# Assignment Title: Database System Design for a Library

## Introduction

### Overview of the Project

This project deals with the designing and implementation of an efficient database management system for a public library which is to be executed in MYSQL. The key tasks of the project are:

* Drawing of an Entity-Relationship (ER) diagram.
* The implementation of the database schema using MySQL, and
* Presenting of the advanced SQL queries to manage and query the data. Also, it provides a theoretical section on the CAP theorem concerning the database system.

### Importance of a Database System for a Public Library

The database system of a public library is an essential component since it facilitates the organization of the library’s activities. This system allows the organization to monitor the stock of the books, control the patron details, follow the borrowing and returning process and besides manage reservations. This means that when the processes are enacted, the improvement of service delivery to users is enhanced, the accountability of the availability of resources is ensured, and record-keeping is maintained. Besides, the correct organization of the database allows for the improvement of data quality, eliminates the problem of data duplication, and promotes the efficient use of data for decision-making.

### Objectives

The overall goal of this report is to gain hands on experience of creating and populating a database, and querying the data using MySQL. The tasks are structured to achieve the following goals:

* Design a Database System: Developing a detailed ER diagram that depicts the library’s data need and relationship.
* Implement the Database: Designing schema in MySQL basically by creating the tables and relations/ constraints and adding a set of sample data that fit the library environment at large.
* Write Advanced SQL Queries: Providing examples of using SQL in Writing data manipulation queries and Retrieval operations/Join operations/sub queries.
* Discuss Theoretical Concepts: Explaining the CAP theorem and some of the issues which will be relevant to the library’s database system, and how it is best to compromise one between consistency, availability, and partition tolerance.

## Database Design

### Scope and Objectives

#### Detailed Scope of the Database

This database focuses more specifically on who, what, where, how and why of various subjects. The scope of the database system for the public library encompasses the following areas:

* Book Management: Shelving of the books, keeping record on the copies in store, and processing of reserved books.
* Patron Management: Permanent registration of user details, Identification card details, correspondent address, Library membership type etc.
* Transaction Management: Cataloguing the usage of the borrowed books, reminding borrowers of the date the books need to be returned and collecting money for overdue books.
* Staff Management: Archiving all the library staff, their appointments, and dealing with the system.
* Reservation System: The processes involved in handling the reservation of the books by the patrons as well as handling the status of the reservation.

#### Goals Taking into Account of the Stakeholders, Needs, and Functions

#### Stakeholders

The key stakeholders of the public library database system include:

* Library Users (Patrons): Those who attend the library and make use of the available materials through borrowers’ check out, bookings, and use of other library services.
* Library Employees: This group consists of staffs who are involved in the selection, acquisition, processing, organization of collections, and providing user support that are basic to the functioning of a library as well as administrative and technical officers who are involved in the day-to-day running and co-ordination of the library.
* Library Executives: Community of leaders within the organization headed by a director who is charge of the over-all planning, direction, administration and setting the strategic vision and policies of a library.

#### Requirements

For a library environment and particularly a public library, the database system must be able to meet the following critical success factors for it to work smoothly: These include, improve library functions, and improve patrons experience and accuracy and consistencies in the data processing. The key requirements are:

1. Efficient Cataloging and Retrieval of Books: They include the ability to rapidly and efficiently capture books’ metadata by possibly indexing through barcode or ISBN number, the ability for the users to efficiently search the database to gain access to book details.
2. Accurate and Up-to-Date Records of Patrons and Their Borrowing History: Peculiar records of the patrons including the records of borrowed material is a very crucial aspect in library management and user services hence require up to date records.
3. Streamlined Transaction Processing for Borrowing and Returning Books: This is another operational requirement which implies that the use of the database in the processing of book borrowing, and returning transactions should not be time consuming.
4. Transparent Reservation System for Books: Self-service reservation should be easy and straightforward, as well as incorporate a system for book selection and follow up on book status.
5. Comprehensive Management of Staff Roles and Activities: The staff roles and activity to be performed in the library should be properly managed to enable the library run effectively through the direction of specific roles and efficient working of jobs.

### Entity-Relationship (ER) Diagram

Explanation of the Entities, Attributes, Relationships, and Cardinalities

1. Entities:

- Book: `BookID`, `Title`, `Author`, `Publisher`, `YearPublished`, `ISBN`, `Genre`, `CopiesAvailable`

- Patron: `PatronID`, `FirstName`, `LastName`, `DOB`, `Address`, `Phone`, `Email`

- Staff: `StaffID`, `FirstName`, `LastName`, `Position`, `Email`, `Phone`

- Transaction: `TransactionID`, `BookID`, `PatronID`, `StaffID`, `BorrowDate`, `ReturnDate`, `Fine`

- Reservation: `ReservationID`, `BookID`, `PatronID`, `ReservationDate`, `Status`

2. Relationships:

- Book - Transaction: One-to-Many (A book can be involved in multiple transactions)

- Patron - Transaction: One-to-Many (A patron can have multiple transactions)

- Staff - Transaction: One-to-Many (A staff member can handle multiple transactions)

- Book - Reservation: One-to-Many (A book can have multiple reservations)

- Patron - Reservation: One-to-Many (A patron can make multiple reservations)

3. Cardinalities:

- Each book can have multiple transactions, but each transaction involves only one book.

- Each patron can make multiple transactions, but each transaction involves only one patron.

- Each staff member can handle multiple transactions, but each transaction is handled by one staff member.

- Each book can have multiple reservations, but each reservation is for one book.

- Each patron can make multiple reservations, but each reservation is made by one patron.

### Justification of Design Choices Based on Library Needs

Just as requirements of the operation of the public library are met when designing the system, the design of the database system for the public library is unique to the operation of the library. This includes the choice of the entities involved, the characteristics of these entities, the relationships between the entities, and the varying cardinalities displayed so as to address all the basic functional needs of a library.

* Entity Selection: More of the entities represent the fundamental functioning of the library with regards to its books, patrons, monetary transactions and employees. These entities provide on the key areas that are needed in the efficient management of a library.
* Attributes: For attributes four or five attributes are chosen for each entity to record as much relevant information as needed. For example, for book details one can provide author and publisher while details of the patron can include the phone number in order to reach the latter.
* Relationships: They depict contact or interactions within and between the entities within the context of the library. For instance, the interaction between the books and the transactions guarantees that the book borrowing and returning processes have been recorded correctly.
* Cardinalities: The cardinalities also aid in the capacity of the database to accommodate multiple interactions for the likes of transactions for a specific book and reservations to a specific patron by more than one person.