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Lab Manual – ER Modeling and Normalization

Experiment No. 1

Title: ER Modeling and Normalization for Real-Time Application

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1. Aim

To analyze a real-time problem, formulate a case study, design its conceptual schema using **Entity-Relationship (ER) modeling**, and convert it into a normalized relational database schema.

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2. Problem Statement

*"Design a database system for an **Online Bookstore** that manages books, customers, orders, and payments. The system should support functionalities like customer registration, book search, order placement, and payment tracking."*

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3. Theory

3.1 ER Modeling

- **Entity**: Real-world object (e.g., Book, Customer, Order, Payment).
- **Attributes**: Properties of entities (e.g., Book → ISBN, Title, Price).
- **Primary Key**: Unique identifier for entity (e.g., ISBN for Book, Cust_ID for Customer).
- **Relationships**: Associations between entities (e.g., Customer *places* Order).
- **Cardinalities**: One-to-One, One-to-Many, Many-to-Many.
- **Generalization/Specialization**: Hierarchical relationships (e.g., Payment → Online Payment, Cash Payment).

3.2 Conversion from ER to Relational Model

- Strong Entity → Table with PK.
- Weak Entity → Table with PK + FK.
- Relationship → Converted based on cardinality.

3.3 Normalization

Process of organizing data to reduce redundancy and dependency.

- **1NF**: Remove multivalued attributes; ensure atomic values.
- **2NF**: Remove partial dependencies (non-key attribute depends on part of composite key).
- **3NF**: Remove transitive dependencies (non-key depending on another non-key).
- **BCNF**: Every determinant is a candidate key.

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4. Tools Used

- **ERDPlus** (Free online tool: https://erdplus.com)
- **ERWin / Draw.io / Lucidchart** for ER diagrams

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5. Procedure

1. **Case Study Selection**
   - Select a real-world domain (e.g., Bookstore, Hospital, Library, Banking).
   - Define scope and functional requirements.
2. **Identify Entities and Attributes**
   - Example (Bookstore): Book (ISBN, Title, Author, Price), Customer (Cust_ID, Name, Email), Order (Order_ID, Date), Payment (Pay_ID, Type, Amount).
3. **Identify Relationships**
   - Customer *places* Order
   - Order *contains* Book (M:N relationship resolved by Order_Details)
   - Order *has* Payment
4. **Draw ER Diagram**

- Using ERDPlus / ERWin.
- Show all entities, relationships, cardinalities, keys.

5. **Convert ER Diagram to Relational Schema**
   Example:
   - Customer(Cust_ID PK, Name, Email, Phone)
   - Book(ISBN PK, Title, Author, Price)
   - Order(Order_ID PK, Order_Date, Cust_ID FK)
   - Order_Details(Order_ID FK, ISBN FK, Quantity)
   - Payment(Pay_ID PK, Pay_Type, Amount, Order_ID FK)
6. **Normalization Steps**
   - Apply 1NF, 2NF, 3NF to ensure optimized schema.
   - Justify removal of redundancy.

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6. Equations / Rules Applied

- **Functional Dependency (FD):**
  If X → Y, then attribute Y is functionally dependent on X.
- **Keys:**
  - Candidate Key: Minimal set of attributes uniquely identifying a tuple.
  - Primary Key: Chosen candidate key.
- **Normalization Rules:**
  - 1NF: Eliminate repeating groups.
  - 2NF: Eliminate partial dependencies.
  - 3NF: Eliminate transitive dependencies.

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7. Sample Output

ER Diagram (Bookstore Example)

[Here students will paste ERD diagram created in tool]

Normalized Relational Tables

- Customer(Cust_ID PK, Name, Email, Phone)
- Book(ISBN PK, Title, Author, Price)
- Order(Order_ID PK, Order_Date, Cust_ID FK)
- Order_Details(Order_ID FK, ISBN FK, Quantity)
- Payment(Pay_ID PK, Pay_Type, Amount, Order_ID FK)

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8. Conclusion

In this experiment, we successfully designed a **conceptual schema** for a real-time application using ER modeling, converted it into a **normalized relational model**, and applied database normalization principles up to **3NF**. This lays the foundation for developing a complete mini-project backend system.
