Criterion B: Design

CrossBox Gymnasium Management System

System Architecture

The system employs a three-tier Model-View-Controller architecture. The presentation layer uses React.js for building dynamic user interfaces with component-based design and responsive CSS styling. The business logic layer implements RESTful API endpoints using Node.js and Express.js, handling authentication through JWT tokens, data validation, and business rules enforcement. The data persistence layer utilizes MySQL 8.0 with seven interconnected tables maintaining referential integrity through foreign key constraints. This separation ensures scalability, maintainability, and clear responsibility boundaries across the application.

Database Schema

The database comprises seven tables: members (14 fields storing personal information, membership details, payment status), trainers (10 fields with credentials and specializations), workouts (7 fields containing exercise templates and difficulty levels), member_workouts (junction table linking members to assigned workouts with trainer references), workout_logs (tracking performance data including sets, reps, weights), schedules (managing gym events with datetime fields for conflict detection), and admins (storing administrator credentials). All tables use auto-incrementing primary keys with appropriate foreign key relationships ensuring data integrity through CASCADE deletion rules where appropriate.

Key Algorithms

Schedule Conflict Detection: Queries existing schedule records for matching trainer and location, then checks time overlap by comparing new event start/end times against existing events using datetime range logic, returning boolean conflict indicator.

Renewal Reminder System: Cron job executes daily at 9:00 AM, querying members with expiry dates within seven days and unpaid status, generating personalized email content, and sending via nodemailer SMTP configuration.

Analytics Calculation: Aggregates database records using SQL COUNT and SUM functions to calculate active members, monthly revenue, upcoming renewals, and daily sessions for dashboard visualization.

User Interface Design

The login page features role selection buttons (admin/trainer/member) with email and password input fields. Admin dashboard displays four statistics cards showing key metrics plus recent members table with search and filter capabilities. Member management interface includes sortable data tables with action buttons for CRUD operations. Scheduling calendar

presents weekly grid view with color-coded event blocks and click-to-create functionality. All interfaces use responsive design with CSS Flexbox layouts and media queries at 768px and 480px breakpoints for tablet and mobile optimization.

Security Design

Authentication implements bcrypt password hashing with ten salt rounds and JWT tokens with 24-hour expiration. Authorization uses role-based middleware verifying permissions before resource access. SQL injection prevention employs parameterized queries throughout. HTTPS encryption secures data transmission. Input validation occurs at frontend and backend layers with comprehensive error messaging for user guidance.

Word Count: 479