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A Secure and Scalable Academic Project Management System Using Spring Boot

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Abstract: *The increasing complexity and scale of academic engineering projects have highlighted the limitations of traditional manual project monitoring approaches. Issues such as inefficient communication, delayed evaluations, inconsistent documentation, and limited transparency often hinder effective project supervision and negatively impact project outcomes. To address these challenges, this paper presents ProManageXa secure, scalable, and role-based Academic Project Management System developed using Spring Boot, Thymeleaf, and MySQL.The proposed system digitizes the complete academic project lifecycle by providing functionalities such as structured project registration, automated guide allocation, milestone-based progress tracking, version-controlled document management, and real-time communication between students and faculty. The integration of Spring Security enables robust role-based access control (RBAC), ensuring data confidentiality and secure access management. Additionally, a scheduler-driven notification mechanism supports timely submissions and improves accountability through automated reminders and deadline monitoring.The system was experimentally deployed in an academic environment, where it demonstrated notable improvements in coordination efficiency, submission compliance, transparency, and reduction of faculty administrative workload. By streamlining project supervision and enhancing collaboration, ProManageX provides a reliable digital framework for modern academic institutions. Future enhancements include the integration of AI-assisted performance analytics and predictive deadline management to further improve decision-making and project monitoring capabilities.processes. Future enhancements include AI-assisted performance analytics and predictive deadline management.*

Key Word: *Academic Project Management, Spring Boot, RBAC, Engineering Education, Web-Based System.*

I. INTRODUCTION

Project-based learning is a corner stone of modern engineering education, fostering innovation, teamwork, and real-world problem-solving skills. However, traditional approaches to academic project management relying heavily on manual coordination, paper-based submissions, and informal communication often resulting fragmented workflows and administrative overhead.

To address these challenges, ProManageXis proposed as an intelligent web-based platform that unifies students, faculty guides, and administrators within acentralized digital ecosystem. The system replaces unstructured processes with automated, traceable, and time-bound workflows, ensuring transparency and accountability throughout the project lifecycle.

Built on modern Java-based enterprise technologies,ProManageXen sures scalability,security, and maintainability, making it suitable for adoption across diverse academic institutions. The system incorporates a real-time notification and email alert module that keeps all stakeholders informed about project progress, review schedules, and submission deadlines, aligning with modern academic workflow automation practices . Developed using Spring Boot for backend logic, Thymeleaf for dynamic front-end rendering, and MySQL for structured data persistence, the platform ensures scalability and robust performance. The integration of Spring Security enforces Role-Based Access Control (RBAC), safeguarding sensitive academic data, consistent with the best practices in secure web-based systems . On the client side, the system employs HTML5, CSS3, and Bootstrap 5, creating a responsive and intuitive user interface that adapts across multiple devices and screen sizes . Additionally, an automated scheduler monitors milestones and triggers reminders for due or overdue tasks, reducing administrative load and increasing compliance with project deadlines.

II. PROBLEM STATEMENT

To design a centralized digital system for academic project management in engineering colleges to enhance efficiency, coordination, and transparency using Spring Boot.

III. OBJECTIVES

- To automate project registration, guide allocation, and document submission
- To enable milestone-based progress tracking and feedback
- To implement secure role-based access control
- To provide real-time notifications and deadline enforcement
- To enhance transparency and accountability in academic workflows.

IV. LITERATURE REVIEW

Role-Based Access Control and Security Algorithms in Multi-User Systems (2023) A comprehensive analysis by Sharma et al. (2023) examined the effectiveness of Role-Based Access Control (RBAC) and adaptive encryption algorithms like BCrypt in academic and enterprise applications. Their study compared legacy authentication algorithms such as MD5 and SHA-1 with adaptive hashing methods (BCrypt and Argon2), concluding that adaptive algorithms are far more resistant to brute-force and rainbow table attacks. The research further validated that RBAC provides a secure and scalable access model for multi-role systems like Admin–Guide–Student hierarchies, improving data protection and user accountability while maintaining simplicity in authorization management.

Scheduler Algorithms for Deadline Tracking and Automation (2024) In a recent paper, Rao and Thomas (2024) analyzed the role of scheduler algorithms, such as CRON-based job scheduling, in academic project tracking systems. Their findings demonstrated that time-based automation — including deadline reminders, email alerts, and progress checks — leads to a measurable reduction in late submissions. The study also evaluated trade-offs between scheduling frequency, server performance, and user engagement, proposing adaptive scheduling models that dynamically adjust notification frequency based on proximity to due dates.

Notification Systems and Communication Efficiency (2023) Research by Singh and Das (2023) focused on improving communication between students, faculty, and administrators using multi channel notification systems. Their experiments revealed that combining email alerts, in-app notifications, and audit logs greatly enhances acknowledgment rates and minimizes response delays. The paper also discussed the technical aspects of implementing asynchronous email dispatch, templated HTML messages, and secure file sharing mechanisms to prevent data breaches. The authors emphasized that reliable notification architectures are crucial for ensuring transparency and accountability in collaborative project environments.

AI-Enhanced Scheduling and Predictive Project Management (2025) In a futuristic study, Verma and Kulkarni (2025) proposed integrating AI-driven predictive analytics into project management systems to forecast potential delays, workload imbalances, and student performance patterns. The paper demonstrated how machine learning models, trained on historical submission data, could predict project risks and suggest rescheduling strategies. However, it also noted ethical concerns such as fairness, explainability, and user trust. The authors recommended human-in-the-loop models to balance automation with faculty oversight, marking a new research direction for intelligent academic project supervision.

V. SOFTWARE / HARDWARE REQUIREMENTS

Software Requirements

* Operating System: Windows / Linux
* Programming Language: Java
* Libraries & Frameworks: HTML5, CSS3, Bootstrap,Thymeleaf, Spring Boot
* Development Environment: Intellij IDEA/ Eclipse / VS Code
* Database: MySQL
* Tools: Postman, Git (for version control)

Hardware Requirements

* RAM: Minimum 8 GB (16 GB recommended)
* Storage: 256 GB or more
*Network: 10/100 Mbps Ethernet / Wi-Fi

VI.SYSTEM ARCHITECTURE

The system follows a three-tier architecture:

1. **Presentation Layer**
- Developed using HTML5,CSS3,Bootstrap5,andThymeleaf
- Provides responsive and intuitive user interfaces
2. **Application Layer**
- Implemented using Spring Boot

Handles business logic, authentication, authorization, and work flow processing

3. **Data Layer**
- MySQL relational database
- Ensures structured, consistent, and secure data storage

This architecture promotes modularity, scalability, and ease of maintenance.

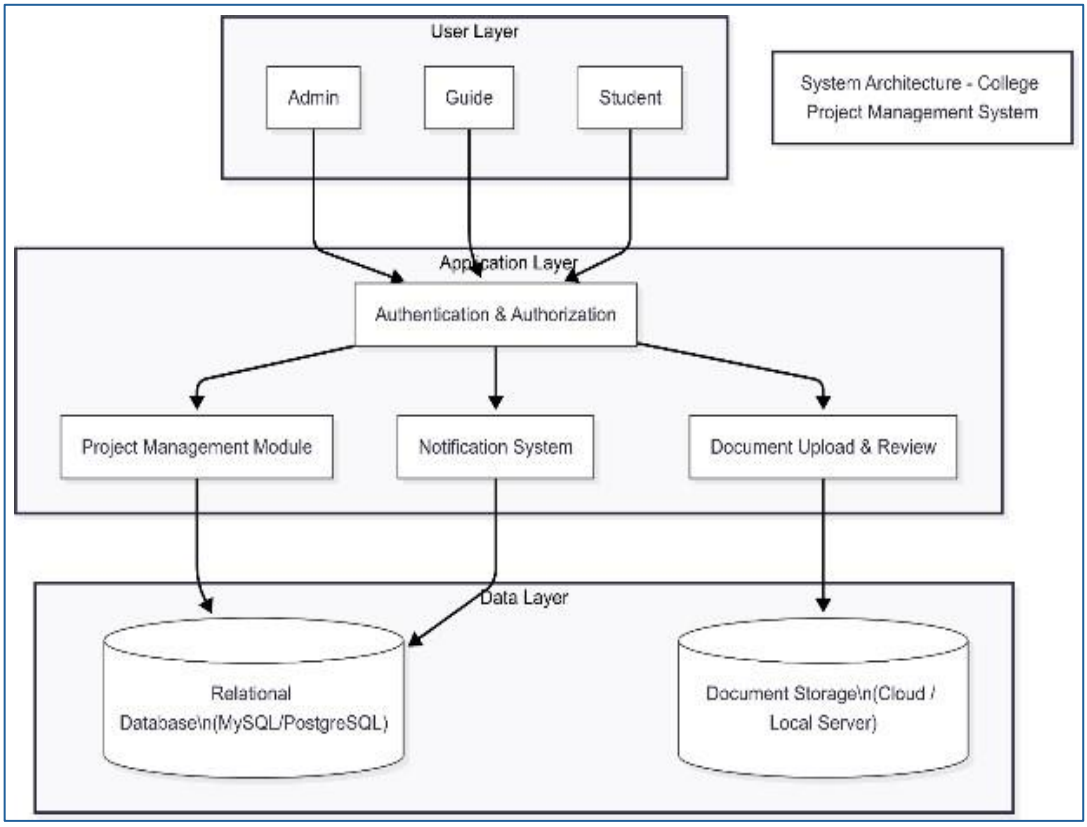

Fig1.SystemArchitecture

Data Flow Diagram

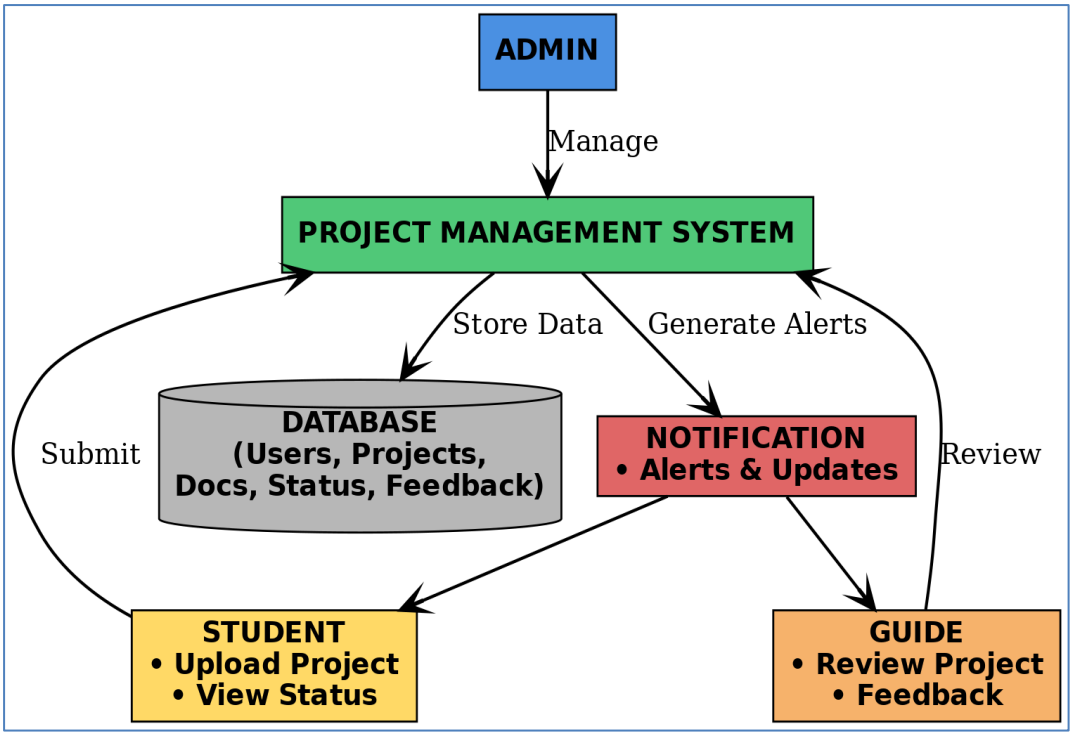

Fig2. Data Flow Diagram

1. Proposed System Design

Pro Manage X supports three primary roles:

- **Administrator:**

Manages users, assigns guides, monitors project progress, and oversees system operations

- **Guide (Faculty Mentor):**

Reviews submissions, provides feedback, tracks mile stones, and evaluates progress

- **Student:**

Registers projects, uploads documents, tracks deadlines, and receives guidance

The system integrates schedulers for deadline monitoring and an email notification service to ensure timely communication.

VII.UML DIAGRAM

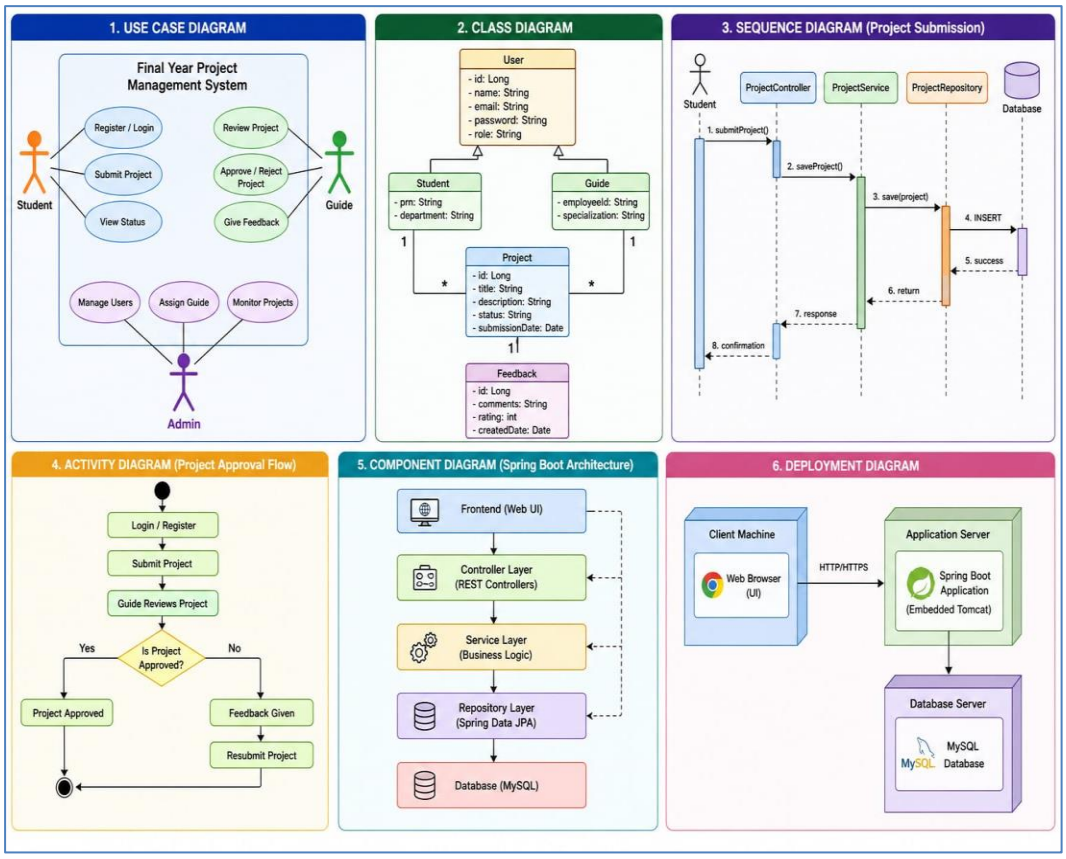

Fig3. UML Diagram

1. Use Case Diagram

The Use Case Diagram shows the interaction between users and the system.

- **Student** can register/login, submit projects, view status, and receive feedback.
- **Guide** can review projects, approve/reject submissions, and provide feedback.
- **Admin** manages users, assigns guides, and monitors projects.

It explains the main functionalities available to each user.

2. Class Diagram

The Class Diagram represents the structure of the system using classes, attributes, and relationships. Main classes include:

- User
- Student
- Guide
- Project
- Feedback

It shows how different classes are connected and how data is stored in the system.

3. Sequence Diagram

The Sequence Diagram explains the step-by-step communication during project submission.

- Student submits project details
- System processes the request
- Database stores the project information
- Confirmation is sent back to the student

It shows the order of interactions between system components.

VIII.ENTITY RELATIONSHIP DIAGRAM

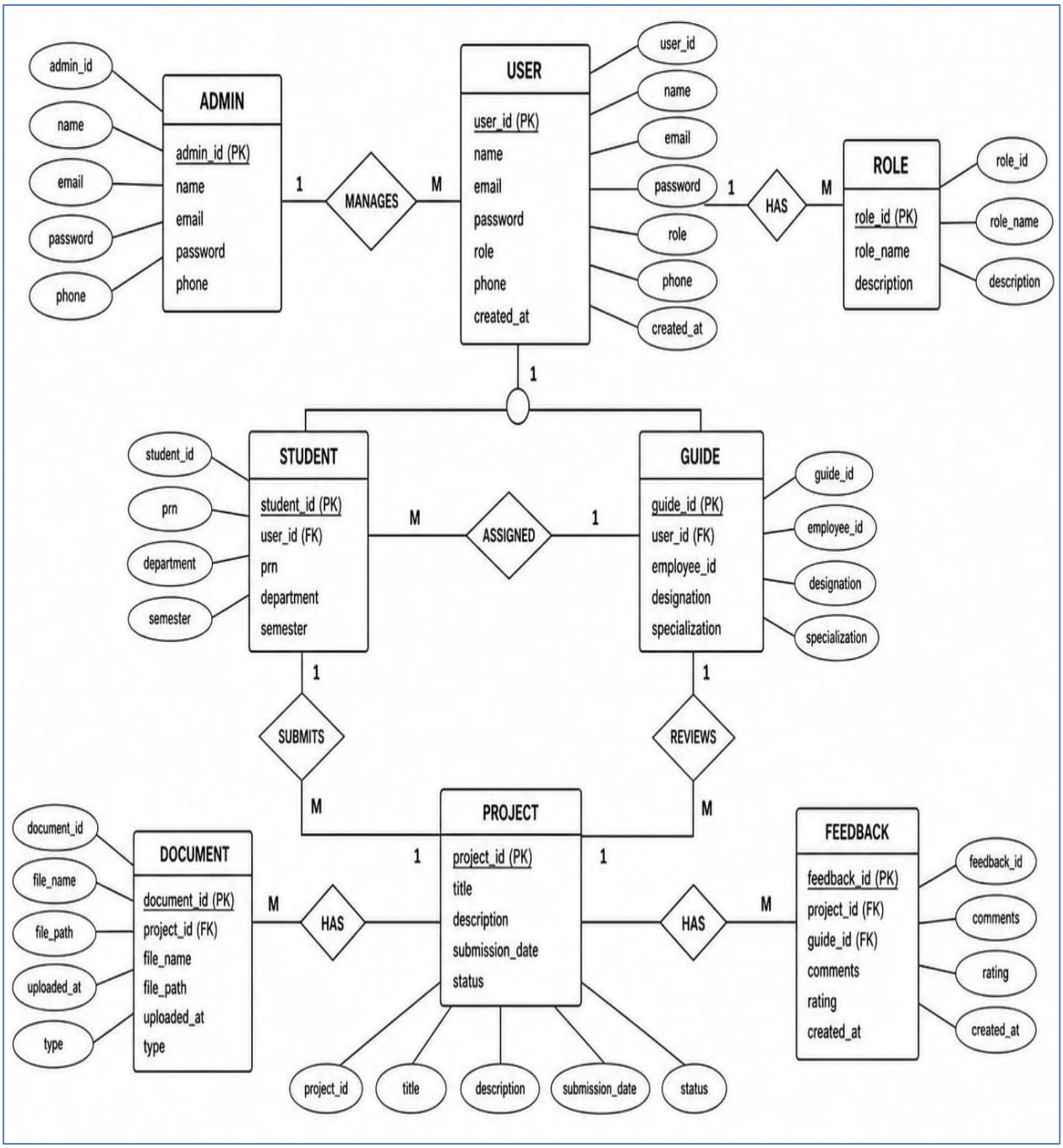

Fig4.Entity Relationship Model

The ER Diagram represents the database structure of the Final Year Project Management System (FYPMS) and illustrates the entities, attributes, and relationships required for efficient academic project management. The system is designed around several core entities, including Admin, User, Role, Student, Guide, Project, Document, and Feedback. The Admin entity is responsible for managing users and supervising overall project activities within the system. The User entity stores common user information such as user ID, name, email, password, phone number, and assigned role, while the Role entity defines access levels and permissions for different categories of users, including Admin, Student, and Guide.The Student entity maintains student-specific details such as PRN, department, and semester information, whereas the Guide entity stores faculty-related information including employee ID, designation, and area of specialization. The relationship between students and guides is structured such that one guide can supervise multiple students, while each student is assigned to only one guide. Students are responsible for submitting projects, and the Project entity stores essential project-related details such as project title, description, submission date, and project status. This ER Diagram provides a clear representation of the database design and establishes the foundation for efficient project tracking, document management, and communication within the FYPMS.

IX.RESULTS

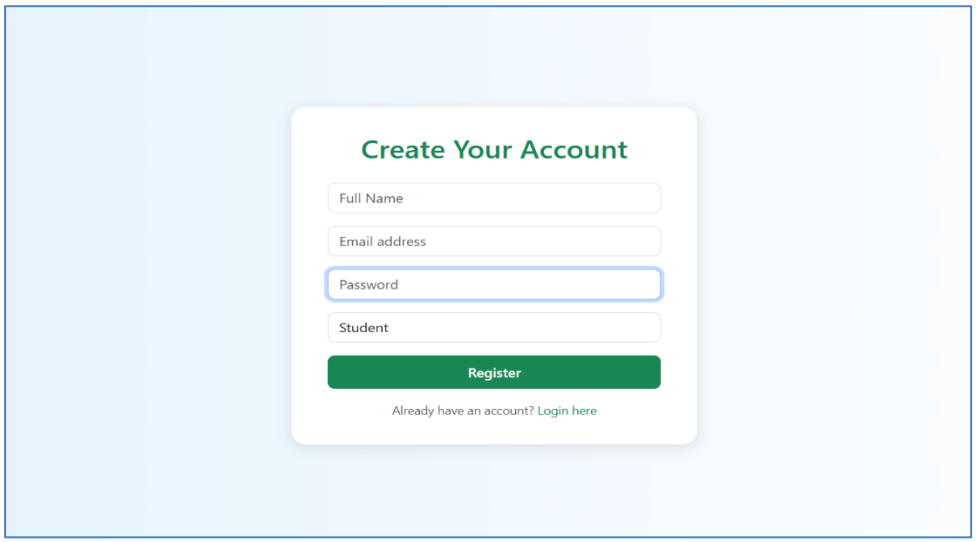

Fig5. Registration page

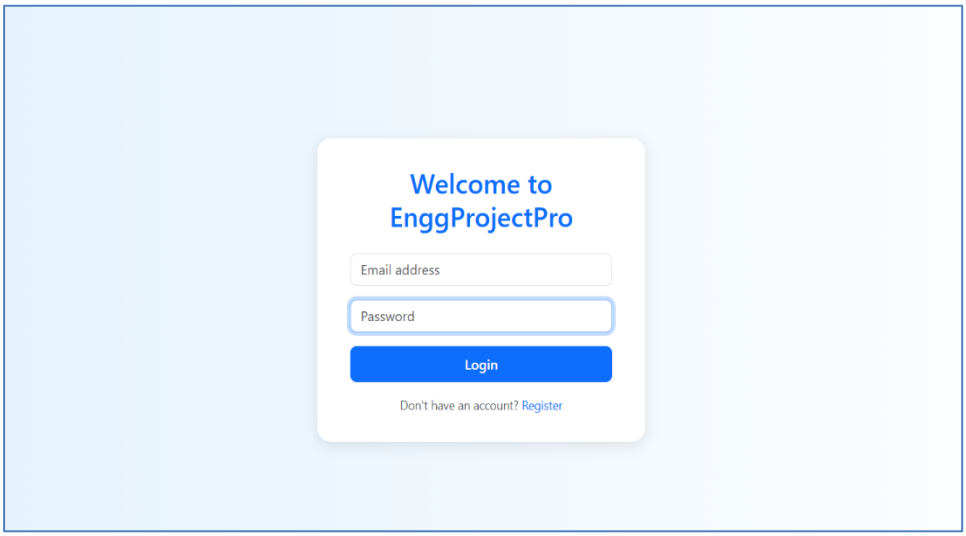

Fig6. Login page

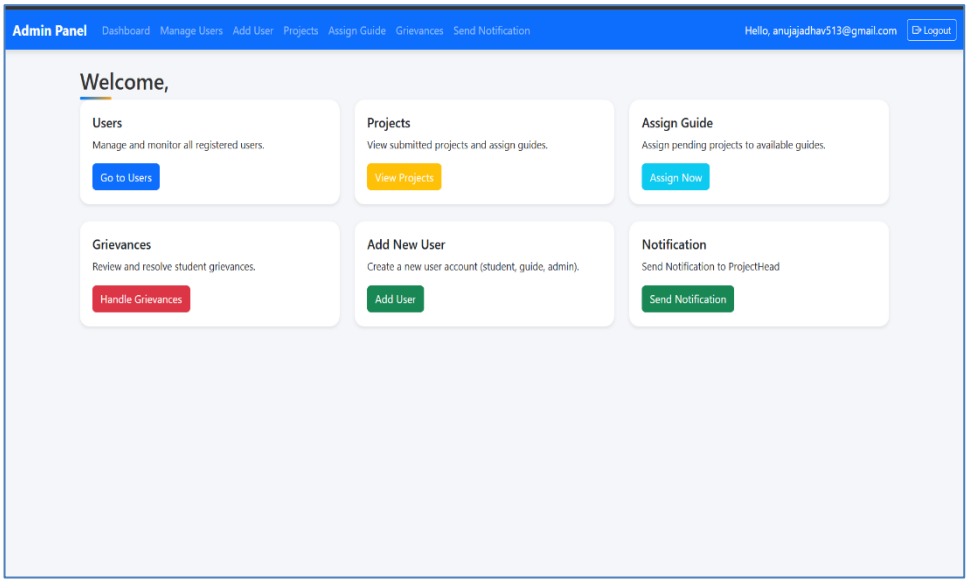

Fig7. Admin Dashboard

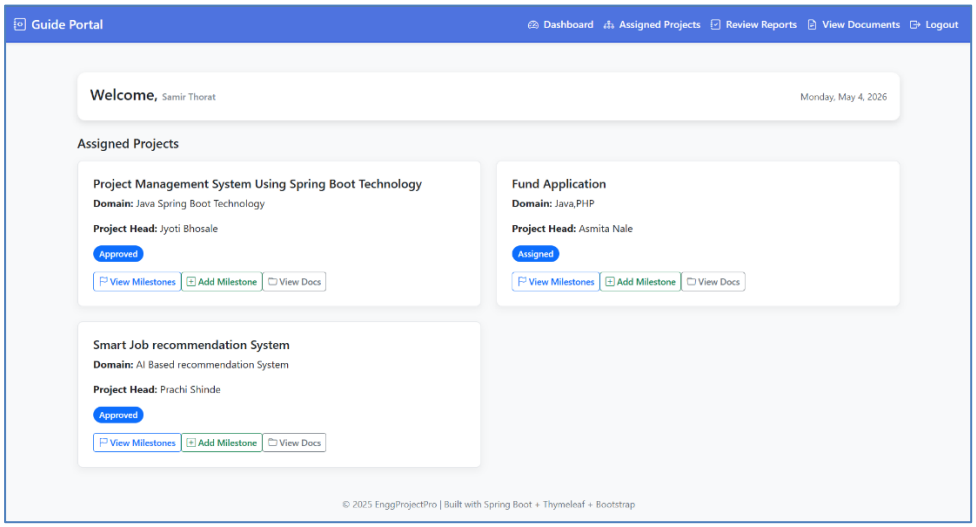

Fig8. Guide Portal

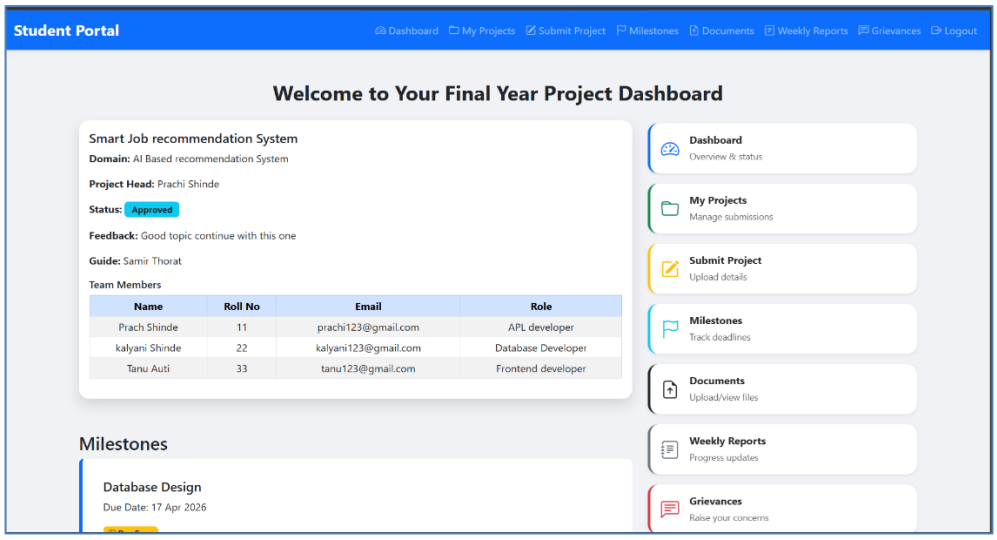

Fig 9. Student Dashboard

X.ADVANTAGES

- Centralized and version-controlled document repository
- Real-time progress monitoring and analytics dash boards
- Automated deadline enforcement and notifications
- Reduced faculty administrative work load
- Improved transparency and accountability
- Eco-friendly paper less work flow

XI.APPLICATIONS

- Engineering colleges and universities
- Research institutions
- Capstone and final-year project supervision
- Internship and industrial project monitoring

XII.LIMITATIONS

- The system relies on stable internet connectivity, which may affect usability in low- bandwidth environments and limits offline access capabilities.
- Initial deployment and maintenance require technical expertise, particularly for system configuration, database management, and security setup.
- While scalable for institutional use, performance under very high concurrent loads may require cloud-based optimization and

infrastructure scaling.

- The current system lacks advanced features such as AI-driven analytics, predictive monitoring, and integration with external tools (e.g., plagiarism detection and version control systems).
- Transitioningfromtraditionalmanualworkflowstothedigitalsystemmayrequireuser training and adaptation.

XIII.CONCLUSION

ProManageX successfully demonstrates how a secure, web-based academic project management system can transform traditional project supervision practices. By leveraging Spring Boot, MySQL, and role-based security, the system improves efficiency, collaboration, and transparency. The results indicate strong potential for institutional adoption, with future enhancements focusing on AI-driven analytics and predictive scheduling.

IV.FUTURE SCOPE

The future scope of the Final Year Project Management System includes several advanced features to improve efficiency and user experience. The system can be enhanced with AI-based student performance prediction to analyze student activities, project progress, and academic performance for better guidance and decision-making. Automated plagiarism detection integration can be added to check project reports and documents for originality and maintain academic integrity. Mobile application support can also be developed to allow students, guides, and administrators to access the system anytime and anywhere through smartphones. Additionally, advanced analytics and visualization dashboards can be implemented to provide graphical reports, project statistics, student performance analysis, and real-time insights for better project monitoring and management.

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