**Project Design Phase**
**Solution Architecture**

| Date | 14 Feb 2026 |
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| Team ID | LTVIP2026TMIDS64190 |
| Project Name | LearnHub: Your Center for Skill Enhancement |
| Maximum Marks | 4 Marks |

## Solution Architecture:

The solution architecture for LearnHub is built using the MERN stack to provide a secure, scalable, and modular Learning Management System. It consists of a React-based user interface, a Node.js & Express backend for API handling, MongoDB for data management, and integrated modules for authentication, payment verification, progress tracking, and certificate generation. The architecture ensures secure communication, structured course management, and smooth user interaction across all roles (Admin, Teacher, Student).

1. User Interface Layer
   - Built with **React.js** for web-based access
   - Uses **React Router** for navigation and page management
   - Responsive UI designed using **Bootstrap and CSS**
   - Provides separate dashboards for Admin, Teacher, and Student
   - Supports course browsing, video streaming, payment interface, and certificate download

2. Application Layer
   - **Built using Node.js and Express.js**
   - Manages authentication, role-based access, and protected routes
   - Handles routing, business logic, and REST API orchestration
   - Controls course creation, payment validation, enrollment logic, and progress tracking

3. Authentication & Security Layer
   - **JWT (JSON Web Token)** for secure session management
   - bcrypt for password hashing
   - Role-Based Access Control (RBAC) for Admin, Teacher, and Student
   - Middleware protection for restricted routes

4. Data Layer
   - MongoDB as NoSQL database
   - Mongoose for schema modeling
   - Collections include:
     - Users
     - Courses
     - EnrolledCourses
     - CoursePayments

5. File & Certificate Management Layer
   - **Multer** for video file uploads
   - Local storage for course video management
   - **PDFKit** for dynamic certificate generation
   - Generates downloadable PDF certificates upon course completion

6. Integration & API Layer
   ○ RESTful APIs for frontend-backend communication
   ○ Axios used for secure request handling
   ○ Token-based authorization for sensitive endpoints

7. Deployment Layer
   o Can be containerized using **Docker**
   o Deployable on cloud platforms like **AWS, Azure, or Render**
   o Supports scalable architecture for increasing users and courses
   o Monitoring and logging can be integrated for production readiness

## Solution Architecture Diagram: