

Subject: Introduction to Databases
Subject code: CSE 3151
Theory Assignment 1

Submission Date: 10-04-2025

This assignment is designed to give you practice with the concepts of

- Database design using entity relationship model
- Mapping an ER diagram to relational model
- Constructing schema diagram of a database
- Key terms related to normalization such as functional dependency, attribute closure, canonical cover etc.
- Designing relational database schema using decomposition and normalization techniques

1. Design a database for an online bookstore using ER model. The bookstore includes information about the books, author, publisher, and customer. Each book is represented by its ISBN number, title, year and price. Each book has a unique ISBN number. Author of the book is characterized by author_id, name and address. Each author has a unique author_id. Address of the author includes city, state, country and pin_code. The association of author and book is represented by the relationship named as written_by. One book may have more than one author. Many books written by same author is available in the store. The publisher of the Book is represented by its name, address, phoneno. Publishers are uniquely identified by its name. One publisher may have multiple phoneno.s. Address of the publisher includes city, state, country and pin_code. The association of publisher and book is represented by the relationship named as published_by. One book is published by exactly one publisher. The customer of the store is represented by its email, name, address, phoneno. Each customer should have one unique email. Address of the publisher includes city, state, country and pin_code. One phoneno. is included for each customer in the database. Customer has a shopping_basket. The shopping_basket is represented by its basket_id. Association between customer and shopping_basket is represented by the relationship named as basket_of. One customer has exactly one shopping_basket. The shopping basket may contain many books. Same book can be included in multiple shopping_baskets. Association between book and shopping_basket is represented by the relationship named as contains. When book is added to shopping_basket a number field associated with relationship contains is updated. Draw the ER diagram for the above online bookstore representing entity set, relationship set, mapping cardinality and participation constraint.
2. Map the following ER diagram (Figure 1) to its corresponding relational schema. Also indicate the primary key and foreign key for the relational schema.

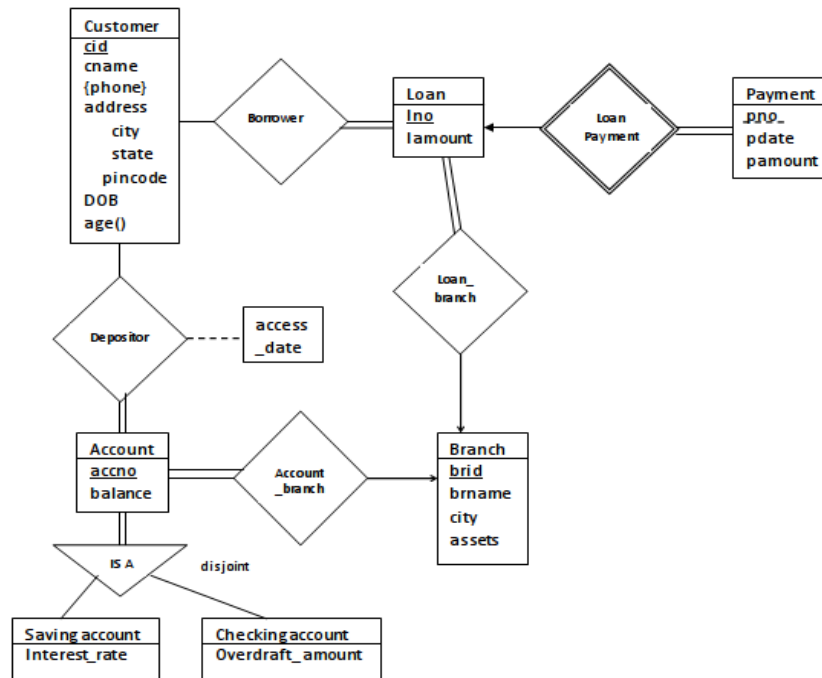


Figure 1.

3. Draw the schema diagram for the relational schema resulted in question 2.
4. Compute the closure of the following set F of functional dependencies for relation schema $r(A, B, C, D, E, F)$.

$A \rightarrow BC$
 $CD \rightarrow E$
 $B \rightarrow D$
 $E \rightarrow A$

List the candidate keys for r.

5. Consider the relation schema Student mark (regd, name, course_id, title, grade) with functional dependency set $F = \{\text{regd} \rightarrow \text{name}, \text{course_id} \rightarrow \text{title}, (\text{regd}, \text{course_id}) \rightarrow \text{grade}\}$. In what normal form the relational schema is in? Comment whether it satisfies 2NF or not with reason. If it is not in 2NF, find the 2NF decomposition of the schema and check the properties of decomposition.
6. Consider the relation schema Book (Title, Author, Catalog_no, Publisher, Year, Price) with functional dependency set $F = \{(\text{Title}, \text{Author}) \rightarrow (\text{Catalog_no}, \text{Price}), \text{Catalog_no} \rightarrow \text{Title}, \text{Catalog_no} \rightarrow \text{Publisher}, \text{Catalog_no} \rightarrow \text{Year}, \}$ Comment whether it satisfies 3NF or not with reason. If it is not in 3NF, find the 3NF decomposition of the schema and check the properties of decomposition.
7. Consider the following set F of functional dependencies on the relation schema $r(A, B, C, D, E, G)$: $F = \{A \rightarrow BCD, BC \rightarrow DE, B \rightarrow D, D \rightarrow A\}$

- a) Prove (using Armstrong's axioms) that AG is a super key.
 - b) Compute a canonical cover for the above set of functional dependencies F; give each step of your derivation with an explanation.
 - c) Give a 3NF decomposition of R based on the canonical cover
 - d) Find the BCNF decomposition of the schema r.
8. Consider the relation schema r (PAN, PI, DI, DRUG, QTY, COST) with functional dependency set

$$F = \{ \text{PAN} \rightarrow \text{PI}, \\ \text{PI} \rightarrow \text{DI}, \\ (\text{PI}, \text{DRUG}) \rightarrow \text{QTY}, \\ (\text{DRUG}, \text{QTY}) \rightarrow \text{COST} \}$$
 - a) Comment whether it satisfies 3NF or not with reason. If it is not in 3NF, find the 3NF decomposition of the schema and check the properties of decomposition.
 - b) Comment whether it satisfies BCNF or not with reason. If it is not in BCNF, find the BCNF decomposition of the schema and check the properties of decomposition.
9. A database of research articles in a journal uses the following schema.
 (VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, YEAR, PRICE)
 The primary key is (VOLUME, NUMBER, STARTPAGE, ENDPAGE) and the following functional dependencies exist in the schema.
 (VOLUME, NUMBER, STARTPAGE, ENDPAGE) \rightarrow TITLE
 (VOLUME, NUMBER) \rightarrow YEAR
 (VOLUME, NUMBER, STARTPAGE, ENDPAGE) \rightarrow PRICE
 the database is redesigned to use the following schemas.
 (VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, PRICE)
 (VOLUME, NUMBER, YEAR)
 Which is the weakest normal form that the new database satisfies, but the old one does not?
10. Consider the following schema, with given constraints:

books(accessionno, isbn, title, author, publisher)

users(userid, name, deptid, deptname)

accessionno \rightarrow isbn

isbn \rightarrow title

isbn \rightarrow publisher

isbn $\rightarrow \rightarrow$ author

userid \rightarrow name

userid \rightarrow deptid

deptid \rightarrow deptname

 - a. What is the highest normal form whose properties are satisfied by the schemas?
 - b. Normalize the schemas with given constraints to 4NF.

-----**End**-----