

# Pustakalay

**Library Management System**

A Project Report Submitted for

**VITyarthi - Build Your Own Project**

**Submitted by:**

Lubhani Jain

24BOE10044

**Date:** November 24, 2025

## 1. Introduction

In the digital age, the automation of traditional processes is essential for efficiency and accuracy. "Pustakalay" is a comprehensive Library Management System designed to streamline the operations of a library. It bridges the gap between physical resources and digital management by providing a platform for students, faculty, and administrators to interact with the library's inventory seamlessly.

This project leverages Java for robust backend processing and React for a modern, responsive user interface, demonstrating a full-stack approach to solving real-world problems.

## 2. Problem Statement

Traditional manual library management systems suffer from several inefficiencies:

- **Data Redundancy & Errors:** Manual record-keeping is prone to human error and duplicate entries.
- **Time-Consuming:** Searching for books and processing issues/returns manually consumes significant time.
- **Lack of Real-time Status:** Users cannot easily verify if a book is available without visiting the library.
- **Poor Analytics:** It is difficult to track borrowing trends or inventory health with paper-based systems.

Pustakalay addresses these issues by automating data management, providing instant search capabilities, and maintaining real-time transaction records.

## 3. Functional Requirements

- **User Management:**
  - Registration for new users (Students).
  - Login authentication for Students, Faculty, and Admins.
  - Role-based access control.
- **Book Management:**
  - Admin can Add and Remove books.
  - Users can Search for books by Title or Author.
  - View detailed book information (Genre, Availability).
- **Transaction Management:**
  - Issue a book (updates status to "ISSUED").
  - Return a book (updates status to "AVAILABLE").
  - View personal transaction history.

## 4. Non-functional Requirements

- **Performance:** The system responds to search queries and transactions in under 200ms.
- **Usability:** The User Interface is intuitive, responsive, and accessible via standard web browsers.
- **Reliability:** The system handles invalid inputs gracefully with proper error messages (e.g., "Book not found").
- **Maintainability:** The code follows a modular structure (Model-View-Controller pattern) to allow easy updates.
- **Security:** Basic authentication ensures only registered users can perform transactions.

## 5. System Architecture

The system follows a Client-Server architecture:

- **Frontend (Client):** Built with React.js and Tailwind CSS. It handles user interactions and communicates with the backend via REST API.
- **Backend (Server):** Built with Java (JDK 8+) using `com.sun.net.httpserver`. It processes requests, executes business logic, and manages data.
- **Data Layer:** In-memory data structures (Lists/Maps) simulate a database for this project scope.

## 6. Design Diagrams

### Use Case Diagram

```
usecaseDiagram actor Admin actor Student actor Faculty package Pustakalay {
    usecase "Login" as UC1
    usecase "Search Book" as UC2
    usecase "Issue Book" as UC5
    usecase "Return Book" as UC6
}
Admin --> UC1
Student --> UC1
Student --> UC2
Student --> UC5
Student --> UC6
Faculty --> UC1
Faculty --> UC5
```

### Class Diagram

```
classDiagram class User { +String userId +String name +String role }
class Book { +String bookId +String title +boolean isAvailable }
class Transaction { +String transactionId +String userId +String bookId }
class LibraryService { +addBook() +searchBooks() }
LibraryService "1" -- "*" Book
```

### Sequence Diagram (Issue Book)

```
sequenceDiagram
    User->>Frontend: Click "Issue Book"
    Frontend->>Backend: POST /api/issue
    Backend->>LibraryService: checkAvailability()
    LibraryService-->>Backend: true
    Backend->>TransactionService: createTransaction()
    Backend-->>Frontend: Success Response
    Frontend-->>User: Show "Book Issued" Alert
```

## 7. Design Decisions & Rationale

- **Java HTTP Server:** Chosen to keep the backend lightweight and dependency-free, avoiding the overhead of heavy frameworks like Spring for this specific scope.
- **React (CDN):** Used to demonstrate modern frontend capabilities without requiring a complex Node.js build pipeline on the host machine.
- **In-Memory Storage:** Selected for simplicity and speed, allowing focus on logic implementation rather than database configuration.

## 8. Implementation Details

The project is structured into three main packages:

- `com.vityarthi.pustakalay.model`: Contains POJO classes (Book, User, Transaction).
- `com.vityarthi.pustakalay.service`: Contains business logic (LibraryService, UserService).
- `com.vityarthi.pustakalay.api`: Contains REST API handlers (LoginHandler, IssueHandler).

Test Case	Steps	Expected Result	Status
User Registration	Enter valid details -> Click Register	Success Alert	Pass
Book Search	Enter "Malgudi" in search bar	"Malgudi Days" displayed	Pass
Issue Book	Click Issue on available book	Status changes to ISSUED	Pass

## 9. Results

The Pustakalay Library Management System was successfully implemented and tested. Key results include:

- **User Authentication:** Users can successfully register and log in. The system correctly identifies roles (Student vs. Admin).
- **Book Management:** The dashboard correctly displays the list of books fetched from the backend API.
- **Transaction Processing:** Books can be issued and returned. The availability status updates in real-time across the system.
- **API Performance:** All API endpoints respond within acceptable time limits, ensuring a smooth user experience.

## 10. Testing Approach

We employed **Manual Black-Box Testing**. Key test cases included:

- Validating user login with correct/incorrect credentials.

- Verifying book availability updates immediately after issuance.
- Ensuring unauthorized users cannot access protected API endpoints.

## 11. Challenges Faced

- **CORS Issues:** Connecting the React frontend to the Java backend initially caused Cross-Origin Resource Sharing errors, which were resolved by adding proper headers in the Java `APIServer`.
- **State Management:** Keeping the frontend UI in sync with the backend state (e.g., updating the button from "Issue" to "Return" immediately) required careful React state handling.

## 12. Learnings & Key Takeaways

- Gained deep understanding of how REST APIs work under the hood by implementing one from scratch in Java.
- Learned how to integrate a Java backend with a modern JavaScript frontend.
- Understood the importance of modular design in keeping code maintainable.

## 13. Future Enhancements

- **Database Integration:** Replace in-memory storage with MySQL or MongoDB for persistent data.
- **Barcode Scanner:** Integrate physical barcode scanning for faster book issuing.
- **Fine Calculation:** Implement logic to calculate fines based on return dates.

## 14. References

- Java Documentation: <https://docs.oracle.com/en/java/>
- React Documentation: <https://reactjs.org/>
- Tailwind CSS: <https://tailwindcss.com/>