SSL/TLS protocols enforced for all data-in-transit between frontend, backend, and database.
- **Database Security Features**:

- Use of MySQL's native security features such as user privileges (GRANT, REVOKE).
- Protection against SQL Injection using Prepared Statements.

7.3 Backup Strategies and Disaster Recovery Plan

- **Backup Strategies**:
  - Full database backup performed **daily**.
  - Incremental backups performed **every 6 hours** for critical tables (Users, Courses, Wallets, Enrollments).
  - Backup encryption applied for backup files.
- **Storage Locations**:
  - Backups stored in multiple physical locations (e.g., on-premise + cloud storage) to avoid single-point failure.
  - Retention Policy: Backup copies retained for **30 days**.
- **Disaster Recovery Plan**:
  - Immediate database failover to a **standby replica** in case of failure.
  - Recovery Time Objective (RTO): less than 1 hour.
  - Recovery Point Objective (RPO): data loss limited to maximum 6 hours.
  - Regular mock drills conducted to test recovery processes.
- **Automation**:
  - Cron jobs or MySQL Event Schedulers configured for automatic backup execution.
  - Admin dashboard to monitor backup status and receive failure alerts.

CHAPTER 08

SYSTEM TESTING AND VALIDATION

8.1 DATABASE TESTING STRATEGIES:

A stable database is very important for data consistency, system stability, and user satisfaction. Database testing strategies were executed in multiple layers.
Schema Validation

Entity-Relationship Consistency:

Confirmed that all tables, primary keys, foreign keys, indexes, and constraints were implemented correctly as per the schema design.

Normalization Checks:

Ensured that database normalization rules (up to 3rd Normal Form) were followed to remove data redundancy.

Field Validation:

Verified field types, default values, and nullability to ensure data integrity.
Data Integrity Testing

Referential Integrity:

Ensured foreign keys properly enforce parent-child relationships between tables (e.g., User → Wallet, Course → Enrollment).

Cascade Behaviors:

Verified cascade deletions and updates to ensure there are no orphan records left behind after entity deletions.

Constraint Testing:

Tested unique constraints (e.g., unique user emails) and check constraints (e.g., non-negative wallet balances).

Query Optimization

Slow Query Analysis:

Utilized tools such as MySQL EXPLAIN and slow query logs to identify inefficient queries.

Optimized queries by implementing missing indexes and restructuring query structures.

Load Testing:

Mocked a high volume of data (users, enrollments, transactions) to test database response times and performance under load.

CHAPTER 9

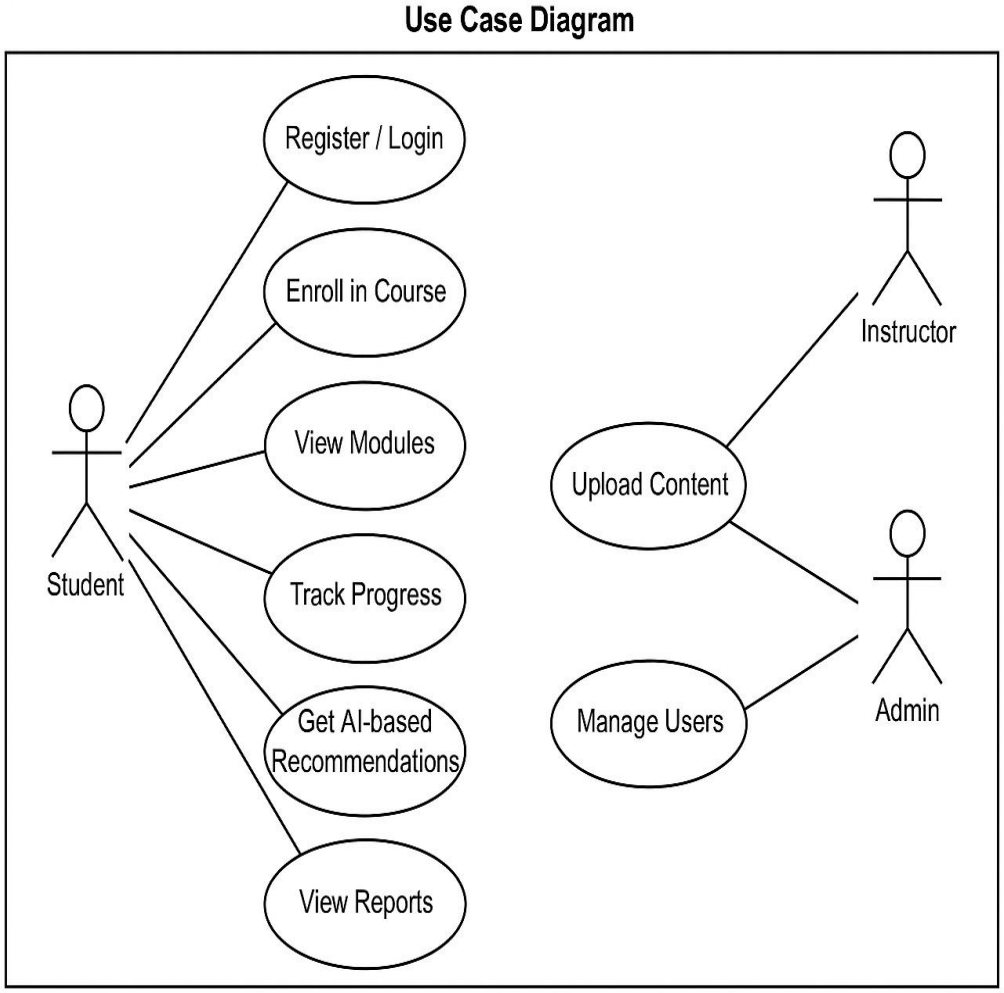
SYSTEM DESIGN:

This section outlines the system design through various standard diagrams to ensure clarity of functionalities, system architecture, and workflows.

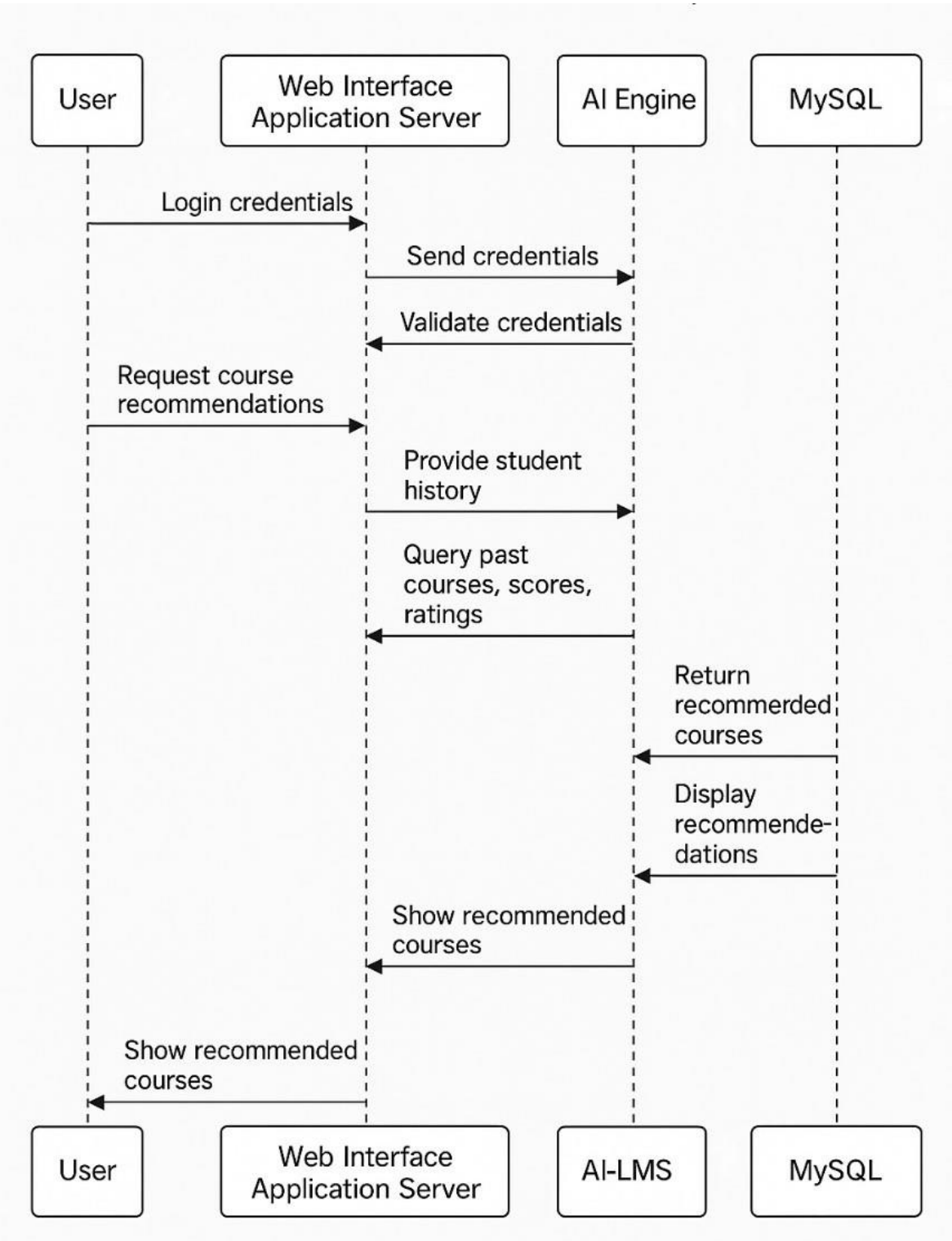
UML DIAGRAMS

01.USE CASE DIAGRAM:

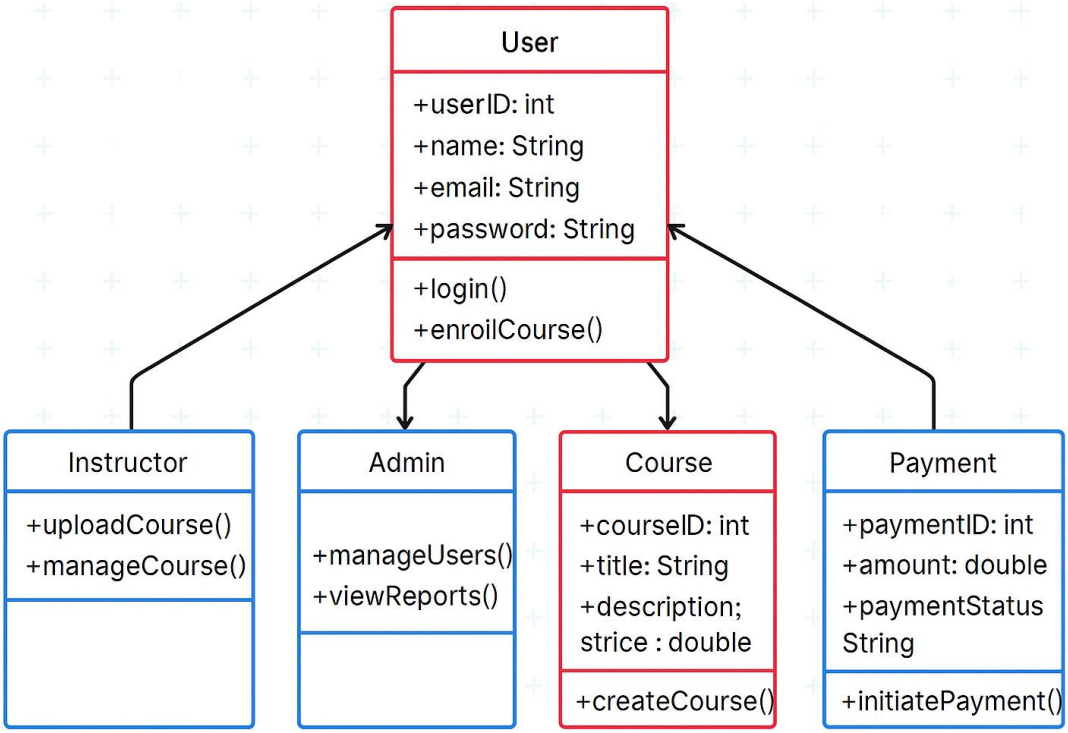
The UML Use Case Diagram for our project *"Structured Data Management in AI-LMS using MySQL"* provides a high-level overview of how various users interact with the system and the functionalities the system provides. It identifies the primary actors—such as the Admin, Instructor, and Student and illustrates the key use cases or system features they engage with.



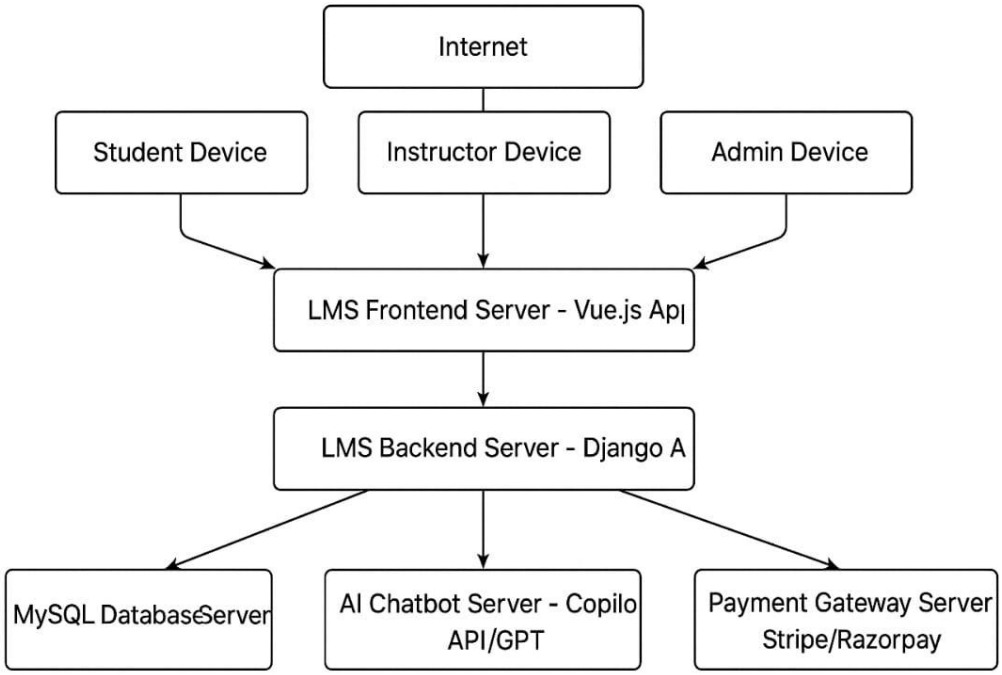
02.SEQUENCE DIAGRAM:



03.CLASS DIAGRAM:



04.DEPLOYMENT DIAGRAM:



CHAPTER 10

Appendices

The appendices provide additional details to support and clarify key aspects of the project. This section includes essential terminology definitions and a comprehensive table outlining various user roles within the LMS, along with their respective permissions.

10.1 Glossary

Below are definitions of fundamental terms used throughout the project:

- LMS (Learning Management System): A software platform designed to administer, deliver, and monitor educational courses and training programs. It typically offers functionalities such as content distribution, student assessments, performance tracking, and administrative management.
- AI (Artificial Intelligence): A domain within computer science that focuses on developing systems capable of executing tasks typically requiring human intelligence. Within an LMS, AI enhances personalized learning paths, provides intelligent feedback, and offers real-time recommendations.
- API (Application Programming Interface): A collection of protocols and rules that enable different software applications to communicate. In the LMS ecosystem, APIs facilitate integration with third-party services, including payment gateways, AI-powered tools, and external databases.

CHAPTER 11

IMPLEMENTATION

The implementation of the Intelligent LMS User Interface Development project focuses on leveraging modern technologies to ensure a dynamic, secure, and scalable learning management system.

Frontend Development

The frontend of the system is built using Vue.js, a progressive JavaScript framework. It uses a modular component-based architecture, which allows for reusability of code and better maintainability. Tailwind CSS is integrated for rapid and responsive UI development, ensuring the application is mobile friendly and easily accessible on various devices.

Backend Development

The backend services are developed using Django and Django REST Framework. Secure APIs are provided for frontend interaction, ensuring that data handling between the client and server remains encrypted and authenticated using JWT tokens. Django's modular structure allows efficient handling of multiple simultaneous user requests.

AI Integration

An AI chatbot is integrated using the API to enhance user interaction. The chatbot provides 24/7 support, guiding students and instructors with common queries, navigation help, and course suggestions. Future enhancements plan to implement a custom GPT-based AI model for even smarter responses.

Payment Gateway Integration

Secure financial transactions are ensured through the integration of Stripe Payment Gateway. Students can enroll in paid courses, make secure online payments, and receive instant enrolment confirmation through seamless API transactions between the frontend and backend.

Database Management

The system uses MySQL as the backend database. The database schema is carefully designed to allow efficient query retrieval, optimize performance, and maintain relational integrity. Key tables include users, courses, enrolments, payments, and chatbot logs.

CHAPTER 12

SOURCE CODE

Build the Database Management System

Phase 1: Initial Setup

1. Install Required Software

Install MySQL Server (for database)

Install Python 3 and pip

Install Django and Django REST Framework

pip install django djangorestframework mysqlclient

Phase 2: Database Configuration

2. Create Database and User in MySQL

Login to MySQL:

mysql -u root -p

Run these commands:

CREATE DATABASE lms_project CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci;

CREATE USER 'lms_user'@'localhost' IDENTIFIED BY 'your_secure_password';

GRANT ALL PRIVILEGES ON lms_project.* TO 'lms_user'@'localhost';

FLUSH PRIVILEGES;

EXIT;

Phase 3: Django Project Setup

3. Create Django Project and App

django-admin startproject lms_backend

cd lms_backend

python manage.py startapp core

4. Configure Django to Connect to MySQL

In lms_backend/settings.py, update the DATABASES setting:

```
DATABASES = {
   'default': {
      'ENGINE': 'django.db.backends.mysql',
      'NAME': 'lms_project',
      'USER': 'lms_user',
      'PASSWORD': 'your_secure_password',
      'HOST': 'localhost',
      'PORT': '3306',
   }
}
```

Also add your app 'core' and 'rest_framework' to INSTALLED_APPS.

5. Define Models

In core/models.py, copy the Django ORM models provided (Users, Courses, Modules, Enrollments, etc.).

6. Create Migration Files and Apply

```
python manage.py makemigrations core
python manage.py migrate
```

DATABASE AND USER SETUP

```
CREATE DATABASE lms_project CHARACTER SET utf8mb4 COLLATE
                                utf8mb4_unicode_ci;
    CREATE USER 'lms_user'@'localhost' IDENTIFIED BY
'your_secure_password';
GRANT ALL PRIVILEGES ON lms_project.* TO 'lms_user'@'localhost'
FLUSH PRIVILEGES;
```

Table Creation Scripts

```
  CREATE TABLE Users (
            user_id INT AUTO_INCREMENT PRIMARY KEY,
          name VARCHAR(100),
         email VARCHAR(100) UNIQUE,
```

```
    password_hash VARCHAR(255),
    role ENUM('Admin', 'Instructor', 'Learner'),
  created_at DATETIME DEFAULT CURRENT_TIMESTAMP
);
```

Courses

```
CREATE TABLE Courses (
  course_id INT AUTO_INCREMENT PRIMARY KEY,
  title VARCHAR(255),
  description TEXT,
  created_by INT,
  is_active BOOLEAN DEFAULT TRUE,
  FOREIGN KEY (created_by) REFERENCES Users(user_id)
);
```

Modules

```
CREATE TABLE Modules (
  module_id INT AUTO_INCREMENT PRIMARY KEY,
  course_id INT,
  title VARCHAR(255),
  content_type VARCHAR(50),
  resource_url TEXT,
  duration INT,
  FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);
```

Enrollments

```
CREATE TABLE Enrollments (
  enrolment_id INT AUTO_INCREMENT PRIMARY KEY,
  user_id INT,
  course_id INT,
  enrolment_on DATETIME DEFAULT CURRENT_TIMESTAMP,
```

```
    status VARCHAR(50),
    FOREIGN KEY (user_id) REFERENCES Users(user_id),
    FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);
```

Progress

```
CREATE TABLE Progress (
    progress_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
    module_id INT,
    status VARCHAR(50),
    score DECIMAL(5,2),
    last_accessed DATETIME,
    FOREIGN KEY (user_id) REFERENCES Users(user_id),
    FOREIGN KEY (module_id) REFERENCES Modules(module_id)
);
```

Certificates

```
CREATE TABLE Certificates (
    certificate_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
    course_id INT,
    certificate_url TEXT,
    issued_on DATE,
    FOREIGN KEY (user_id) REFERENCES Users(user_id),
    FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);
```

AI Logs

```
CREATE TABLE Ai_logs (
    log_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
```

```
    query_text TEXT,
    response_text TEXT,
    confidence_score DECIMAL(4,2),
    timestamp DATETIME DEFAULT CURRENT_TIMESTAMP,
    FOREIGN KEY (user_id) REFERENCES Users(user_id)
);
```

Lab Simulations

```
CREATE TABLE Lab_simulations (
    lab_id INT AUTO_INCREMENT PRIMARY KEY,
    course_id INT,
    config_json JSON,
    environment_type VARCHAR(50),
    created_at DATETIME DEFAULT CURRENT_TIMESTAMP,
    FOREIGN KEY (course_id) REFERENCES Courses(course_id)
);
```

Wallets

```
CREATE TABLE Wallets (
    wallet_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
    balance DECIMAL(10,2) DEFAULT 0.0,
    last_updated DATETIME DEFAULT CURRENT_TIMESTAMP,
    FOREIGN KEY (user_id) REFERENCES Users(user_id)
);
```

Transactions

```
CREATE TABLE Transactions (
    transaction_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
    amount DECIMAL(10,2),
    transaction_type ENUM('credit', 'debit'),
```

```
    reference VARCHAR(255),
    timestamp DATETIME DEFAULT CURRENT_TIMESTAMP,
    FOREIGN KEY (user_id) REFERENCES Users(user_id)
);
```

User Settings

```
CREATE TABLE User_settings (
    setting_id INT AUTO_INCREMENT PRIMARY KEY,
    user_id INT,
    theme VARCHAR(20),
    language VARCHAR(20),
    voice_reader_enabled BOOLEAN DEFAULT FALSE,
    FOREIGN KEY (user_id) REFERENCES Users(user_id)
);
```

Django Models (models.py)

Make sure your Django project is configured to use MySQL in settings.py before proceeding.

```
from django.db import models
from django.contrib.auth.models import AbstractBaseUser
# User Roles
ROLE_CHOICES = (
    ('Admin', 'Admin'),
    ('Instructor', 'Instructor'),
    ('Learner', 'Learner'),
)
class User(models.Model):
    name = models.CharField(max_length=100)
    email = models.EmailField(unique=True)
    password_hash = models.CharField(max_length=255)
    role = models.CharField(max_length=20, choices=ROLE_CHOICES)
```

```
    created_at = models.DateTimeField(auto_now_add=True)
        def _str_(self):
        return self.name
class Course(models.Model):
    title = models.CharField(max_length=255)
    description = models.TextField()
    created_by = models.ForeignKey(User, on_delete=models.CASCADE)
    is_active = models.BooleanField(default=True)
    def _str_(self):
        return self.title
class Module(models.Model):
    course = models.ForeignKey(Course, on_delete=models.CASCADE)
    title = models.CharField(max_length=255)
    content_type = models.CharField(max_length=50)
    resource_url = models.TextField()
    duration = models.IntegerField()
      def _str_(self):
       return self.title
class Enrollment(models.Model):
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    course = models.ForeignKey(Course, on_delete=models.CASCADE)
    enrolment_on = models.DateTimeField(auto_now_add=True)
    status = models.CharField(max_length=50)
class Progress(models.Model):
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    module = models.ForeignKey(Module, on_delete=models.CASCADE)
    status = models.CharField(max_length=50)
    score = models.DecimalField(max_digits=5, decimal_places=2)
    last_accessed = models.DateTimeField(null=True, blank=True)
```

```
class Certificate(models.Model):
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    course = models.ForeignKey(Course, on_delete=models.CASCADE)
    certificate_url = models.TextField()
    issued_on = models.DateField()
class AiLog(models.Model):
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    query_text = models.TextField()
    response_text = models.TextField()
    confidence_score = models.DecimalField(max_digits=4, decimal_places=2)
    timestamp = models.DateTimeField(auto_now_add=True)
class LabSimulation(models.Model):
    course = models.ForeignKey(Course, on_delete=models.CASCADE)
    config_json = models.JSONField()
    environment_type = models.CharField(max_length=50)
    created_at = models.DateTimeField(auto_now_add=True)
class Wallet(models.Model):
    user = models.OneToOneField(User, on_delete=models.CASCADE)
    balance = models.DecimalField(max_digits=10, decimal_places=2,
default=0.0)
    last_updated = models.DateTimeField(auto_now=True)
class Transaction(models.Model):
    TRANSACTION_TYPES = (
        ('credit', 'Credit'),
        ('debit', 'Debit'),
    )
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    amount = models.DecimalField(max_digits=10, decimal_places=2)
    transaction_type = models.CharField(max_length=10,
```

```
choices=TRANSACTION_TYPES)
    reference = models.CharField(max_length=255)
    timestamp = models.DateTimeField(auto_now_add=True)
class UserSetting(models.Model):
    user = models.OneToOneField(User, on_delete=models.CASCADE)
    theme = models.CharField(max_length=20)
    language = models.CharField(max_length=20)
    voice_reader_enabled = models.BooleanField(default=False)
```

1. Serializers (serializers.py)

```
from rest_framework import serializers
from .models import *
class UserSerializer(serializers.ModelSerializer):
    class Meta:
        model = User
        fields = '_all_'
class CourseSerializer(serializers.ModelSerializer):
    class Meta:
        model = Course
        fields = '_all_'
class ModuleSerializer(serializers.ModelSerializer):
    class Meta:
        model = Module
        fields = '_all_'
class EnrollmentSerializer(serializers.ModelSerializer):
    class Meta:
        model = Enrollment
        fields = '_all_'
class ProgressSerializer(serializers.ModelSerializer):
    class Meta:
```

```
        model = Progress
        fields = '_all_'
class CertificateSerializer(serializers.ModelSerializer):
    class Meta:
        model = Certificate
        fields = '_all_'
class AiLogSerializer(serializers.ModelSerializer):
    class Meta:
        model = AiLog
        fields = '_all_'
class LabSimulationSerializer(serializers.ModelSerializer):
    class Meta:
        model = LabSimulation
        fields = '_all_'
class WalletSerializer(serializers.ModelSerializer):
    class Meta:
        model = Wallet
        fields = '_all_'
class TransactionSerializer(serializers.ModelSerializer):
    class Meta:
        model = Transaction
        fields = '_all_'
class UserSettingSerializer(serializers.ModelSerializer):
    class Meta:
        model = UserSetting
        fields = '_all_'
```

2. Views (views.py)

Using Django REST Framework ViewSets for quick scaffolding.

```
from rest_framework import viewsets
```

```
from .models import *
from .serializers import *
class UserViewSet(viewsets.ModelViewSet):
    queryset = User.objects.all()
    serializer_class = UserSerializer
class CourseViewSet(viewsets.ModelViewSet):
    queryset = Course.objects.all()
    serializer_class = CourseSerializer
class ModuleViewSet(viewsets.ModelViewSet):
    queryset = Module.objects.all()
    serializer_class = ModuleSerializer
class EnrollmentViewSet(viewsets.ModelViewSet):
    queryset = Enrollment.objects.all()
    serializer_class = EnrollmentSerializer
class ProgressViewSet(viewsets.ModelViewSet):
    queryset = Progress.objects.all()
    serializer_class = ProgressSerializer
class CertificateViewSet(viewsets.ModelViewSet):
    queryset = Certificate.objects.all()
    serializer_class = CertificateSerializer
class AiLogViewSet(viewsets.ModelViewSet):
    queryset = AiLog.objects.all()
    serializer_class = AiLogSerializer
class LabSimulationViewSet(viewsets.ModelViewSet):
    queryset = LabSimulation.objects.all()
    serializer_class = LabSimulationSerializer
class WalletViewSet(viewsets.ModelViewSet):
    queryset = Wallet.objects.all()
    serializer_class = WalletSerializer
```

class TransactionViewSet(viewsets.ModelViewSet):

queryset = Transaction.objects.all()

serializer_class = TransactionSerializer

class UserSettingViewSet(viewsets.ModelViewSet):

queryset = UserSetting.objects.all()

serializer_class = UserSettingSerializer

3. URLs (urls.py)

```
from django.urls import path, include
from rest_framework.routers import DefaultRouter
from .views import *
router = DefaultRouter()
router.register(r'users', UserViewSet)
router.register(r'courses', CourseViewSet)
router.register(r'modules', ModuleViewSet)
router.register(r'enrollments', EnrollmentViewSet)
router.register(r'progress', ProgressViewSet)
router.register(r'certificates', CertificateViewSet)
router.register(r'ailogs', AiLogViewSet)
router.register(r'labs', LabSimulationViewSet)
router.register(r'wallets', WalletViewSet)
router.register(r'transactions', TransactionViewSet)
router.register(r'settings', UserSettingViewSet)
urlpatterns = [
    path('api/', include(router.urls)),
]
```

Register APIs in Router

In core/urls.py:

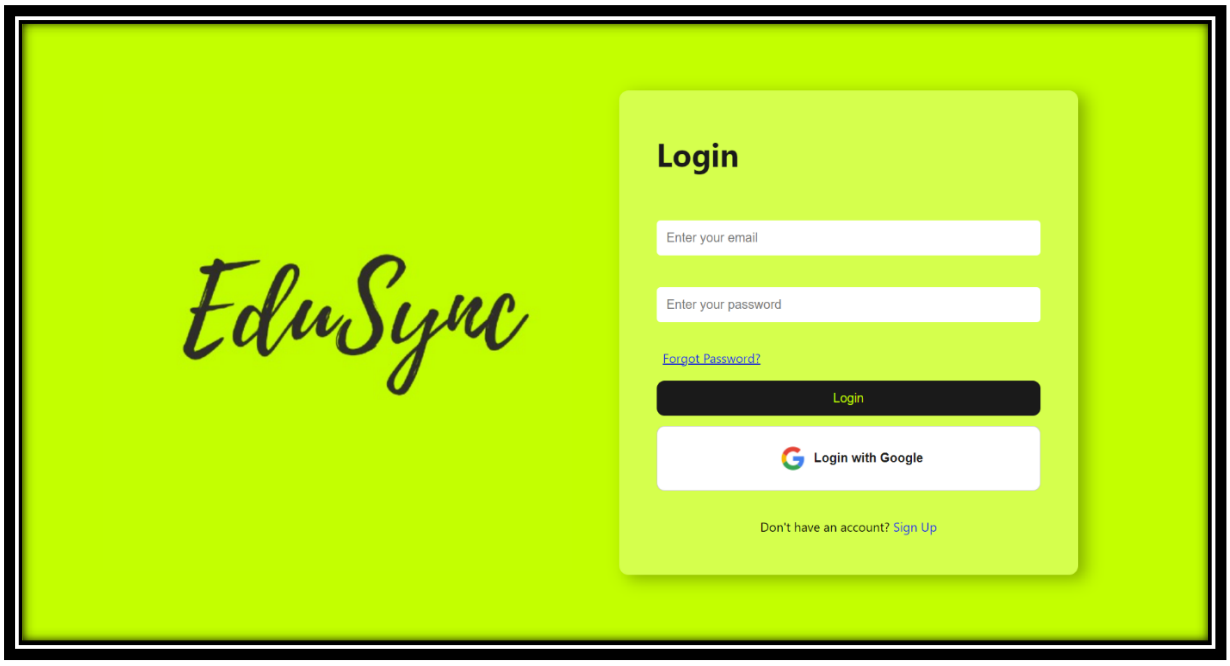
```
from django.urls import path, include
from rest_framework.routers import DefaultRouter
```

```
from .views import *
router = DefaultRouter()
router.register(r'users', UserViewSet)
router.register(r'courses', CourseViewSet)
# (other routers)
urlpatterns = [
    path('api/', include(router.urls)),
]
```

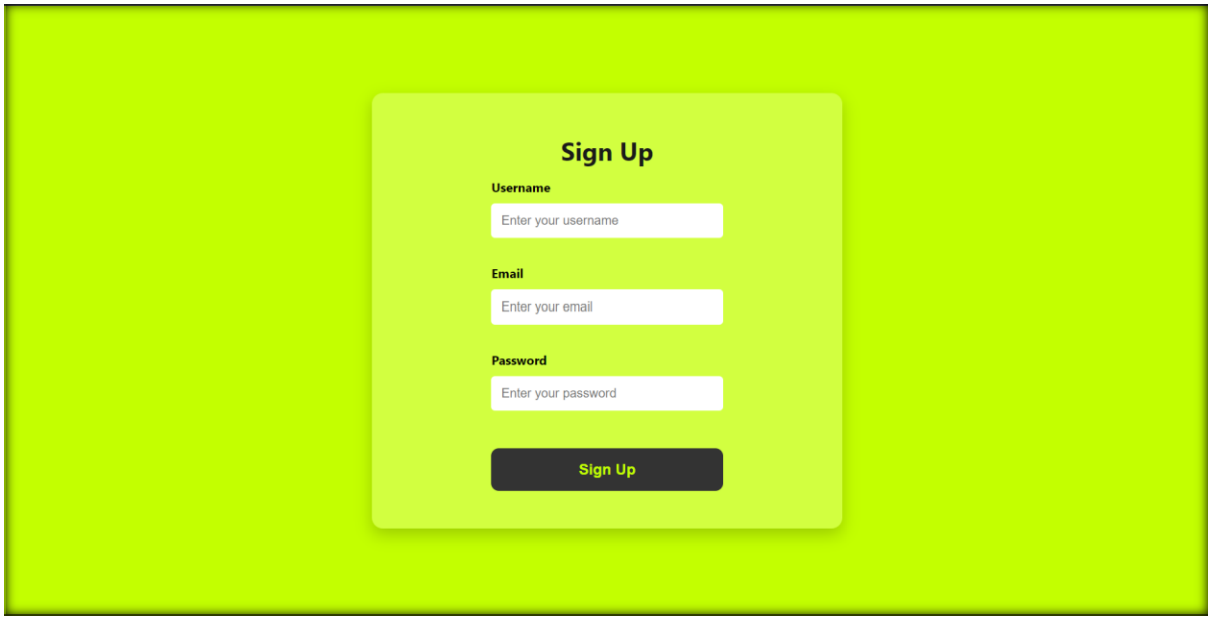
CHAPTER 13

OUTPUT:

LOGIN PAGE



SIGN UP PAGE



FORGOT PASSWORD PAGE

LANDING PAGE

CHAPTER 14

APPLICATIONS

Real-Time Applications of the AI-Integrated LMS Project

1. University & College E-Learning Platforms

- Deployed in universities to manage student enrollment, online lectures, assignments, and automated grading.
- AI personalizes learning paths and supports slow learners with remedial content.

2. Corporate Training & Skill Development

- Companies use it for employee onboarding, training, and certification.
- AI tracks employee performance and recommends training modules based on job roles.

3. Online Course Platforms (like Udemy, Coursera)

- Sell and manage online courses with automated course upload, user feedback, and smart recommendations.
- AI-driven search helps learners quickly find relevant courses.

4. Healthcare Professional Training

- Used in hospitals or medical schools to train doctors and nurses on the latest protocols.
- Tracks completion of certifications and uses AI to schedule training based on past learning trends.

5. Government & NGO Skill Development Programs

- Real-time monitoring of large-scale rural training programs (like PMKVY).
- Uses AI to detect dropout patterns and alert facilitators.

6. K–12 Smart Education Systems

- Schools integrate this with smart classrooms for homework, quizzes, and attendance tracking.
- Provides parents real-time dashboards of student progress.

7. Mobile Learning (M-Learning) Applications

- Learners can access content, exams, and certificates via mobile apps.
- Real-time push notifications for deadlines, payments, and feedback.

8. Secure Exam Portals

- Real-time online test systems with AI-enabled proctoring and result processing.

- Prevents cheating using user behavior analysis and automated warnings.

9. AI-Powered Analytics Dashboards

- Helps institutions monitor instructor effectiveness, course popularity, and user satisfaction in real time.
- Administrators make data-driven decisions to improve operations.

10. Integration with AI Research Projects

- Useful for researchers building AI models on learner behavior, adaptive learning, and dropout prediction.
- Real-time dataset collection from live learners**.**

CHAPTER 15

FUTURE ENHANCEMENTS:

Though the existing platform has a robust, scalable, and dependable infrastructure for online learning, wallet management, reporting, and certification, ongoing improvement and innovation are necessary to ensure competitiveness and meet changing user requirements.

The following chapter details some possible improvements that might be introduced in future releases to enhance functionality, user experience, and the capability of the platform.

15.1 Advanced Personalization and AI-Driven Learning Paths Objective:

Provide a highly personalized learning experience that is customized to individual users' strengths, weaknesses, preferences, and objectives.

Implement AI and Machine Learning models to evaluate quiz scores, engagement levels, and learning patterns.

Suggest personalized course pathways, supplemental resources, or remedial modules based on user performance.

Employ Natural Language Processing (NLP) to offer intelligent chatbot assistance for course inquiries and advice.

Impact:

Increases learner engagement, enhances learning outcomes, and supports increased course completion rates.

15.2 Blockchain-Based Certificate Verification Objective:

Improve the credibility, security, and global acceptability of certificates issued.

Store certificate metadata on a blockchain to render certificates tamper-proof and verifiable by third parties at ease.

Enable employers or institutions to verify certificates on their own without resorting to manual validation processes.

Impact:

Enhances certificate authenticity, minimizes risks of fraud, and improves platform reputation in the market of professional education.

15.3 Gamification Features Objective:

Boost user motivation, engagement, and retention by engaging users in more interactive and rewarding learning experiences.

Introduce points, badges, leaderboards, and achievement levels based on user

behavior (e.g., course completion, quiz performance).
Create special missions and challenges to motivate ongoing learning.
Impact:
Engages users more, creates a competitive but cooperative community,and enhances platform loyalty.

14.4 Multi-Currency Wallet Support Objective:
Increase platform accessibility and usability for a global audience.
Make wallets multi-currency capable (e.g., USD, EUR, INR).
Include dynamic currency conversion based on real-time exchange rates.
Let users choose their payment currency of choice when making transactions.
Impact:
Enables frictionless transactions for international users, making the site more inclusive and business-ready for global expansion.

15.5 Predictive Analytics and Advanced Reporting Objective:
Use data analysis to forecast user actions and enhance decision-making by administrators and instructors.
Use dashboards displaying predictive indicators such as:
Probability of course completion.
Probability of user dropout.
Course popularity trends.
Allow instructors to receive notifications or suggestions based on anticipated user behavior.
Impact:
Enables proactive intervention strategies, enhances course content planning, and optimizes overall platform performance.

15.6 Mobile Application Development Objective:
Offer users an on-the-go learning experience through specialized mobile apps.
Create native Android and iOS applications.
Facilitate offline access to course material.
Implement push notifications for reminders, updates, and announcements.
Impact:
Enhances accessibility, boosts daily user engagement, and facilitates flexible learning patterns.

15.7 Improved Payment Gateway Options Objective:

Provide customers with more payment options and seamless checkout experiences.

Include additional payment gateways such as PayPal, Google Pay, Apple Pay, and local versions for various regions.

Provide installment-based or subscription-based payment options for expensive courses.

Impact:

Boosts conversion rates at the time of payment, supports more user preferences, and enhances cash flow options for students.

CHAPTER 16

CONCLUSION:

The implementation and development of this system
have effectively provided an end-to-end, scalable, and secure digital learning platform fulfilling the functional needs identified in the initial planning phase. During the course of this project, efforts were kept at high
standards concerning system architecture, database design, backend
API creation, payment integrations, reporting mechanisms, certification processes, and system testing.

Key Accomplishments

01.Robust System Architecture

The architecture was modularized into well
designed Django applications, ensuring maintainability and future scalability. The Django REST Framework provided a standardized, efficient, and extensible API design, ensuring smooth communication between frontend and backend.

02.Secure and Scalable Data Management

MySQL-based database design was normalized, optimized,
and extensively tested to ensure data integrity, high performance,
and responsiveness to future growth.
Sensitive data like user credentials, payment history, and
wallet information were protected by encryption, hashing,
and industry security best practices.

03.Seamless Payment and Wallet

Integration Leading payment gateway integrations (Stripe and
Razorpay) allowed users to enjoy safe, adaptable, and easy financial transactions.
Wallet infrastructure facilitated transparencyand accountability by keeping preci se transaction records and instant balance refreshes.

04.Certification system

The automated certificate creation and
dispatch mechanism facilitated simplified acknowledgment of learner achievem ents, driving user satisfaction and platform integrity.
Thorough System Testing and Verification Comprehensive database testing, API verifications, frontend usability testing, security scanning, and performance benchmarking guaranteed the platform to be trustworthy, robust, and user-oriented.

Early detection correction of latent system weaknesses lowered the likelihood of failures after deployment.

Overall Impact:

This project has achieved a high-quality platform that offers:

Learners with an engaging, intuitive, and rewarding learning experience.

Instructors with powerful tools to conduct courses, monitor learner progress, and reward achievement.

Administrators with secure access to system functions, payments, and user management.

The use of a solid technical foundation and modular design practices during the project ensures that the platform is future-proof, where it can accept new features, technological advancements, and scaling requirements as user demand increases.

CHAPTER 17

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