Case Study 3: City Central Library Management System

LLD Document

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Tables with attributes & keys :

1. Author Table:

Attribute name	Data type	Constraints
Author_id	INT	PRIMARY KEY
Name	VARCHAR(100)	NOT NULL

2. Publishers Table:

Attribute name	Data type	Constraints
Publisher_id	INT	PRIMARY KEY
Publisher_name	VARCHAR(150)	NOT NULL
Location	VARCHAR(100)	

3. Book Table:

Attribute name	Data type	Constraints
Book_id	INT	PRIMARY KEY
Book_title	VARCHAR(100)	NOT NULL
ISBN	VARCHAR(20)	UNIQUE
Genre	VARCHAR(50)	
Total_copies	INT	
Available_copies	INT	
Year	INT	
Author_id	INT	FOREIGN KEY
Publisher_id	INT	FOREIGN KEY

4. Members Table:

Attribute name	Data type	Constraints
Member_id	INT	PRIMARY KEY
Member_name	VARCHAR(100)	NOT NULL
Membership_date	DATE	
Membership_type	VARCHAR(20)	

5. Loans Table:

Attribute name	Data type	Constraints
Loan_id	INT	PRIMARY KEY
Issue_date	DATE	
Due_date	DATE	
Return_date	DATE	
Book_id	INT	FOREIGN KEY
Member_id	INT	FOREIGN KEY

6. Fines Table:
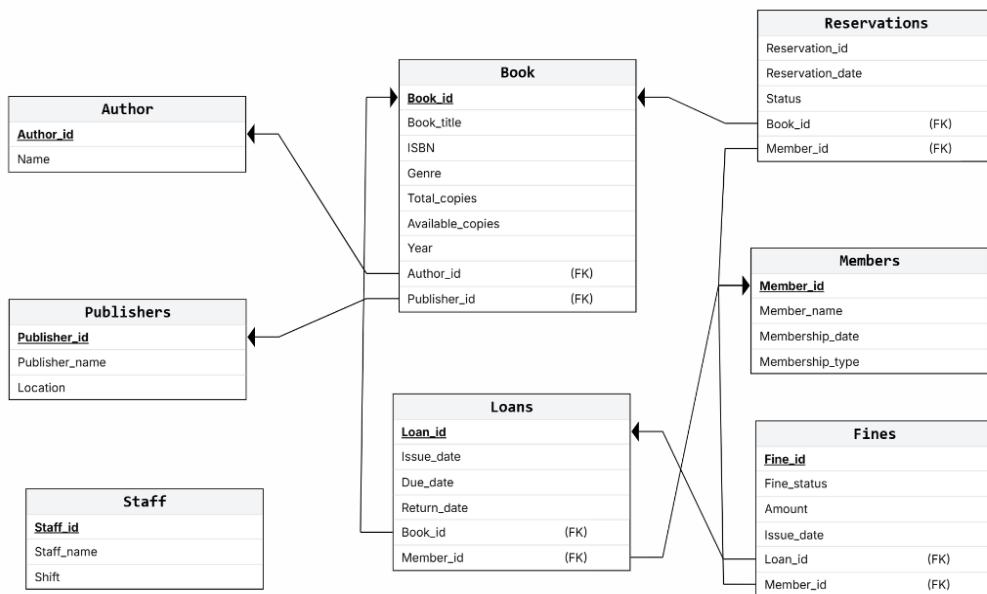
Attribute name	Data type	Constraints
Fine_id	INT	PRIMARY KEY
Fine_status	VARCHAR(20)	
Amount	DECIMAL(4,2)	
Issue_date	DATE	
Loan_id	INT	FOREIGN KEY
Member_id	INT	FOREIGN KEY

7. Reservations Table:
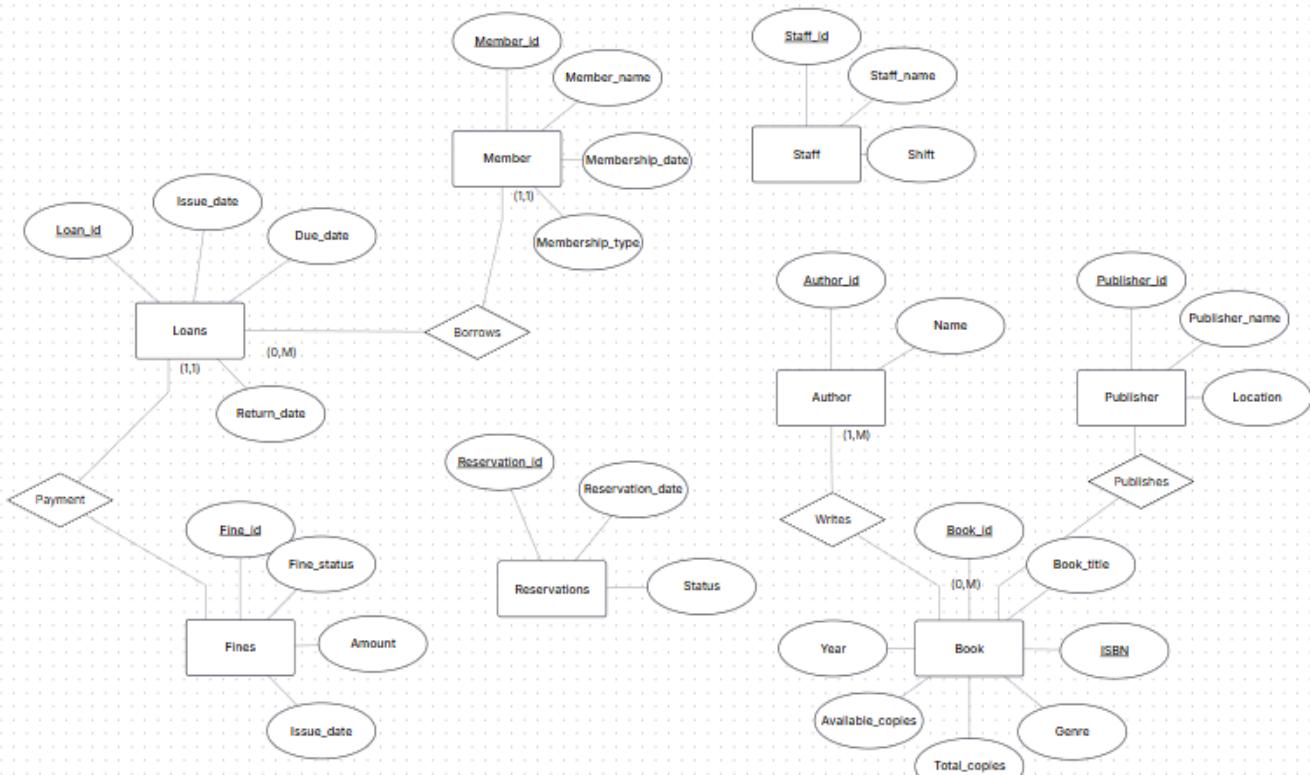
Attribute name	Data type	Constraints
Reservation_id	INT	PRIMARY KEY
Reservation_date	DATE	
Status	VARCHAR(20)	
Book_id	INT	FOREIGN KEY
Member_id	INT	FOREIGN KEY

8. Staff Table:

Attribute name	Data type	Constraints
Staff_id	INT	PRIMARY KEY
Staff_name	VARCHAR(100)	NOT NULL
Shift	VARCHAR(20)	

Relational mapping:

1. Book → Author

Explanation:

Book is connected to Author using Author_id.

It follows a Many-to-One relationship, since a single author can write multiple books.

2. Book → Publishers

Explanation:

Book is connected to Publishers using Publisher_id.

It follows a Many-to-One relationship, because a publisher can publish many books.

3. Loans → Book

Explanation:

Loans is connected to Book using Book_id.

It follows a Many-to-One relationship, since many loan records can belong to the same book.

4. Loans → Members

Explanation:

Loans is connected to Members using Member_id.

It follows a Many-to-One relationship, because a member can have multiple loan entries over time.

5. Reservations → Book

Explanation:

Reservations is connected to Book using Book_id.

It follows a Many-to-One relationship, as multiple members can reserve the same book.

6. Reservations → Members

Explanation:

Reservations is connected to Members using Member_id.

It follows a Many-to-One relationship, since one member can make many reservations.

7. Fines → Loans

Explanation:

Fines is connected to Loans using Loan_id.

It follows a One-to-One / Many-to-One relationship, since typically one loan may generate zero or one fine.

8. Fines → Members

Explanation:

Fines is connected to Members using Member_id.

It follows a Many-to-One relationship, because a single member can accrue multiple fines.

Normalization:

First Normal Form (1NF)

- All tables have atomic fields.
- No repeating groups.
- Primary keys clearly defined.

Second Normal Form (2NF)

- No partial dependencies (all PKs are simple).
- All non-key attributes depend fully on their PK.

Third Normal Form (3NF)

- No transitive dependencies.
- Example checks:
  - Book's Author_name is not stored → avoids redundancy.
  - Fine does not store Book details → uses Loan_id instead.
- Therefore, design is in **3NF**.

BCNF:

- Every determinant is a candidate key.
- No table has non-key attributes determining others.
- All tables satisfy BCNF.