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PROJECT REPORT ON

# "MAINTENANCE LOGBOOK FOR LABS"

## B.TECH IN COMPUTER SCIENCE & ENGINEERING

**Submitted By**

| Name | PRN |
|---|---|
| **1. Akanksha Kishor Naik** | **2124UCEF2049** |
| **2. Prachi Sunil Hirve** | **2124UCEF2014** |
| **3. Samer Pradeep Jadhav** | **2124UCEM2051** |
| **4. Harshad Sachin Pund** | **2124UCEM2002** |
| **5. Durgesh Rajendra Shewale** | **2124UCEM2042** |
| **6. Rihan Mirkha Pathan** | **2124UCEM2025** |

UNDER THE GUIDANCE OF

**PROF. KUSHAGRA JOSHI**

**SANJIVANI UNIVERSITY KOPARGAON-423603**
**COMPUTER SCIENCE & ENGINEERING**

November, 2025

## SANJIVANI UNIVERSITY, KOPARGAON

### EXAMINERS CERTIFICATE

This is to certify that the project work entitled

**“MAINTENANCE LOGBOOK FOR LABS”**

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| **5. Durgesh Rajendra Shewale** | **2124UCEM2042** |
| **6. Rihan Mirkha Pathan** | **2124UCEM2025** |

***For the partial of the requirement of B.Tech In Computer Science & Engineering is examined and certified.***

**Prof. Kushagra Joshi**

(Project Guide)

## Declaration by the Candidate

I hereby declare that the project entitled **“Web-Based Maintenance Logbook System for Computer Lab”** submitted by me in partial fulfillment of the requirements for the award of the degree, is a genuine and original work carried out by me under the guidance of **Prof. Kushagra Joshi**.

I further declare that this project has not been previously submitted to any other institution or university for any award of degree or diploma. All the information and data presented in this project is based on my own research and development work and is duly acknowledged wherever referred.

**Date: ______________________**
**Place:** Kopargaon, Ahilynagar

## Signature of Candidate

| Name | Entrollment |
|---|---|
| **1. Akanksha Kishor Naik** | |
| **2. Prachi Sunil Hirve** | |
| **3. Samer Pradeep Jadhav** | |
| **4. Harshad Sachin Pund** | |
| **5. Durgesh Rajendra Shewale** | |
| **6. Rihan Mirkha Pathan** | |

# Certificate

This is to certify that the project work entitled **“Web-Based Maintenance Logbook System for Computer Lab”** submitted **Akanksha Kishor Naik, Prachi Sunil Hirve, Sameer Pradeep Jadhav**, **Harshad Sachin Pund**, **Durgesh Rajendra Shewale**, **Rihan Mirkha Pathan** by bearing Enrollment No. **(Enrollment Number)** in partial fulfillment of the requirements for the award of the degree **B.Tech in Computer Science and Engineering** for the academic year **2024–2025**, is a **bonafide and original work** carried out under my supervision and guidance.

To the best of my knowledge, the matter embodied in this project has not been submitted previously, in part or full, to any other university or institution for the award of any degree or diploma.

**Project Guide:**
**Name of Guide: Prof. Kushagra Joshi**
**Designation: ______________________________**
**Department: ______________________________**

**Signature of Guide: ______________________**

**Head of Department (HOD):**
**Name: Dr. M.B. Gawali**
**Signature: ______________________________**

# ACKNOWLEDGEMENT

As a student of **Bachelor of Technology (B.Tech)** in **Computer Science and Engineering** at **Sanjivani University, Kopargaon**, I take this opportunity to express my sincere gratitude to all those who have supported and guided me throughout the successful completion of my project titled “Digital Maintenance Logbook for Labs.”

This project has been a transformative journey, blending technical exploration with personal growth. I am deeply thankful to the academic mentors and project coordinators for their consistent guidance, insightful feedback, and encouragement. Their expertise and support helped me navigate challenges and refine the project to meet academic standards. I extend heartfelt appreciation to my fellow project collaborators for their dedication, teamwork, and valuable contributions. Their diverse perspectives and shared commitment to excellence enriched the project and fostered a spirit of innovation.

I am sincerely grateful to the faculty members of the Department of Computer Science and Engineering for cultivating an environment that promotes curiosity, creativity, and critical thinking. Their mentorship and encouragement have played a vital role in shaping my academic journey special thanks are due to the technical staff and support teams who provided timely assistance with software, testing, and infrastructure. Their responsiveness and problem-solving skills ensured the smooth execution of various components and helped overcome practical challenges during implementation.

I also wish to acknowledge the role of the institutional leadership at Sanjivani University for fostering a culture of academic excellence and innovation. Their vision and commitment to empowering students through research and hands-on learning have been instrumental in enabling projects like this to thrive.

My deepest gratitude goes to my family and friends, whose unwavering support, patience, and motivation have been a constant source of strength. Their belief in my efforts has inspired me to persevere and strive for excellence.

I am also thankful to the broader academic and research community for nurturing an atmosphere of intellectual curiosity and collaboration. Engaging with peers, attending seminars, and exploring scholarly resources have significantly enriched the depth and scope of this report.

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# ABSTRACT

The “Digital Maintenance Logbook for Labs” is an innovative web-based solution designed to digitalize and streamline the process of recording, managing, and monitoring laboratory equipment maintenance activities. In educational institutions and research environments, maintaining laboratory equipment is crucial for ensuring operational efficiency, safety, and accountability. However, manual record-keeping often leads to data loss, inefficiency, and mismanagement. This project addresses these challenges by providing a centralized, secure, and automated platform for logging maintenance details digitally.

The system integrates Angular (frontend) and Spring Boot (backend) technologies, supported by a MySQL database to manage and track maintenance activities effectively. It features role-based access control through JWT authentication, ensuring that users such as Admin, HOD, Faculty, and Students can interact with the system according to their assigned privileges. For example, an Admin can oversee all device records and user accounts, while Faculty members can log maintenance requests or view the history of laboratory equipment.

The application provides essential functionalities such as device registration, maintenance tracking, issue reporting, and activity monitoring through an intuitive user interface. The backend handles data persistence, API requests, and user authentication securely, while the frontend offers a responsive and user-friendly experience for data entry and report generation. The system also supports features like downloading device lists in PDF format for administrative convenience.From a technical perspective, the project demonstrates strong integration of RESTful API development, database management, and frontend-backend communication using JSON-based data exchange. It showcases the practical implementation of modern full-stack development concepts within a real-world institutional context.

Overall, the Digital Maintenance Logbook for Labs enhances transparency, reduces manual workload, and ensures that maintenance activities are systematically recorded and monitored. Future developments may include automated maintenance reminders, analytics dashboards, and integration with IoT-enabled laboratory devices to enable predictive maintenance and real-time equipment status monitoring. By combining software engineering principles with practical utility, this project represents a significant step toward smarter and more efficient laboratory management systems

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

In modern educational and research institutions, laboratories serve as the backbone of practical learning and innovation. They house various instruments, equipment, and machinery that require periodic maintenance to ensure safety, reliability, and uninterrupted operation. Traditionally, these maintenance activities are recorded manually in logbooks or registers, which often leads to inefficiencies such as misplaced records, lack of transparency, and difficulty in tracking historical data. To overcome these limitations, there is a growing need for a digitalized maintenance management system that simplifies record-keeping, enhances accountability, and provides easy access to maintenance data.

The “Digital Maintenance Logbook for Labs” project has been developed to address these challenges by offering a web-based application that replaces traditional manual logbooks with an automated, centralized, and secure digital platform. This system enables authorized users to record, monitor, and manage laboratory equipment maintenance activities efficiently. The project is particularly designed for educational institutions, research centers, and technical laboratories, where multiple stakeholders such as Administrators, Heads of Departments (HODs), Faculty members, and Students are involved in the use and upkeep of laboratory equipment.

The primary objective of this project is to streamline maintenance management by integrating digital tools that ensure real-time tracking and accurate record-keeping. The system allows users to add, update, and view equipment details, log maintenance activities, and generate reports based on stored data. It enhances data integrity and accessibility, ensuring that critical information such as maintenance schedules, issue history, and responsible personnel can be retrieved quickly when needed. The application is developed using modern full-stack technologies, including Angular for the frontend, Spring Boot for the backend, and MySQL for database management. The integration of JWT-based authentication and role-based access control ensures data security and privacy, allowing each user role to perform specific actions based on their responsibilities. For instance, an Admin can manage all users and devices, the HOD can monitor department-level maintenance records, Faculty members can submit maintenance requests, and Students can view information related to their assigned laboratories.

The frontend of the application offers an intuitive and responsive user interface that simplifies user interaction and data visualization. The backend provides a robust and scalable API architecture that handles authentication, authorization, and data processing seamlessly. The system also includes functionality for PDF report generation, allowing administrators to download device or maintenance lists for official documentation.

By digitalizing the maintenance workflow, this project not only improves operational efficiency but also contributes to sustainable management practices by reducing paper usage and manual errors. It fosters a transparent maintenance culture where responsibilities are clearly defined, and tasks are monitored effectively. from an academic perspective, this project integrates core concepts of software engineering, web development, database design, and cybersecurity, providing a practical learning experience in developing a real-world application. It demonstrates how theoretical knowledge can be applied to solve actual institutional problems using emerging technologies.

In conclusion, the Digital Maintenance Logbook for Labs serves as an innovative solution for managing laboratory assets in a systematic, transparent, and user-friendly manner. It represents a step toward digital transformation within educational ecosystems, aligning with the vision of Smart Campus Initiatives and promoting efficiency, accountability, and technological advancement in laboratory management.

## 1.2 Objectives of the Project

The primary objective of the Digital Maintenance Logbook System is to modernize and simplify the process of recording, tracking, and managing maintenance activities for laboratory and industrial machines. The system replaces traditional manual logbooks with a secure, efficient, and technology-driven platform.

The key objectives are as follows:

1. **To Digitize Maintenance Records:** Replace manual paper-based logbooks with a centralized digital system that stores all maintenance details, improving accessibility and data reliability.
2. **To Implement QR-Based Machine Identification:** Assign unique QR codes to each machine, allowing users and technicians to instantly retrieve machine details, maintenance history, and service records by scanning the code.
3. **To Enable Role-Based Access Control:** Provide secure, role-specific access for Admins, HODs, Faculty, and Technicians to ensure accountability and prevent unauthorized data modification.

4. **To Facilitate Real-Time Maintenance Logging:** Allow technicians to directly record maintenance or fault updates from any device, ensuring real-time tracking and timely action on reported issues.
5. **To Enhance Data Accuracy and Transparency:** Maintain complete and accurate records of all repairs, replacements, and inspections to support performance analysis and auditing.
6. **To Reduce Machine Downtime:** Enable quick reporting and resolution of technical issues through automated updates and centralized communication.
7. **To Provide Analytical Insights:** Generate maintenance reports and performance analytics to assist management in decision-making, resource allocation, and preventive maintenance scheduling.
8. **To Support Low-Cost Digital Transformation for MSMEs:**
   Offer an affordable, web-based solution that does not require complex infrastructure, making digital maintenance management accessible to smaller organizations.

## 1.3 Advantages

1. **Centralized Data Management:**
   The system maintains all machine-related information in a single, secure digital database, eliminating the need for paper-based logbooks and ensuring easy access to records at any time.
2. **Real-Time Updates:**
   All maintenance entries, additions, or updates are instantly reflected in the database, allowing administrators and faculty to view the latest information without delay.
3. **Improved Accuracy:**
   By automating data entry and updates, the system minimizes human errors that are common in manual record-keeping.
4. **Efficient Maintenance Tracking:**
   It allows users to record each maintenance activity with details such as date, description, and responsible technician, ensuring proper tracking of every machine’s maintenance history.
5. **Enhanced Security:**
   The implementation of JWT-based authentication provides role-based access control,

ensuring that only authorized users (Admin, HOD, Faculty, Student) can perform specific actions.

6. **User-Friendly Interface:**
   Built using Angular, HTML, and CSS, the system offers a clean and responsive user interface that is easy to navigate even for non-technical users.
7. **Quick CRUD Operations:**
   Create, Read, Update, and Delete operations are performed instantly, keeping the frontend and backend data synchronized in real time.
8. **PDF Report Generation:**
   Users can generate and download maintenance records or device lists in PDF format for reports, audits, or administrative use.
9. **Cross-Device Compatibility:**
   The system's responsive design ensures smooth operation on desktops, tablets, and smartphones.
10. **Data Security and Integrity:**
    With a secure MySQL database, the system ensures that data is well-protected from unauthorized access or corruption.
11. **Reduced Paperwork:**
    Digital storage of maintenance data minimizes paperwork and contributes to an eco-friendly, paperless environment.
12. **Scalability:**
    The system can handle an increasing number of machines and users without affecting performance, making it suitable for long-term institutional use.
13. **Faster Decision-Making:**
    Instant access to up-to-date maintenance information helps administrators make quick and informed decisions regarding repairs or replacements.

## 1.4 Limitations

1. **No Offline Functionality:**The system requires an active internet connection to function; users cannot access or update maintenance records offline.
2. **Manual Data Entry:**All machine details and maintenance logs need to be entered manually, as the system is not yet integrated with IoT sensors or automated data collection.

3. **Lack of Notification System:**The current version does not provide automatic alerts or reminders for upcoming maintenance schedules or overdue tasks.

4. **Limited Data Analytics:**The system does not yet support advanced data visualization or trend analysis for maintenance performance and machine health.
5. **Basic Report Generation:**Reports are generated in simple PDF format without advanced customization or graphical representation features.

## 1.5 Scope of the Project

1. **Centralized Digital Maintenance System**: The project aims to replace traditional paper-based logbooks with a centralized digital platform that records all machine maintenance activities.Enables authorized users (Admin, HOD, Faculty, and Technicians) to securely access and update maintenance records anytime.
2. **QR Code-Based Machine Identification**; Each machine is assigned a unique QR code that links directly to its maintenance history.Technicians can simply scan the QR code using a smartphone to view or update details such as inspection dates, repair notes, and spare part replacements.
3. **Role-Based Access Control**; Provides distinct access levels for different users — for example, Admins can manage all data, HODs can approve maintenance requests, and Technicians can log updates. Enhances security and ensures accountability within the system.
4. **Maintenance Scheduling and Tracking**: Facilitates preventive maintenance by tracking service intervals and alerting users when a machine requires inspection or servicing. Reduces unexpected breakdowns and improves equipment lifespan.
5. **Real-Time Data Logging and Updates**; Allows real-time entry, updating, and retrieval of maintenance data directly from smartphones or desktop systems. All records are instantly stored in the database, ensuring data accuracy and minimizing delays.
6. **Cloud-Integrated Database Connectivity**; Uses a MySQL or cloud-hosted database to store all maintenance information, ensuring reliability, scalability, and data backup. Enables seamless data access across multiple departments or locations.
7. **Performance Monitoring and Reporting**: Generates detailed maintenance reports and statistics (e.g., number of repairs, most frequent issues, downtime trends). Helps administrators analyze performance and plan for equipment upgrades or replacements.
8. **User-Friendly Web Interface**; Developed using modern web technologies (Spring Boot + Angular) to ensure a clean, responsive, and intuitive interface for all users. Simplifies the logging process and minimizes training requirements for staff.

9. **Cost-Effective Solution for MSMEs and Institutions**: Designed to be a low-cost, scalable, and easily deployable maintenance management system. Reduces the dependency on expensive industrial maintenance software or IT infrastructure.
10. **Foundation for Future Predictive Maintenance**: The system lays the groundwork for future AI or ML-based predictive maintenance by collecting structured machine data. Enables future expansion into automated fault prediction and smart analytics.

# CHAPTER 2

# LITERATURE REVIEW

**PAPER 1**

**Paper Name: Smart Maintenance Framework Using QR Codes**

**Authors:** Sharma, A., Verma, P., & Patel, R. (2022)

**Themes Discovered:**

This research paper introduces a smart maintenance framework that leverages **QR codes** to streamline the process of accessing and managing machine-related information. The authors emphasize that QR codes can serve as a digital gateway to essential resources such as **user manuals, service histories, maintenance schedules, and troubleshooting guides**.By scanning a machine's QR code, technicians can instantly retrieve critical data, minimizing the dependency on paper-based logs and manual searches. The study demonstrates that this method significantly **reduces the time required for repairs and maintenance activities**, enhances record accuracy, and improves operational efficiency within industrial environments. Furthermore, the paper discusses the integration of QR-based systems with existing enterprise maintenance tools to promote **real-time monitoring** and better decision-making in predictive maintenance.

**Gaps Identified:**

While the proposed system effectively enhances maintenance management in large-scale industries equipped with advanced IT infrastructure, it does not adequately address the challenges faced **by** Micro, Small, and Medium Enterprises (MSMEs)**,** which often operate with limited technological resources.Our project bridges this gap by designing a cost-effective, mobile-friendly Digital Maintenance Logbook that integrates QR code functionality without requiring complex infrastructure or high-end devices. This system is tailored for MSMEs, educational institutions, and small workshops, enabling easy machine tracking, maintenance scheduling, and digital documentation through an accessible web interface.By focusing on affordability, ease of use, and scalability, our approach extends the benefits of QR-based maintenance systems to a wider range of organizations, supporting digital transformation even in resource-constrained settings.

**PAPER 2**

**Paper Name: Digital Logbook Systems for Industrial Maintenance**

**Authors:** Gupta, M., & Rao, S. (2023)

**Themes Discovered:**

This paper explores the adoption of digital logbook systems in industrial maintenance and their role in improving equipment reliability and operational transparency. The authors highlight that transitioning from traditional paper-based logs to digital maintenance records enhances data accuracy, facilitates faster access to historical records, and supports preventive maintenance scheduling.By systematically recording maintenance activities, fault occurrences, and repair histories, the system allows managers to analyze performance trends, predict potential breakdowns, and ensure timely interventions. The study also underscores that digital logbooks streamline auditing and compliance processes, making it easier for organizations to demonstrate adherence to safety and quality standards.Moreover, the research demonstrates that centralized digital maintenance data enables collaboration between departments**,** reduces downtime, and improves resource utilization through better planning and reporting.

**Gaps Identified:**

Despite its effectiveness, the proposed solution was primarily designed **for** large-scale industrial environments with dedicated maintenance teams and fixed desktop systems. This limits accessibility for field technicians and smaller organizations that lack constant access to computers or complex infrastructure.Our project addresses this limitation by introducing a mobile-first, QR-enabled Digital Maintenance Logbook that empowers technicians to record and retrieve maintenance data directly from their smartphones on the shop floor. This adaptation ensures real-time logging, minimizes delays in record updates, and enhances convenience for users working in dynamic industrial settings.By extending digital logbook accessibility to handheld devices, our solution promotes flexibility, inclusiveness, and operational efficiency, making modern maintenance management feasible for both large industries and MSMEs alike.

**PAPER 3**

**Paper Name:** Predictive Maintenance Using AI in Manufacturing

**Authors:** Lee, J., & Kim, S. (2021)

**Themes Discovered:**

This paper explores the application of Artificial Intelligence (AI) **and** Machine Learning (ML) techniques in predictive maintenance within the manufacturing industry. The authors emphasize how AI algorithms can analyze large volumes of real-time sensor data—such as vibration, temperature, and pressure readings—to detect anomalies and predict potential machine failures before they occur.By leveraging data-driven insights**,** predictive maintenance helps in minimizing unplanned downtime, reducing maintenance costs, and optimizing asset performance. The study showcases how advanced models like neural networks, regression analysis, and decision trees can forecast component wear and estimate the remaining useful life (RUL) of machines.
Additionally, the paper discusses how AI-based maintenance systems contribute to improved safety, productivity, and decision-making by providing proactive alerts and maintenance recommendations to operators. These systems are positioned as a critical step toward achieving Industry 4.0 standards in manufacturing operations.

**Gaps Identified:**

While the research highlights the significant potential of AI in predictive maintenance, it also points out that such systems are cost-intensive and require high-quality, continuous sensor data for effective functioning. Many small and medium-scale industries (MSMEs) face challenges in implementing these AI-driven systems due to financial constraints and limited digital infrastructure**.** Our project addresses this gap by initiating a low-cost, QR-based Digital Maintenance Logbook as the foundation for future AI integration. In Phase 1, the focus is on building a reliable database of machine maintenance history through easy, smartphone-based QR scanning and logging. This data will serve as the groundwork for future predictive analytics **and**AI-driven maintenance insights once sufficient records are accumulated.
Thus, our approach provides a scalable pathway **-** starting from affordable digital record-keeping and gradually evolving toward intelligent predictive maintenance using AI.

## PAPER 4

### Title: Smart Maintenance Framework Using QR Codes

**Authors:** Sharma, A., Verma, P., & Patel, R. (2022)
**Published In:** *International Journal of Industrial Engineering and Technology*

### Overview of Study:

This paper proposed a Smart Maintenance Framework that integrates QR code technology into industrial maintenance operations. The main objective of the study was to reduce downtime, minimize paper-based documentation, and enhance real-time accessibility of maintenance data. Each machine or equipment was assigned a unique QR code that contained encoded information about the machine's technical specifications, previous maintenance history, spare part details, and troubleshooting instructions.When maintenance personnel scanned the QR code using a smartphone or tablet, all relevant data were retrieved instantly from a centralized database. The system effectively connected physical assets to digital information, bridging the gap between field technicians and the management system.

### Methodology:

The authors implemented their model in **a** manufacturing plant environment with 15 machines over a 3-month testing period. QR codes were generated using open-source tools and linked to a MySQL database. Data was accessed through an Android mobile interface. Metrics such as maintenance response time**,** information retrieval speed**, and** error rate in reporting were measured before and after system deployment.

### Findings:

The results demonstrated that integrating QR codes in maintenance management significantly:

- Reduced machine downtime by 27%.
- Improved data accessibility and accuracy by 40%.
- Minimized dependency on physical manuals and paper records.
- Enhanced the traceability of maintenance activities.

Additionally, the system was user-friendly, easy to deploy, and cost-effective for large industries with existing IT support.

### Limitations Identified:

Although efficient, the proposed solution required substantial IT infrastructure and technical training for setup and maintenance. It was primarily suited for large-scale industries where cost and technology were not major constraints. The system's scalability for smaller organizations or academic environments remained unexplored.

### Relevance to Current Project:

The Digital Maintenance Logbook (SmartLabTracker**)** adapts this concept to a simpler, **cost-**efficient, and mobile-based model**.** Instead of relying on high-end IT infrastructure, the project uses **web-based access (Angular + Spring Boot)** and MongoDB for lightweight storage. Each machine in the lab or industry is tagged with a unique QR code**,** enabling users to log maintenance directly from their smartphones. This adaptation ensures accessibility for MSMEs, educational institutions, and technical workshops where affordability and ease of use are crucial.

## PAPER 5

### Title: Digital Logbook Systems for Industrial Maintenance

**Authors:** Gupta, M., & Rao, S. (2023)
**Published In:** *Journal of Smart Manufacturing and Automation*

### Overview of Study:

Gupta and Rao's study explored the benefits of transitioning from manual maintenance logs **to** digital logbook systems in industrial settings. The focus was on improving the efficiency and accuracy of machine maintenance records while facilitating preventive maintenance scheduling. The digital logbook was designed to maintain a comprehensive record of every maintenance event, including date, time, technician details, part replacements, and maintenance type (corrective or preventive).

### Methodology:

The researchers developed a desktop-based application using a relational database to store and manage maintenance data. The system was tested across three manufacturing units for a duration of six months. Various parameters such as data entry accuracy**,** reporting efficiency**,** and maintenance compliance rate were measured to assess its effectiveness.

### Findings:

The study concluded that implementing digital logbooks led to:

- A 35% reduction in reporting errors.
- Enhanced scheduling of preventive maintenance tasks.
- Easier tracking of machine history and service intervals.
- Improved compliance with industrial audit requirements.

The paper also highlighted that digital logs improved communication between maintenance staff and supervisors by providing real-time access to maintenance records and generating automated notifications.

**Limitations Identified:**

Despite its advantages, the system required dedicated maintenance staff, and access was limited to desktop computers within the facility. The lack of a mobile interface reduced its usability in real-time situations, particularly for technicians working directly on the shop floor. Additionally, it relied on constant network connectivity and was not easily scalable for smaller organizations.

**Relevance to Current Project:**

The Digital Maintenance Logbook extends this concept by developing a mobile- and web-based solution accessible through smartphones, tablets, and PCs. It eliminates the need for dedicated maintenance staff by enabling technicians and faculty to update logs immediately after performing maintenance. QR codes simplify data entry, while the responsive Angular interface ensures smooth usage across all devices. Unlike the desktop-only model, Smart Lab Tracker emphasizes real-time updates**,** role-based access, and cloud integration, making it far more practical for modern technical environments and academic institutions.

# CHAPTER 3

## PROBLEM IDEFINITION AND SCOPE

### 3.1 Problem Definition

In today’s technology-driven academic and industrial environments, laboratories form the core of practical education, research, and innovation. These laboratories are equipped with a wide range of instruments, tools, and machinery that require regular maintenance to ensure accuracy, safety, and operational efficiency. However, in many institutions, the management of laboratory maintenance activities still relies on manual logbooks, paper records, or fragmented communication, leading to inefficiencies, data loss, and lack of accountability. Traditional maintenance tracking methods often result in delayed repairs, unrecorded issues, and incomplete maintenance histories. When records are scattered or inconsistently maintained, administrators and technical staff face challenges in identifying frequently failing equipment, scheduling timely inspections, or verifying whether maintenance tasks were completed. This not only affects the overall functionality of the laboratories but also impacts teaching, research, and safety outcomes.

The absence of a centralized digital platform for recording and monitoring maintenance activities makes it difficult to manage information systematically. Manual entries are prone to human errors, are difficult to update in real-time, and cannot be easily analyzed for decision-making. Additionally, there is a lack of role-based access and accountability, meaning that roles such as Admin, HOD, Faculty, and Students often have no clear mechanism for reporting issues, approving requests, or tracking progress. Further more, without an integrated digital system, data retrieval and reporting become tedious and time-consuming. For example, generating summaries of maintenance activities for audit or compliance purposes requires manually scanning multiple registers, which is inefficient and error-prone. This lack of digital traceability also makes it difficult to ensure transparency and timely follow-up of maintenance requests.

Security and data integrity are also major concerns in traditional record-keeping. Physical logbooks can be misplaced, damaged, or tampered with, while unauthorized personnel may gain access to sensitive information. These limitations highlight the urgent need for a secure, scalable, and user-friendly digital platform that automates maintenance tracking and ensures data consistency across departments. The Digital Maintenance Logbook for Labs aims to bridge this gap by providing an integrated web-based solution that enables users to log maintenance activities, track device performance, and generate reports efficiently. The system provides real-time access to maintenance records, supports role-based authentication, and ensures data accuracy through automated database management.

In summary, the problem addressed by this project lies in the inefficiency, inaccuracy, and lack of transparency in current manual maintenance management systems. By transforming the traditional maintenance process into a digital, secure, and interactive platform, this project enhances the reliability and productivity of laboratory operations while fostering accountability and streamlined communication among all stakeholders.

### 3.2 Scope

#### 1. Application Design and Development

The Digital Maintenance Logbook for Labs is a full-stack web application designed and developed using modern technologies to ensure scalability, security, and user convenience. The system aims to digitalize laboratory maintenance management by providing a centralized platform for recording, tracking, and monitoring equipment-related activities.

The frontend of the application is developed using Angular, along with HTML, CSS, and TypeScript, focusing on a clean structure, responsive design, and user-friendly interface. It provides distinct dashboards for different user roles—Admin, HOD, Faculty, and Students—ensuring secure and role-based access through JWT authentication. Each user logs in with unique credentials and interacts with the system based on assigned permissions.

The interface includes features such as device registration, maintenance logging, and issue tracking, allowing users to easily view and update information in real time. Angular's reactive components and routing are used to handle smooth navigation between sections such as Add Device, View Devices, Maintenance Logs, and Reports. The design is fully responsive, ensuring usability across desktops, tablets, and mobile devices. Dynamic data handling and interaction between the frontend and backend are achieved using RESTful APIs. Angular's HTTPClient module enables seamless data exchange between the client and the server, ensuring that all user operations (such as adding or updating device details) are immediately reflected in the database.

The backend of the system is developed using Spring Boot, which provides a robust framework for building scalable and secure APIs. It manages authentication, role-based access, and database operations. The backend connects to a MySQL database, where all maintenance data, user credentials, and device records are securely stored. The use of Spring Security with JWT ensures safe login and authorization mechanisms, preventing unauthorized access. Additionally, the system includes functionality for PDF report generation, enabling users (especially Admins and HODs) to download and print maintenance and device lists for documentation and record-keeping.

Overall, the scope of this application encompasses the design, development, and deployment of a digital maintenance management system that ensures accuracy, transparency, and efficiency in laboratory operations. It provides a practical, scalable, and secure solution adaptable to any institution aiming to modernize its maintenance workflow.

# CHAPTER 4

## SOFTWARE REQUIREMENT SPECIFICATION

### 4.1 REQUIREMENT SPECIFICATION

### 4.1.1 Normal Requirements

Design and develop a responsive web-based interface using Angular, HTML, CSS, and TypeScript to allow users to securely log in, manage lab equipment details, and record maintenance activities digitally. The system should support role-based access control for different users -Admin, HOD, Faculty, and Student - ensuring that each user can perform operations relevant to their role.

- Implement a secure login and registration system with JWT authentication and encrypted passwords to ensure that only authorized users can access the system.
- Allow users to add, update, and view device details, including equipment name, serial number, lab location, and maintenance history.
- Enable Faculty and HOD users to log and track maintenance issues, update repair statuses, and verify completion details.
- Provide Admins with full control to manage users, assign roles, and monitor all maintenance activities across departments.
- Validate all user inputs and backend transactions to maintain data integrity, prevent errors, and ensure smooth, secure communication between frontend and backend systems.
- Ensure a responsive and intuitive user interface, allowing seamless use across devices such as desktops, tablets, and smartphones.
- Integrate PDF report generation functionality to allow users (Admin/HOD) to download device lists or maintenance logs for documentation and analysis.

### 4.1.2 Expected Requirements

- Implement a user registration feature that allows creation of new users with required details such as name, email, password, and role.
- Enable users to update their personal information, including name, email, and password.
- Implement a role assignment mechanism to define user privileges and restrict unauthorized actions within the application.

- Display a tabular list of registered users, showing details such as username, email, and assigned role for easy management.
- Provide functionality to view, add, edit, and delete devices with clear validation and real-time updates.
- Enable HOD and Faculty members to view maintenance history for lab equipment and verify records as per departmental responsibilities.

### 4.1.3 Excited Requirements

- Implement a search functionality that allows Admins and HODs to filter and search users or devices based on attributes such as role, name, or lab location.
- Develop an intuitive dashboard interface that clearly displays maintenance statistics, recent activities, and pending issues.
- Enable PDF report generation for maintenance records, device lists, or user data for record-keeping or submission purposes.
- Optimize the overall system performance through regular code reviews, testing, and iterative improvements, ensuring a seamless and efficient user experience.
- Provide scope for future enhancements like automated maintenance reminders, analytics dashboards, or IoT-based monitoring for predictive maintenance in labs.

## 4.2 VALIDATION OF REQUIREMENT

### 4.2.1 Requirements

- The software requirements, including Visual Studio Code, Eclipse IDE, MySQL Workbench, Angular CLI, Node.js, Spring Boot, Java, and web browsers, are necessary and appropriate for developing and deploying the application.
- The hardware requirements, such as an Intel Core i3 or higher processor, minimum 4GB RAM, and 100MB of available storage, along with access to testing devices (PCs, tablets, and smartphones), are suitable for running the application and performing system testing.
- The expected requirements — user creation, data update functionality, role assignment, and displaying users and device data in a tabular format — are essential and align with standard maintenance management features in web applications.
- The validation of software functionality through testing ensures that authentication, data handling, and role-based operations meet the intended design specifications, ensuring a reliable and secure application.

## 4.3 SOFTWARE REQUIREMENT

- **Editor:** Visual Studio Code
- **Database Connectivity:** MySQL Workbench
- **Web Development Languages:** HTML, CSS, Angular CLI, JavaScript
- **Programming Language:** TypeScript
- **Security Tools:** Authentication and Encryption Modules
- **Framework:** Angular CLI

## 4.4 HARDWARE REQUIREMENT

- Processor: Intel Core i3 or higher
- Operating System Version: 10.0.22621 Build 22621
- RAM: Minimum 4GB
- Storage: 100MB (Minimum)
- System Model: 82H8

# CHAPTER 5

## SYSTEM DESIGN

### 5.1 DESIGNING THE SYSTEM

The Digital Maintenance Logbook for Labs is designed to streamline and digitize the process of recording, tracking, and managing laboratory equipment maintenance activities. The system provides an intuitive, secure, and role-based interface for different users — Admin, HOD, Faculty, and Students — ensuring transparency and accountability in all maintenance operations.

The user interface is designed with simplicity and clarity in mind. Built using Angular, HTML, CSS, and JavaScript, the frontend ensures responsiveness and cross-device compatibility, working smoothly on desktops, laptops, tablets, and smartphones. Clear navigation bars and modular dashboards help each user quickly access relevant features like viewing device details, adding maintenance records, and generating reports.The backend, developed with Spring Boot and MySQL, provides secure data handling, authentication using JWT tokens, and RESTful APIs for reliable frontend-backend communication. This design ensures both data integrity and real-time synchronization across modules.

### 5.1.1 SYSTEM OVERVIEW

The Digital Maintenance Logbook consists of several modules integrated to handle the entire maintenance workflow — from device registration to report generation.

**Modules in the System**

**1. User Management Module**

- Handles registration and authentication of users (Admin, HOD, Faculty, Student).
- Uses JWT-based login to ensure secure access.
- Enables role assignment and permission-based access control.

**2. Device Management Module**

- Allows users to add, view, edit, or delete laboratory devices.
- Stores key details such as device name, model number, serial number, location, and date of purchase.
- Admins can view all devices, while faculty manage devices assigned to their lab.

**3. Maintenance Log Module**

- Records maintenance activities such as repairs, inspections, or servicing.
- Captures details like maintenance date, performed by, issue description, and status (updated/pending).
- Faculty and lab assistants can update maintenance records, while the HOD or Admin can review and approve them.

**4. Report & Analysis Module**

- Generates reports of maintenance history per device or lab.
- Allows export of maintenance logs in PDF format for audits or departmental reviews.
- Enables Admin and HOD to track lab performance and maintenance efficiency.

**5. Notification Module**

- Sends alerts for upcoming maintenance dates, overdue tasks, or new device additions.
- Keeps users informed through real-time status updates.

### 5.1.2 IMPLEMENTATION OVERVIEW

The implementation is divided into frontend, backend, and database layers, ensuring modularity and maintainability.

**1. Frontend Implementation**

- Built with Angular for component-based UI.
- Users can log in, view assigned devices, and record maintenance updates.
- Data is dynamically fetched from the backend using HTTP requests.
- CSS and Angular Material ensure a clean and consistent design.

**2. Backend Implementation**

- Developed in Spring Boot, following REST architecture.
- Handles authentication using JWT (JSON Web Tokens).
- Includes controllers for user management, device handling, and log tracking.
- Validates all requests and ensures secure database operations.

### 3. Database Implementation

- MySQL serves as the relational database.
- Tables include users, devices, maintenance_logs, and roles.
- Primary-foreign key relationships ensure consistency and efficient data retrieval.

### 5.1.3 DATA FLOW OVERVIEW

1. Login Process:
   The user logs in → credentials verified by backend → JWT token issued → frontend stores token for session authentication.
2. Device Addition:
   Authorized user adds device → data sent to backend API → saved in MySQL → updated list displayed instantly.
3. Maintenance Update:
   Faculty updates maintenance info → data validated and stored → HOD/Admin reviews record.
4. PDF Report Generation:
   User clicks "Download Report" → backend fetches device data → generates PDF using report library → file sent to frontend for download.

This architecture provides security, maintainability, and scalability, ensuring the system meets the needs of both academic and administrative users.

# CHAPTER 6

# MODELLING

## 6.1 BEHAVIOURAL MODELLING

### 6.1.1 USE CASE DIAGRAM

A Use Case Diagram describes how different users (actors) interact with the *Digital Maintenance Logbook System* and what functionalities they can access.

***Actors:***

- **Admin:**
  Manages all users, assigns roles, approves maintenance logs, generates reports.
- **HOD:**
  Monitors device and maintenance status for assigned labs.
- **Faculty:**
  Adds and updates maintenance logs for their devices.
- **Student:**
  Views maintenance records and reports for reference.

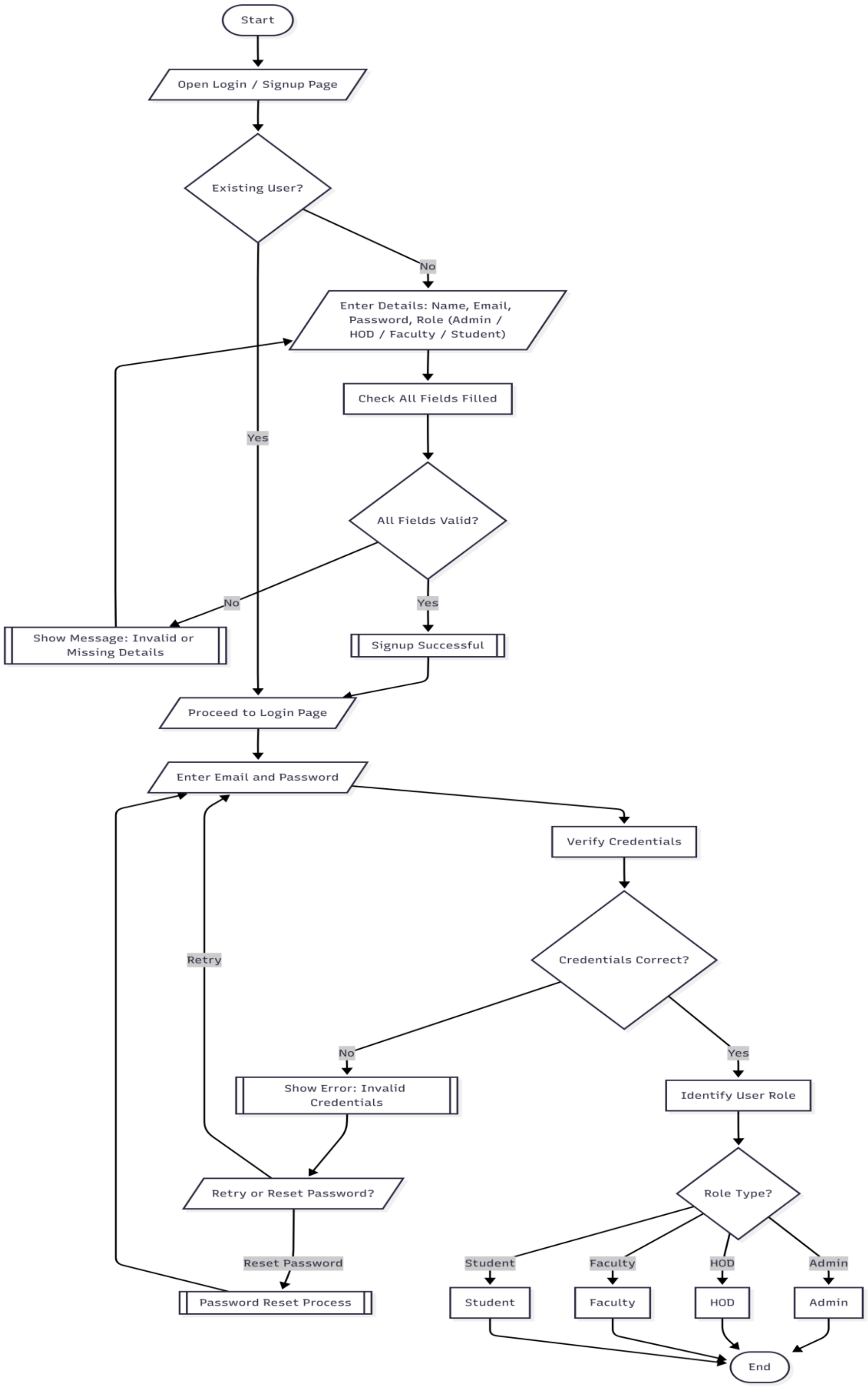
**Primary Use Cases:**

1. **Login / Logout** - All users authenticate with credentials.
2. **Add Device** - Admin or Faculty registers a new device.
3. **View Device List** - All users view assigned devices.
4. **Add Maintenance Log** - Faculty records maintenance activities.
5. **View Maintenance Log** - HOD and Admin view and verify logs.
6. **Generate PDF Report** - Authorized users export maintenance data.
7. **Assign Roles** - Admin assigns user roles (Admin/HOD/Faculty/Student).
8. **Send Alerts** - System notifies users about due maintenance.

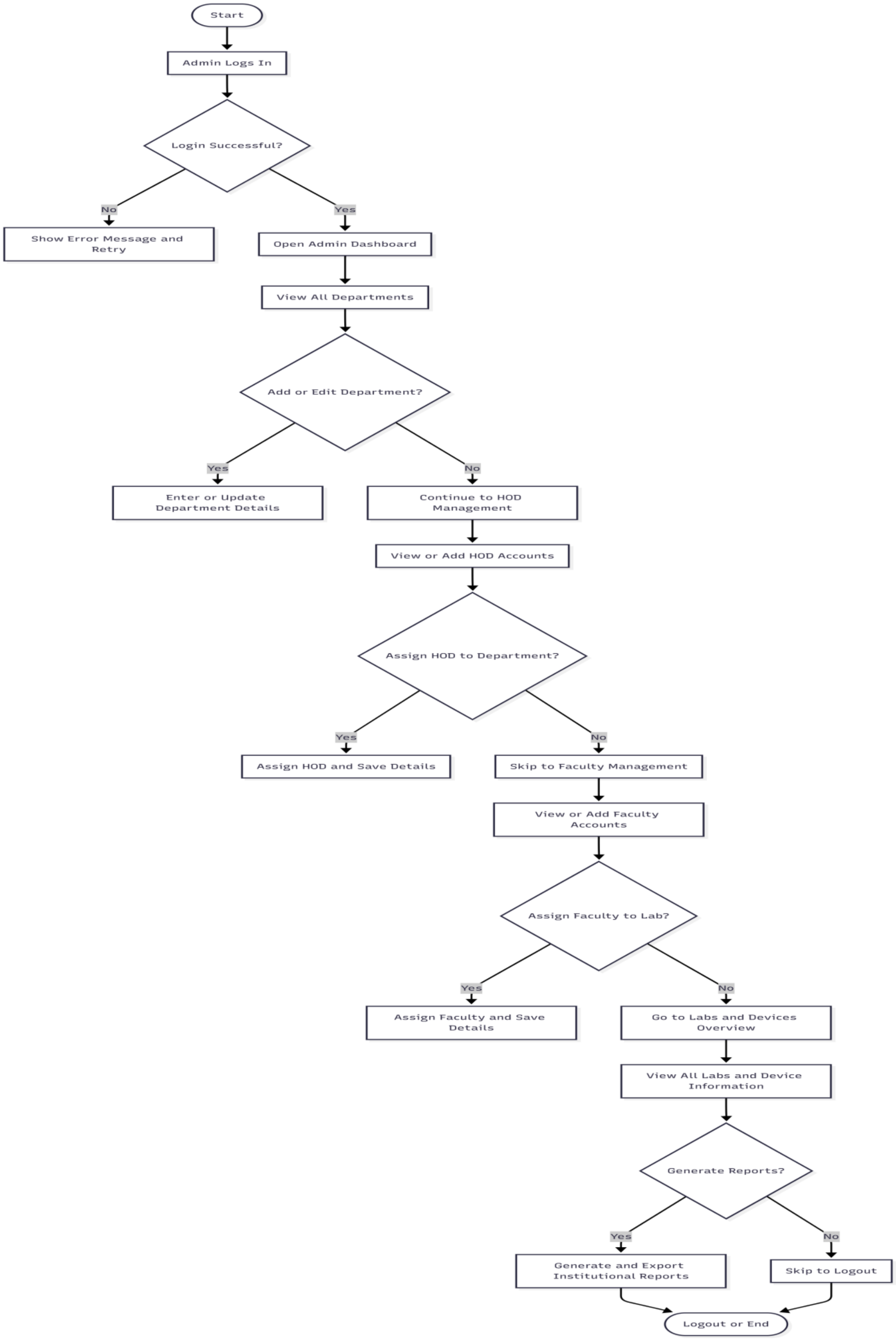
The Use Case Diagram depicts interactions among these actors and the system.

- The Admin manages users, roles, and overall system data.
- The HOD monitors maintenance status and validates reports.
- The Faculty enters and updates maintenance records.
- The Student has read-only access to view lab equipment status.
  The system automatically generates alerts and supports real-time synchronization between frontend and backend modules.

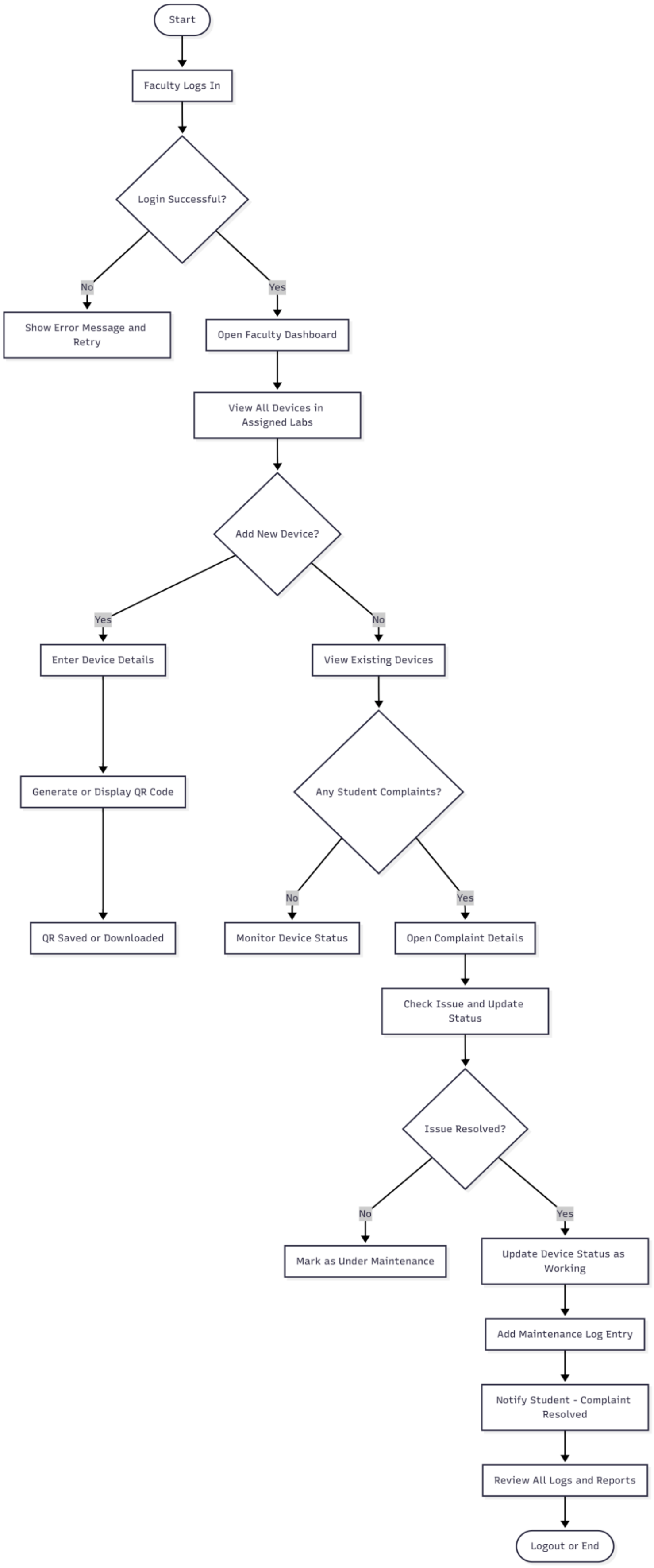
## SIGNUP & LOGIN



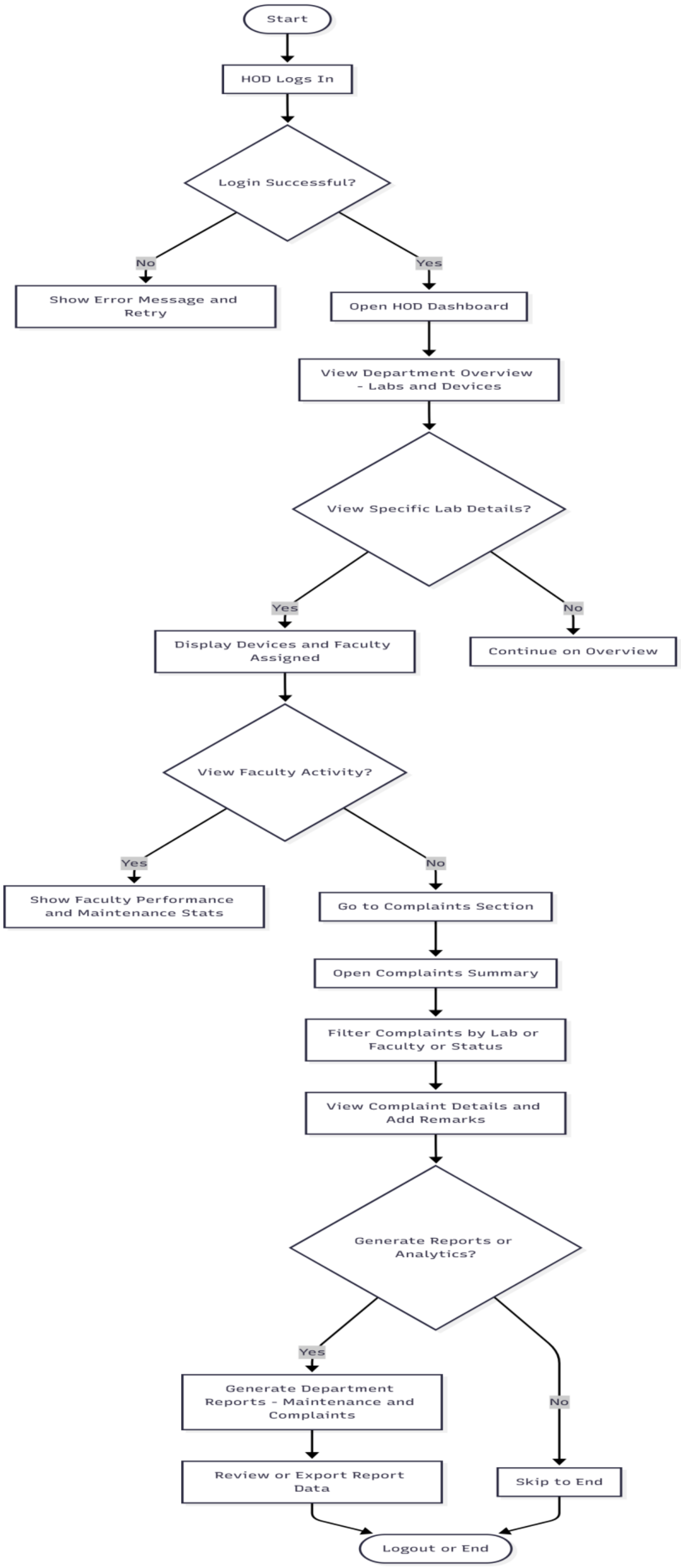
## ADMIN DASHBOARD


Start
Admin Logs In
Login Successful?
No
Yes
Show Error Message and Retry
Open Admin Dashboard
View All Departments
Add or Edit Department?
Yes
No
Enter or Update Department Details
Continue to HOD Management
View or Add HOD Accounts
Assign HOD to Department?
Yes
No
Assign HOD and Save Details
Skip to Faculty Management
View or Add Faculty Accounts
Assign Faculty to Lab?
Yes
No
Assign Faculty and Save Details
Go to Labs and Devices Overview
View All Labs and Device Information
Generate Reports?
Yes
No
Generate and Export Institutional Reports
Skip to Logout
Logout or End

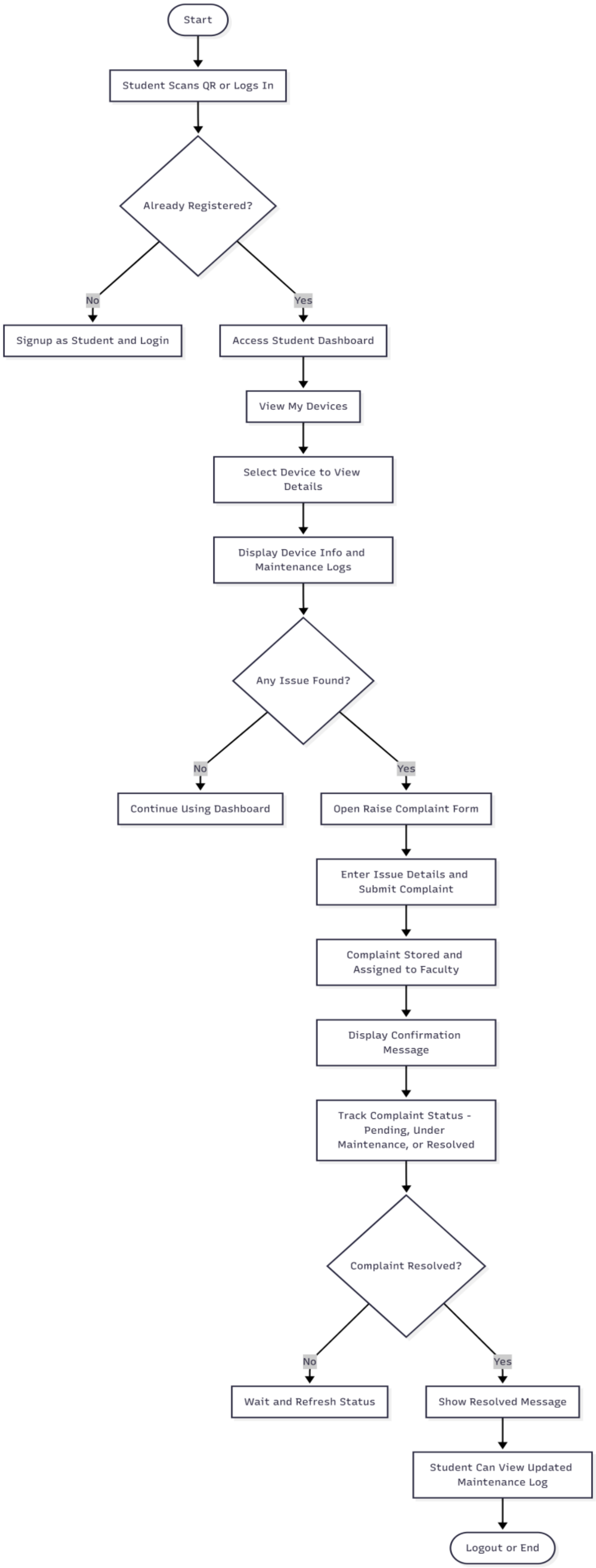
## FACULTY DASHBOARD


Start
Faculty Logs In
Login Successful?
No
Yes
Show Error Message and Retry
Open Faculty Dashboard
View All Devices in Assigned Labs
Add New Device?
Yes
No
Enter Device Details
View Existing Devices
Generate or Display QR Code
Any Student Complaints?
No
Yes
QR Saved or Downloaded
Monitor Device Status
Open Complaint Details
Check Issue and Update Status
Issue Resolved?
No
Yes
Mark as Under Maintenance
Update Device Status as Working
Add Maintenance Log Entry
Notify Student - Complaint Resolved
Review All Logs and Reports
Logout or End

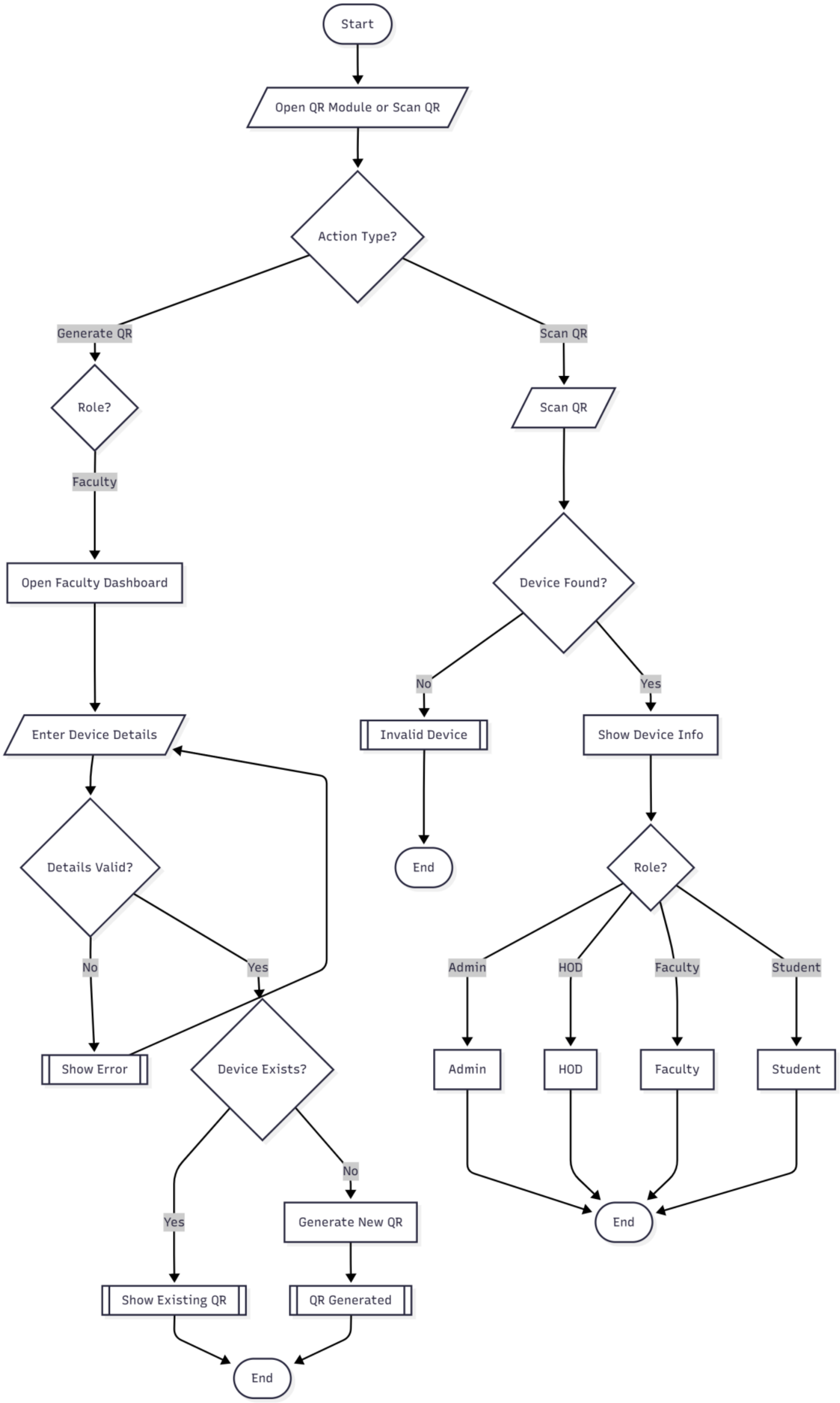
# HOD DASHBOARD


Start
HOD Logs In
Login Successful?
No
Yes
Show Error Message and Retry
Open HOD Dashboard
View Department Overview - Labs and Devices
View Specific Lab Details?
Yes
No
Display Devices and Faculty Assigned
Continue on Overview
View Faculty Activity?
Yes
No
Show Faculty Performance and Maintenance Stats
Go to Complaints Section
Open Complaints Summary
Filter Complaints by Lab or Faculty or Status
View Complaint Details and Add Remarks
Generate Reports or Analytics?
Yes
No
Generate Department Reports - Maintenance and Complaints
Review or Export Report Data
Skip to End
Logout or End

# STUDENT DASHBOARD


Start
Student Scans QR or Logs In
Already Registered?
No
Yes
Signup as Student and Login
Access Student Dashboard
View My Devices
Select Device to View Details
Display Device Info and Maintenance Logs
Any Issue Found?
No
Yes
Continue Using Dashboard
Open Raise Complaint Form
Enter Issue Details and Submit Complaint
Complaint Stored and Assigned to Faculty
Display Confirmation Message
Track Complaint Status - Pending, Under Maintenance, or Resolved
Complaint Resolved?
No
Yes
Wait and Refresh Status
Show Resolved Message
Student Can View Updated Maintenance Log
Logout or End

# QR MODULE


Start
Open QR Module or Scan QR
Action Type?
Generate QR
Scan QR
Role?
Faculty
Open Faculty Dashboard
Enter Device Details
Details Valid?
No
Yes
Show Error
Device Exists?
Yes
No
Generate New QR
Show Existing QR
QR Generated
End
Scan QR
Device Found?
No
Yes
Invalid Device
End
Show Device Info
Role?
Admin
HOD
Faculty
Student
Admin
HOD
Faculty
Student
End

# CHAPTER 7

## IMPLEMENTATION AND TESTING

### 7.1 PROCESS

### Requirement Elicitation

At the beginning of the Digital Maintenance Logbook for Machines (SmartLabTracker) project, requirements were gathered from the perspective of various user roles such as Admin, HOD, Faculty, and Student.
Each role was assigned specific responsibilities:

- Admin – manages user accounts and permissions.
- HOD – verifies maintenance logs and oversees departmental machines.
- Faculty – adds and updates maintenance records for lab equipment.
- Students – view device information and maintenance history for learning purposes.

The required functionalities identified included:

- User authentication and role-based access using JWT.
- Adding, editing, viewing, and deleting machine details.
- Recording and monitoring maintenance logs.
- Generating and downloading maintenance reports in PDF format.
- Sending alerts or notifications for scheduled maintenance.

These requirements helped shape the database schema, backend services, and frontend interfaces.

### Dashboard Design

The system design was outlined after analyzing entities and relationships among various modules like Users, Machines, and Maintenance Logs.
A MySQL database was used for storing relational data efficiently.

The database includes the following main tables:

- Users – stores user details and credentials.
- Roles – manages role-based access (Admin, HOD, Faculty, Student).

- Machines – maintains machine records with details such as serial number, location, and condition.
- Maintenance Logs – records each maintenance activity, including date, issue description, and technician remarks.

Proper relationships and constraints (primary and foreign keys) were defined to ensure data consistency and integrity.

### Backend Development

The backend was developed using Spring Boot, which provides a fast and efficient framework for building RESTful APIs. It manages user authentication, machine data, maintenance logs, and communication between the frontend and the database.

### Building Model Layer

Each model class represents a database entity. The main models include:

- User.java
- Role.java
- Machine.java
- MaintenanceLog.java

These models are connected using JPA (Java Persistence API) annotations such as @Entity, @Table, and @ManyToOne to establish relationships.
The backend also includes Repository Interfaces (e.g., UserRepository, MachineRepository, MaintenanceLogRepository) for CRUD operations.

### Controller and Service Layer

The Controller Layer handles HTTP requests and responses, while the Service Layer contains the business logic for processing maintenance data, validating users, and managing database interactions.

JWT (JSON Web Token) authentication ensures secure login and prevents unauthorized access to protected routes.

## Frontend Development

### Designing the User Interface

The frontend of the project was built using Angular, integrated with HTML, CSS, and TypeScript for structure, design, and interactivity.

The UI was divided into standalone components such as:

- **LoginComponent** – handles user authentication.
- **AddDeviceComponent** – allows adding new machines.
- **ViewDeviceComponent** – displays all added machines.
- **MaintenanceLogComponent** – records and views maintenance details.
- **ReportComponent** – generates and downloads machine reports in PDF format.

A responsive design approach was adopted using CSS and Angular Material for consistent appearance across desktops, tablets, and mobile devices.

Common UI elements such as the navbar, sidebar, and footer were implemented as reusable components to ensure consistency and reduce code redundancy.

### Defining Properties, Methods, and Logic

Angular services and TypeScript classes define the key properties and logic for handling data and state.

Examples:

- **DeviceService**: Connects to backend APIs for CRUD operations on machine data.
- **AuthService**: Manages login, registration, and JWT token handling.
- **ReportService**: Generates and fetches PDF reports.

The frontend communicates with the backend using HTTPClient to send and receive data via REST APIs. Two-way data binding ensures that updates made in the view automatically reflect in the model and vice versa, ensuring a smooth and real-time user experience.

### Monitoring and System Behavior

The system enables real-time tracking and management of machine maintenance records. Admins and faculty can easily monitor which machines require maintenance, when the last

service occurred, and download summarized reports.
The dashboard visualizes the overall health of lab equipment, helping improve efficiency and transparency within the department.

## Testing

Testing was conducted at different levels to ensure functionality, performance, and security.

***Types of Testing:***

- Unit Testing – verified individual components and services.
- Integration Testing – ensured smooth interaction between Angular frontend, Spring Boot backend, and MySQL database.
- Functional Testing – validated that each user role (Admin, HOD, Faculty, Student) could perform their assigned operations.
- Security Testing – tested JWT token validation and restricted unauthorized access.
- UI/UX Testing – checked for responsiveness and ease of use on multiple devices and browsers.

Each test case was documented and executed to ensure that all components worked as expected before deployment.

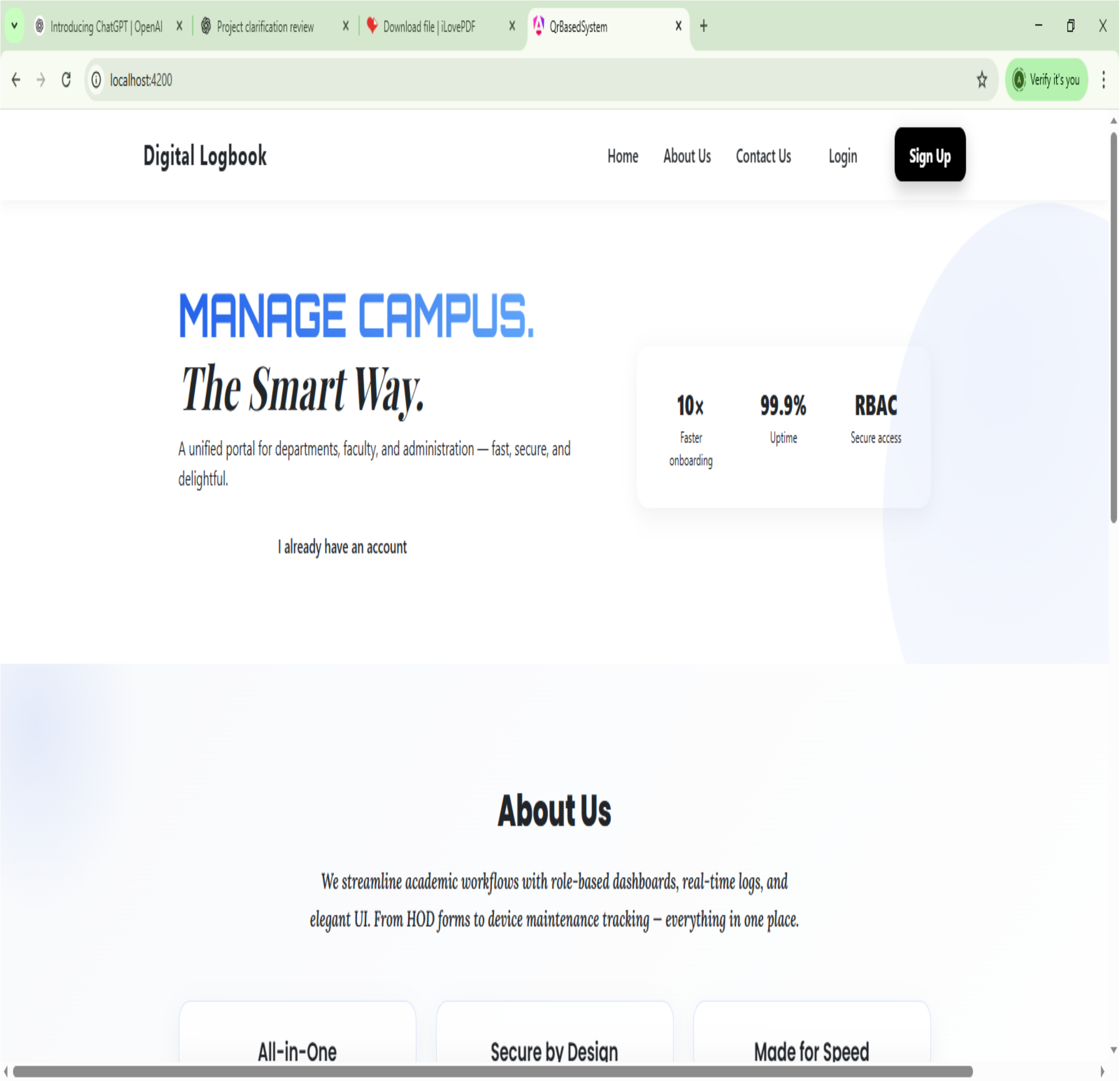
## Deployment

Once testing was completed, the project was deployed to a production environment.
The backend (Spring Boot) was hosted on a server, and the frontend (Angular) was deployed using build files generated via ng build.

Both components communicate through REST APIs, ensuring seamless data exchange between the user interface and the database.
Environment variables were configured to connect the application to the MySQL database.

Post-deployment, continuous monitoring ensures system reliability. Future upgrades can include mobile app integration and AI-based predictive maintenance suggestions.

## LANDING PAGE



Digital Logbook

Home About Us Contact Us Login **Sign Up**

**MANAGE CAMPUS.**

*The Smart Way.*

A unified portal for departments, faculty, and administration — fast, secure, and delightful.

| | | |
|---|---|---|
| **10x** | **99.9%** | **RBAC** |
| Faster onboarding | Uptime | Secure access |

I already have an account

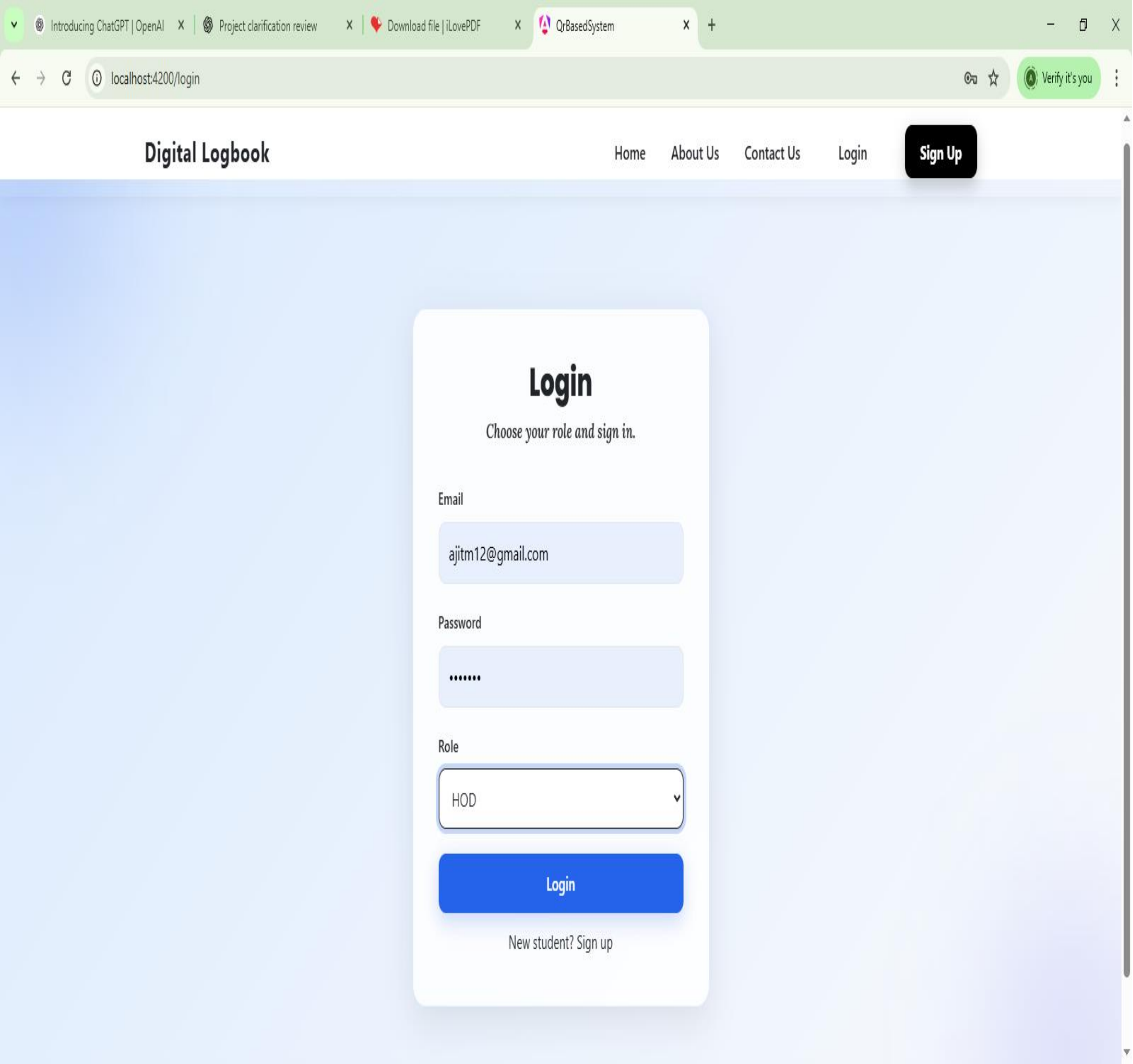
**About Us**

*We streamline academic workflows with role-based dashboards, real-time logs, and elegant UI. From HOD forms to device maintenance tracking – everything in one place.*

All-in-One

Secure by Design

Made for Speed



Login

Choose your role and sign in.

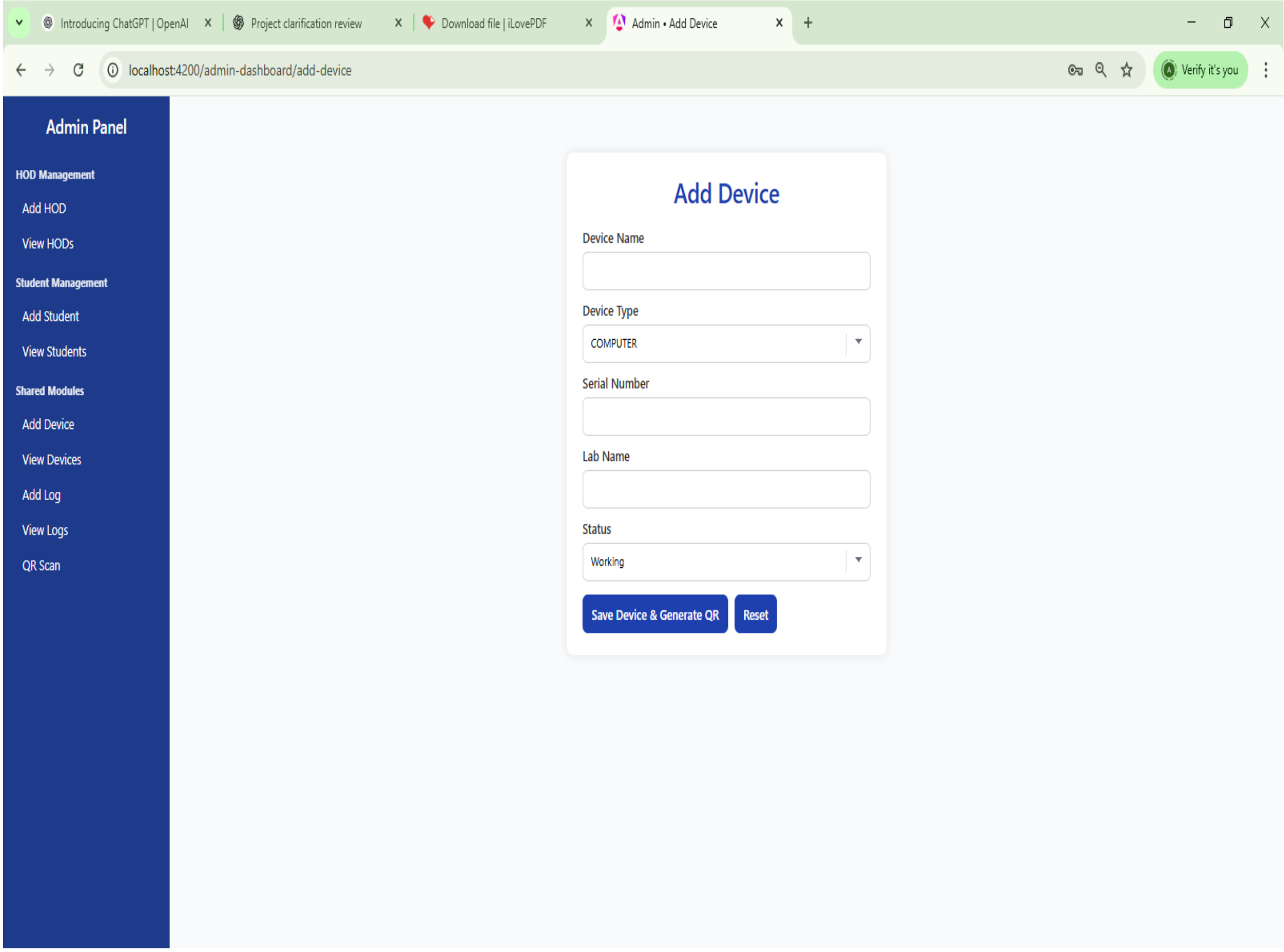
Email: ajitm12@gmail.com

Password: •••••••

Role: HOD

**LOGIN PAGE**

# ADD DEVICE



Add Device

Device Name

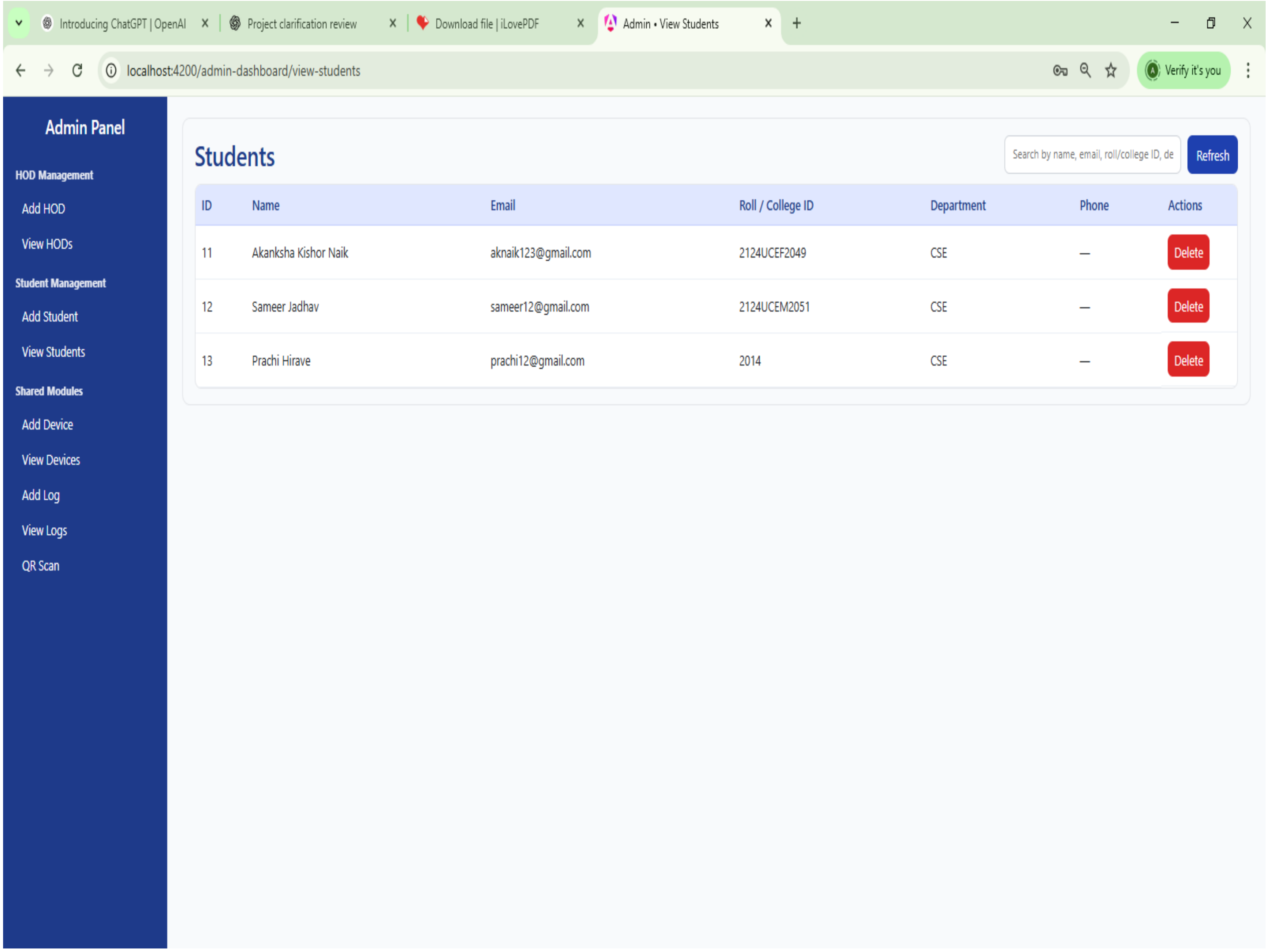
Device Type: COMPUTER

Serial Number

Lab Name

Status: Working

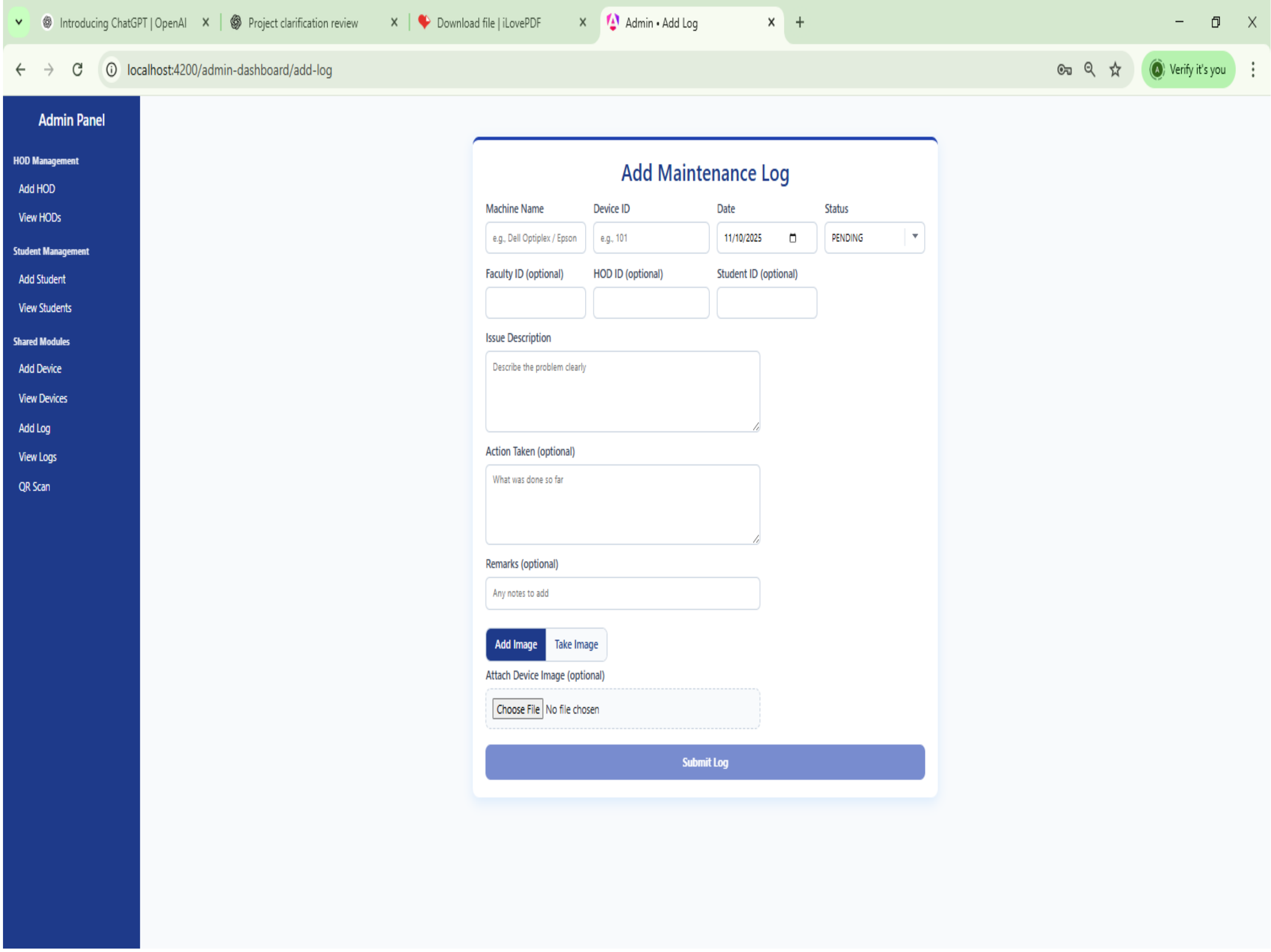
# VIEW STUDENTS



Students

| ID | Name | Email | Roll / College ID | Department | Phone | Actions |
|---|---|---|---|---|---|---|
| 11 | Akanksha Kishor Naik | aknaik123@gmail.com | 2124UCEF2049 | CSE | — | Delete |
| 12 | Sameer Jadhav | sameer12@gmail.com | 2124UCEM2051 | CSE | — | Delete |
| 13 | Prachi Hirave | prachi12@gmail.com | 2014 | CSE | — | Delete |

# ADD MAINTENANCE LOG



Add Maintenance Log

Machine Name: e.g., Dell Optiplex / Epson

Device ID: e.g., 101

Date: 11/10/2025

Status: PENDING

Faculty ID (optional)

HOD ID (optional)

Student ID (optional)

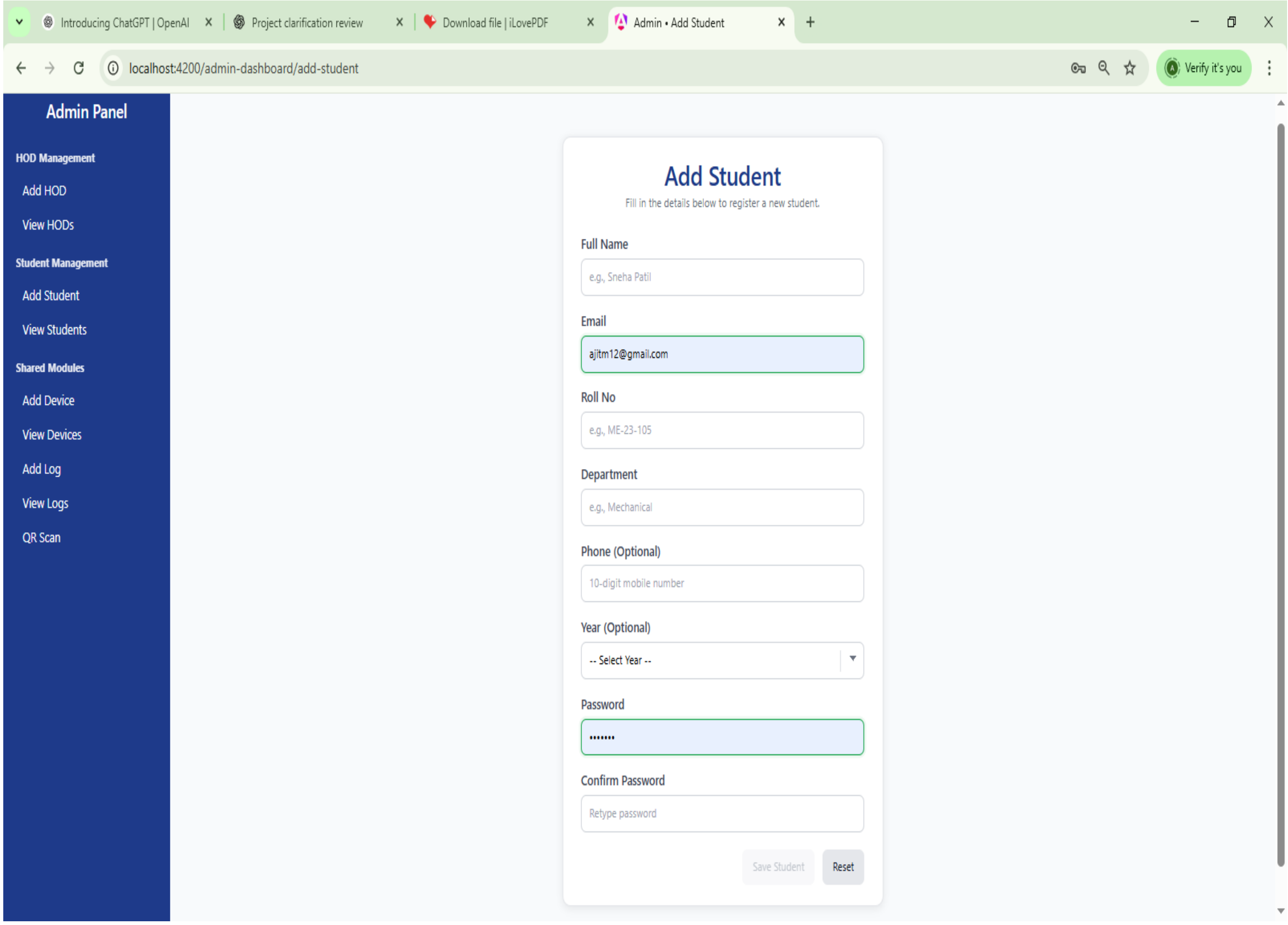
Issue Description: Describe the problem clearly

Action Taken (optional): What was done so far

Remarks (optional): Any notes to add

Attach Device Image (optional)

# ADD STUDENTS



## Add Student

Fill in the details below to register a new student.

Full Name: e.g., Sneha Patil

Email: ajitm12@gmail.com

Roll No: e.g., ME-23-105

Department: e.g., Mechanical

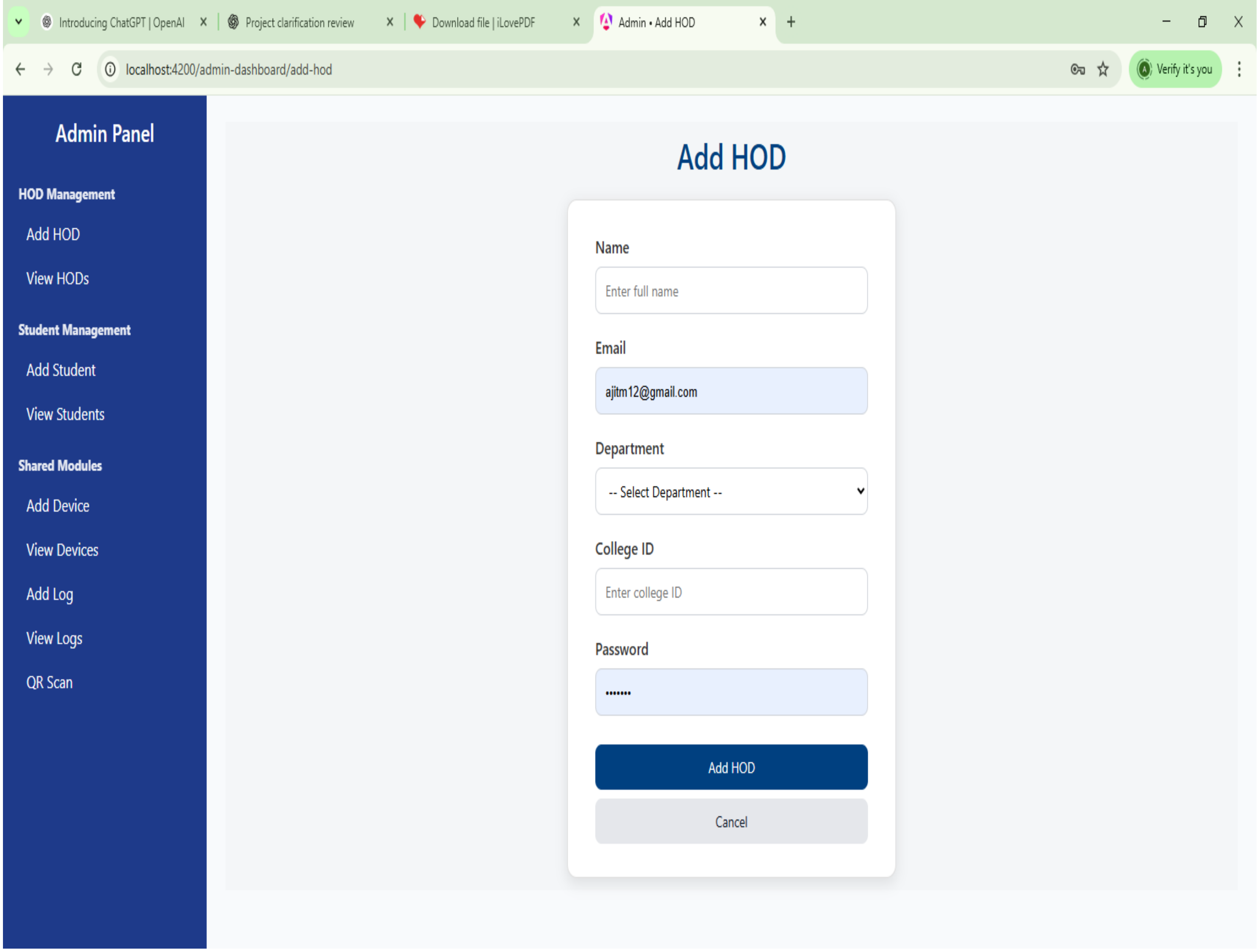
Phone (Optional): 10-digit mobile number

Year (Optional): -- Select Year --

Password: •••••••

Confirm Password: Retype password

# ADD HOD



Add HOD

Name: Enter full name

Email: ajitm12@gmail.com

Department: -- Select Department --

College ID: Enter college ID

Password: •••••••

## 7.3 TESTING

### Testing

To ensure that the Digital Maintenance Logbook for Machines (SmartLabTracker) operates reliably and fulfills its intended objectives, extensive testing was carried out across all core modules. The testing focused on verifying the correct functioning of authentication, device management, maintenance logging, and report generation features.The primary goal of testing was to validate that each module performed as expected under various conditions, ensuring the system’s robustness, usability, and security.

### 1. User Authentication Testing

The login module was tested thoroughly to confirm secure access using both valid and invalid credentials.

- Users with correct email IDs and passwords were authenticated successfully and redirected to their respective dashboards based on roles (Admin, HOD, Faculty, or Student).
- Invalid inputs triggered proper error messages such as “Invalid credentials” or “User not found.”
- JWT token handling was verified to ensure session security and protection against unauthorized access.
- Token expiration and logout functionalities were also tested to validate session management.

### 2. Device Management Module Testing

This module allows users (primarily Faculty and Admin) to add, edit, view, and delete machine records.

- Each operation was tested individually using different input combinations.
- Form validation checks were performed to ensure all mandatory fields (e.g., device name, serial number, department) were properly filled before submission.
- Upon successful addition, devices appeared instantly in the device list table through Angular’s two-way data binding.
- The edit and delete operations were tested for correctness and reflected real-time updates in the database.

### 3. Maintenance Log Testing

The maintenance log module was tested for accurate entry and retrieval of maintenance records.

- Faculty users could successfully log maintenance details, including issue description, date, and status.
- The HOD could view and verify these logs, ensuring data integrity between users.
- Each update made by the faculty or admin was reflected in real time on the dashboard.
- Tests also confirmed that logs were properly linked to the correct device through unique IDs.

### 4. PDF Report Generation Testing

The report generation feature was tested to verify the correctness and format of downloadable reports.

- Each report contained accurate device details, maintenance history, and responsible personnel.
- The download process was tested in multiple browsers and devices to ensure cross-platform compatibility.
- The generated PDFs maintained proper formatting, including headers, tables, and timestamps.

### 5. UI Responsiveness and Error Handling

The entire application UI was tested across different screen sizes (desktop, tablet, smartphone) to ensure responsiveness.

- Angular Material and CSS flex/grid layouts were verified for proper rendering on all devices.
- Error messages for empty fields, invalid formats, or failed operations were displayed clearly and consistently.
- Navigation between modules (Login → Dashboard → Devices → Logs → Reports) was smooth and without lag.

**6. Integration and Flow Testing**

Comprehensive end-to-end testing was conducted to verify the seamless flow between the frontend (Angular), backend (Spring Boot), and database (MySQL).
A typical flow—user login → add device → log maintenance → generate report—was executed multiple times to ensure consistency and correctness.

- Data synchronization between frontend components and backend APIs was verified through network request monitoring.
- CRUD operations were validated to confirm that each change in the UI accurately reflected in the database.
- Role-based access control was tested to ensure that each user could only perform permitted actions.

**Test Cases**

| Test Case ID | Test Case Description | Status |
|---|---|---|
| TC_1 | Verify correct username/email for login module. | Pass |
| TC_2 | Verify that invalid username or password displays an error message. | Pass |
| TC_3 | Verify that valid credentials allow successful login. | Pass |
| TC_4 | Verify that password input field hides entered characters. | Pass |
| TC_5 | Verify that single click on Login with valid credentials redirects to dashboard. | Pass |
| TC_6 | Verify that the “Add Device” form opens upon clicking Add Device. | Pass |
| TC_7 | Verify that all required device details are mandatory before saving. | Pass |
| TC_8 | Verify that Edit and Delete buttons work correctly for devices. | Pass |
| TC_9 | Verify that a new maintenance log entry is successfully saved. | Pass |
| TC_10 | Verify that generated PDF report includes correct data and formatting. | Pass |

| Test Case ID | Test Case Description | Status |
|---|---|---|
| TC_11 | Verify that UI is responsive across desktop, tablet, and mobile devices. | Pass |
| TC_12 | Verify end-to-end flow (Login → Add Device → Log Maintenance → Generate Report). | Pass |

# CHAPTER 8

## RESULTS AND DISCUSSION

### 8.1 DATASET

### 1. Project Overview and Significance

• The Digital Maintenance Logbook for Machines is a comprehensive web-based system designed to digitize and streamline the process of recording and tracking maintenance activities of laboratory and institutional machines.
• It replaces traditional manual logbooks with an efficient, secure, and user-friendly platform that enables users to log, monitor, and manage all machine-related maintenance details digitally.
• The project supports four user roles - Admin, HOD, Faculty, and Student - each having specific access permissions to ensure proper task distribution and data security.
• The system enhances operational efficiency by maintaining real-time records of maintenance history, ensuring timely service, and reducing data loss due to manual errors.
• The digital logbook helps improve coordination between departments and ensures accountability by keeping a complete maintenance history of every machine.
• This system contributes to institutional automation and transparency while promoting paperless record management, a key step towards sustainable digital transformation.

**User Access Features**

**• Login & Signup:**

- Secure login system with JWT-based authentication.
- Role-based access control for Admin, HOD, Faculty, and Student.

**• Dashboard:**

- Displays machine details, maintenance records, and pending issues.
- Each role sees features relevant to its permissions — e.g., Faculty can add logs, Admin can manage users and machines.

• **Machine Management:**

- Admin can add, view, update, or delete machine details.

- HOD and Faculty can view or log maintenance reports for the machines they manage.

• **Maintenance Log Tracking:**

- Faculty and HOD users can record or review maintenance actions, along with remarks and dates.

• **Report Generation:**

- Allows downloading maintenance data or machine lists in PDF format directly from the dashboard.

**Maintenance Data Management Techniques**

• **Data Centralization:**

- All records are stored in a MySQL database connected through Spring Boot.

• **Role-Based Access Control:**

- Each role has specific permissions using JWT authentication tokens.

• **Real-Time Updates:**

- CRUD operations (Create, Read, Update, Delete) are instantly reflected on the Angular frontend.

• **Analytics and Insights:**

- The system can track frequently maintained machines and overdue maintenance schedules to help in better decision-making.

## 8.2 EXPERIMENTAL SETUP

1. **Project Overview and Scope Definition:**

- Modules: Authentication, Machine Management, Maintenance Log Management, PDF Report Generation.
- Target Users: Admin, HOD, Faculty, and Student.

- Technologies: Angular, HTML, CSS, TypeScript, Spring Boot, and MySQL.
- Defined milestones for backend setup, frontend design, integration, and testing.

2. **Requirements Gathering and Analysis:**

- Requirements gathered from department-level maintenance tracking processes.
- Prioritized secure login, role-based access, and maintenance record storage.
- Created use cases for each role's interactions.

3. **System Architecture Design:**

- Frontend: Angular handles user interface and routing.
- Backend: Spring Boot API manages authentication, validation, and database operations.
- Database: MySQL used for storing user, machine, and maintenance data.

4. **Development Environment Setup:**

- Frontend: Developed using Angular in Visual Studio Code.
- Backend: Developed in Eclipse IDE using Spring Boot.
- Database: MySQL Workbench connected with backend using JPA/Hibernate.

## 8.3 RESULT

### 1.1 Authenticated Access

The JWT authentication system ensures that only authorized users can log in and access specific sections of the application.
Each user role has restricted functionalities:

- Admin: Manage users and machines.
- HOD: View and verify maintenance logs.
- Faculty: Add and update maintenance reports for assigned machines.
- Student: View machine status and submit issue reports.

This enhances data confidentiality and accountability, ensuring that each action in the system is traceable and secure.

### 1.2 Expeditious Updates

The system enables real-time data updates across frontend and backend modules.
Whenever a user adds, edits, or deletes a record — for example, when a Faculty logs new

maintenance activity — the change is instantly visible in the dashboard and MySQL database. This ensures consistency and smooth operation during concurrent usage.

Key features of expeditious updates include:

- Fast CRUD operation handling via Spring Boot REST APIs.
- Instant reflection of changes using Angular's data binding.
- Reduced latency and improved system performance.

### 1.3 Search Operation

A search feature is integrated to help users quickly find machines or logs based on key details such as:

- Machine Name
- Serial Number
- Department
- Date of Maintenance

The search function dynamically filters data on the Angular frontend, ensuring faster access and better user convenience.
This is especially useful for Admin and HOD users managing multiple devices.

### 8.4 PERFORMANCE METRICS

| REQUIREMENT | NORMAL REQUIREMENT | EXPECTED REQUIREMENT | EXCITED REQUIREMENT |
|---|---|---|---|
| Simple UI | | ✔ | |
| User Friendly | | | ✔ |
| Database Management | ✔ | ✔ | |
| Quick Updation | | ✔ | |
| Scripting (Angular + TS) | ✔ | | |
| Response Time | | | ✔ |

| REQUIREMENT | NORMAL REQUIREMENT | EXPECTED REQUIREMENT | EXCITED REQUIREMENT |
|---|---|---|---|
| Search Functionality | | | ✔ |
| Loading Time | | ✔ | |
| Code Structure | ✔ | | |
| Report Generation (PDF) | | ✔ | |
| Development Process | | ✔ | |

### 8.5 DISCUSSION

#### 1. Authenticated Access

The Digital Maintenance Logbook employs role-based authentication to ensure that only authorized users can perform specific actions.
The JWT-based security ensures data protection during communication between frontend and backend.
For example, an Admin can add machines and manage users, while Faculty can only record maintenance logs — ensuring data integrity and operational control.
By applying password encryption and token-based validation, the system safeguards against unauthorized access and enhances reliability.

#### 2. Expeditious Updates

The system architecture ensures that all CRUD operations execute rapidly and reflect instantly on the user interface.
Using RESTful APIs and MySQL database integration, any modification (Add, Update, Delete) appears in real time without delay.

This minimizes redundancy and keeps the maintenance records accurate and synchronized

between users.
This fast update mechanism improves the responsiveness and usability of the application, especially during multi-user operations.

### 3. Search Operation

The search feature simplifies data access for all users.
It allows Admin, HOD, and Faculty to quickly locate specific machines or logs using keywords or parameters.
Angular’s dynamic filtering ensures that results are displayed instantly as users type, providing an efficient, user-friendly experience.
This feature significantly reduces the time spent navigating large datasets and supports smooth daily operations

# CHAPTER 9

## CONCLUSION

The Digital Maintenance Logbook for Machines is a comprehensive digital solution that successfully replaces the traditional manual process of maintaining and tracking laboratory machine records with an intelligent, automated, and secure system. It has been developed with the objective of streamlining the management of machine data, maintenance schedules, and service histories within educational and institutional environments. Through the integration of Spring Boot as the backend framework, Angular for the frontend, and MySQL as the database, the system ensures reliability, scalability, and high performance in every aspect of operation.

This project was conceptualized to address the common challenges of manual record-keeping, such as data loss, inefficiency, and lack of transparency. By digitizing the entire maintenance process, the system provides a unified platform for users to add machines, record maintenance activities, generate reports, and access data in real time. Each feature is designed to enhance accessibility and accountability, ensuring that machine-related information is securely stored and easily retrievable whenever required. The inclusion of JWT-based authentication ensures secure access for all users, safeguarding sensitive institutional data and maintaining proper role-based permissions for Admin, HOD, Faculty, and Students.

The Digital Maintenance Logbook provides an efficient way to manage and monitor the maintenance lifecycle of all laboratory machines. The system allows authorized users to view service logs, update machine information, and download PDF reports, thereby simplifying the process of documentation and auditing. Furthermore, the use of a responsive Angular interface ensures that users can interact with the platform seamlessly across different devices, making the system user-friendly and accessible. The connection between the backend and database has been optimized for quick data transactions, ensuring that updates, deletions, and new entries reflect instantly across the system.

Throughout the development process, extensive testing was carried out to ensure system reliability, data integrity, and smooth user experience. Each module — including login, machine management, and maintenance tracking — was thoroughly validated for accuracy and efficiency. The system demonstrated excellent responsiveness, secure access control, and effective handling of errors, thus confirming its readiness for real-world deployment in academic institutions or industrial labs.

The outcome of this project reflects the successful implementation of digital transformation in maintenance record management. It minimizes manual effort, improves operational efficiency, and promotes sustainability through paperless data handling. The Digital Maintenance Logbook not only enhances the organization and accessibility of maintenance information but also establishes a foundation for further technological advancements in this field. The project can be extended in the future by incorporating IoT-based automatic machine monitoring, reminder notifications for upcoming maintenance, and advanced analytics dashboards for decision-making.

In conclusion, the Digital Maintenance Logbook for Machines stands as a robust and practical system that bridges the gap between traditional record-keeping and modern digital solutions. It embodies innovation, efficiency, and reliability, providing a smarter way to manage institutional machine maintenance. The system's secure design, responsive interface, and data-driven functionality make it a valuable asset in promoting transparency, accountability, and long-term sustainability in maintenance operations.

# CHAPTER 10

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