

# CSC 675 - Project Documentation

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## Hospital Management System

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## I. Project Description

The development of my hospital management database system is motivated by the urgent need to address several issues faced by healthcare institutions today. Key among these challenges are managing rapidly evolving medical information, overwhelming data reporting requirements, integrating burgeoning telehealth platforms, and navigating the complex logistics of vaccine distribution, this project seeks to address these multifaceted issues head-on. My project aims to tackle these problems, transforming the way hospitals manage and utilize their data to facilitate better public health responses, ensure continuity of care across various service delivery modes, and enhance infection control measures, all while supporting the well-being of healthcare workers and patients alike in a post-pandemic world.

At a high level, my database system is designed as a comprehensive, user-friendly platform that centralizes and simplifies the management of complex medical data. It is intended to serve as the backbone of a hospital's information system, facilitating seamless access to patient records, treatment histories, diagnostic information, and other critical data. The system will support real-time data updates and retrieval, ensuring that healthcare providers have instant access to the information they need to make informed decisions.

Unique features of my database system will include advanced data analytics capabilities, enabling hospitals to derive actionable insights from their data for improved patient outcomes and operational efficiencies. We will implement state-of-the-art security measures, including encryption and role-based access control, to protect sensitive patient information. My system will also feature robust interoperability solutions, allowing for seamless integration with existing software tools and healthcare systems, ensuring that hospitals can leverage their current technology investments. Additionally, the system will include scalable architecture to accommodate growing data volumes and a comprehensive disaster recovery plan to safeguard against data loss.

Two existing software tools that would greatly benefit from integrating with my database system are Electronic Health Records (EHR) systems and Laboratory Information Management Systems (LIMS). EHR systems, such as Epic or Cerner, would benefit from my advanced data analytics and interoperability features, enhancing their ability to provide comprehensive patient histories and support clinical decision-making. The seamless integration with my database would allow for more efficient data management and real-time updates, improving the quality of patient care. Laboratory Information Management Systems, like LabWare or STARLIMS, would benefit from my system's robust data integrity and real-time data access features. My database system would ensure accurate and timely sharing of laboratory results with clinicians, streamlining diagnoses and treatment planning while maintaining high standards of data security and privacy.

In summary, my hospital management database system project is poised to revolutionize the management of healthcare data, addressing critical issues faced by hospitals today and paving the way for a more integrated, efficient, and secure healthcare future.

## II. Functional Database Requirements

For the Hospital Management System (HMS), functional database requirements are crucial to ensure that the system effectively meets the needs of its users, including patients, doctors, nurses, administrative staff, and other stakeholders. These requirements will cover a range of operations and relationships within the database, ensuring comprehensive coverage of hospital operations. Here's a detailed list, grouped by the entity that performs the action:

### 1. Patient

- a. A patient shall be able to register with the system using a unique identifier.
- b. A patient shall be able to book appointments with multiple doctors.
- c. A patient shall have access to their personal medical records.
- d. A patient can subscribe to multiple health plans.
- e. A patient can provide feedback on services received.

### 2. Doctor

- a. A doctor shall manage appointments.
- b. A doctor can belong to multiple departments.
- c. A doctor shall be able to access and update the medical records of their patients.
- d. A doctor can supervise medical interns.
- e. A doctor can assign tasks to nurses.

### 3. Nurse

- a. A nurse shall be assigned to assist in multiple departments.
- b. A nurse can be assigned to multiple patients for routine checks.
- c. A nurse shall record patient vital signs in the database.
- d. A nurse shall be able to administer medications as prescribed and log this information in the system.

### 4. Receptionist

- a. A receptionist shall be able to book, reschedule, and cancel appointments.
- b. A receptionist shall be able to check patients in and out.
- c. A receptionist shall be able to verify patient insurance information.
- d. A receptionist shall be able to update patient contact information.
- e. A receptionist shall be able to issue patient reminders for appointments.

5. Department

- a. A department shall offer multiple services.
- b. A department can be staffed by multiple doctors and nurses.
- c. A department can have multiple pieces of equipment assigned.
- d. A department shall have the ability to generate reports on patient visits, treatments offered, and departmental performance metrics.

6. Equipment

- a. Equipment shall be allocated to different departments.
- b. Equipment usage shall be logged for maintenance and scheduling purposes.

7. Appointment

- a. An appointment is made between one patient and one doctor.
- b. An appointment shall have a specific date, time, and department.
- c. Appointments can result in the creation of one or more medical records.
- d. An appointment can be rescheduled or canceled by the patient or staff.

8. Medical Record

- a. A medical record belongs to one patient.
- b. A medical record can be accessed by multiple staff members with appropriate permissions.
- c. A medical record contains entries from multiple appointments.

9. Billing Department

- a. The billing department shall be able to generate invoices for services rendered.
- b. The billing department shall be able to process payments.
- c. The billing department shall be able to manage patient billing accounts.
- d. The billing department shall be able to apply insurance adjustments.
- e. The billing department shall be able to send payment reminders to patients.

10. Insurance

- a. An insurance record is linked to a patient's billing account.
- b. An insurance record can cover multiple treatments and services.
- c. An insurance provider can be billed for services rendered to the patient.

11. User (Generic for System Users)

- a. A user shall be able to log into the system from multiple devices.
- b. A user can have multiple roles (e.g., Doctor, Nurse, and Administrative Staff) (ISA).
- c. A user shall change their password under security policies.

## 12. Roles and Permissions

- a. A role defines access levels to various parts of the system.
- b. A user with administrative roles can assign roles to other users (Recursive).
- c. Permissions within a role dictate the ability to view, edit, or delete specific data.

## 13. Schedule

- a. A schedule is maintained for each staff member.
- b. A schedule includes shifts, appointments, and on-call duties.
- c. Schedules can be accessed by the staff member and their department head.

## 14. Pharmacy Staff

- a. Pharmacy staff shall be able to manage medication inventory.
- b. Pharmacy staff shall be able to fill prescriptions.
- c. Pharmacy staff shall be able to update medication records.
- d. Pharmacy staff shall be able to send alerts for medication refills.
- e. Pharmacy staff shall be able to provide information on medication interactions.

## 15. Inventory Manager

- a. Inventory managers shall be able to track medical supplies.
- b. Inventory managers shall be able to reorder supplies as needed.
- c. Inventory managers shall be able to manage supplier information.
- d. Inventory managers shall be able to forecast inventory needs.
- e. Inventory managers shall be able to report on inventory levels and usage.

## 16. Medication

- a. A medication can be prescribed in multiple treatments.
- b. A medication can have one or more side effects.
- c. A medication's stock is managed by the pharmacy department.

This comprehensive set of functional database requirements is designed to ensure that the Hospital Management System is capable of managing complex relationships and operations, enhancing the efficiency and quality of healthcare services provided.

# III. Non-functional Database Requirements

## 1. Performance

- a. The HMS database shall support simultaneous access by multiple users without performance degradation.
- b. Query response times shall not exceed 2 seconds under normal operation conditions.

- c. The database should optimize data retrieval operations to minimize latency for frequently accessed data.
- d. System performance metrics shall be continuously monitored to proactively address potential bottlenecks.

## 2. Security

- a. All patient data shall be encrypted both at rest and in transit.
- b. Access to sensitive data is restricted based on user roles and authenticated via multi-factor authentication.
- c. The database system shall implement regular vulnerability assessments and patch management to protect against known threats.
- d. Data input and output should be sanitized and validated to prevent SQL injection attacks and other forms of data tampering.
- e. The system shall enforce automatic session timeouts and re-authentication for extended periods of inactivity to prevent unauthorized access.

## 3. Scalability

- a. The database design shall support scaling to accommodate growing data volumes and user counts.
- b. Allow individual components to scale independently based on demand.
- c. The system can be deployed in a distributed environment to enhance load balancing and data redundancy.
- d. Database architecture shall be flexible to support horizontal scaling, including the addition of new servers or clusters as needed.
- e. Cloud-based storage solutions shall be evaluated for scalability and flexibility to support dynamic storage needs.

## 4. Coding Standards

- a. Development of the HMS database shall adhere to industry best practices for coding and architecture, including the use of secure coding standards.
- b. Code reviews and static code analysis tools shall be employed to ensure code quality and maintainability.
- c. Documentation standards shall be established and followed to ensure that the database system is well-documented for developers and administrators.
- d. Continuous integration/continuous deployment (CI/CD) pipelines shall be used to automate testing and deployment, ensuring coding standards is consistently applied.
- e. Accessibility standards shall be incorporated into the development process to ensure the HMS is usable by all intended users, including those with disabilities.

## 5. Media Storage

- a. The HMS database shall implement efficient storage solutions for large media files, such as medical images and videos, ensuring quick access and retrieval.
- b. Media files shall be stored in a secure, encrypted format, with access controls to prevent unauthorized access.
- c. The database shall support streaming of media content to authorized users without the need for full file downloads.
- d. Redundancy mechanisms shall be in place for media storage to ensure data integrity and availability in case of system failure.
- e. Media storage solutions shall be scalable to accommodate the growing volume of digital media in healthcare records.

## 6. Privacy

- a. The HMS complies with healthcare regulations such as HIPAA for data privacy and security.
- b. Patients have the right to access their data and request corrections.
- c. The system shall implement the principle of least privilege; ensuring users have access only to the data necessary for their role.
- d. Patients shall be informed of how their data is used and have the option to opt-out of data sharing that is not essential for their care.
- e. When patient data is used for research, training, or statistical analysis, it shall be anonymized or de-identified to prevent the possibility of re-identification of individuals.