

including concurrency control, backup and recovery.

5. Review the fundamental view on unstructured data and describe other emerging database technologies.

Section - I

Answer all Questions (2 × 15 Marks)

*M - Marks

*M CO BL

15 1,2 6

Q.No

Question

01. a) Construct the Entity Relationship (ER) diagram that could be the foundation for building a relational database to store and query data in the online bookstore system. On the book_store database, each book in the store's inventory has attributes such as year, title, price, and a unique ISBN. Books are stored in one or more warehouses, with a specific quantity of each book kept in stock. Each book is written by one or more authors. The store keeps information about each author, including their name, address, and URL (e.g., a personal website or profile). Each book is also published by a publisher. Each publisher has a name, address, phone number, and URL (e.g., a company website). Books are stored in multiple warehouses. Each warehouse has a unique code, address, and phone number. The store maintains the stock levels of each book in each warehouse, allowing it to manage inventory effectively. Customers register on the store's platform with their name, address, phone number, and email. Customers can add books to their shopping baskets, where each basket is identified by a basket_ID. The basket-of relationship associates each shopping basket with a specific customer. The contains relationship keeps track of the books in each shopping basket, including the quantity (or number) of each book added. The system would support functionalities such as:

- Displaying available books and authors.
- Checking stock levels in warehouses.
- Tracking customer orders and contents of shopping baskets.

For the given scenario, specify the key attributes, and add all possible notations of the ER and the Extended ER diagram by assuming the required attributes/ entities/ relationships/mapping cardinalities, specialization/ generalization of your choice. (10 Marks)

b) Convert the following functional dependencies into relational schema and identify the key attributes and the non-key attributes (5 Marks)

$AB \rightarrow C$

$AB \rightarrow D$

$A \rightarrow E$

$B \rightarrow F$

$AB \rightarrow G$

$C \rightarrow E$

$D \rightarrow F$

$C \rightarrow G$

$E \rightarrow G$

$F \rightarrow G$

02. Consider the following social media database

user(user_id, user_name, email, date_joined)

post(post_id, user_id, content, post_date)

comment(comment_id, post_id, user_id, comment_content, comment_date)

friendship(user_id1, user_id2, friendship_date)

like(like_id, post_id, user_id, like_date)

a) Write the SQL query for the following:

(i) Add a check constraint to accept the *comment_date* greater than the current date. (1 Mark)

(ii) Drop the primary key constraint set to *user_id* (2 Marks) [Note: Assume that the table is already created. A parent key cannot be dropped without dropping the reference key]

(iii) Add a not null constraint to *post_date* (1 Mark)

(iv) Add a default constraint to any of the attributes of your choice (1 Mark)

b) Write relational algebra expressions for the following (5*2=10 Marks)

(i) List the content of the comment posted by the user 'jack' who created the post on 24th July 2024.

(ii) Count the number of comments posted by the friends on the same post

(iii) Find the user's email ID who has not given a single like to any of the comments

(iv) Find the name of the user who has given a maximum like and a minimum number of comments

(v) List the names of the users with more than 1000 friends

Section - II

Answer all Questions (7 × 10 Marks)

*M - Marks

Q.No

Question

*M CO BL

03. Imagine a Library Management System (LMS) used by a large university library. The library has a massive collection of books, journals, and digital resources, all stored and managed in a database. The system should support various user roles, including librarians, library patrons, and system administrators, each with different permissions and functionalities. Librarians have to add, update, or delete book records, while patrons search, view, and reserve books. Administrators manage user roles and monitor the system's performance. For the given LMS scenario,

a) Design an architecture and illustrate the components and layers of its structure with a detailed diagram. (6 Marks)

b) Discuss the User layer, DBMS components, data storage layer, query processor, storage manager, and data storage. (4 Marks)

04. Decompose the art relational schema until it reaches its highest normal form, based on the specified functional dependencies (FD). Justify your answer for each decomposition and specify which normal form does it violates.

10 1 2

10 2 1

Art(Art_ID, Title, Artist_ID, Artist_Name, Year_Created, Style, Gallery_ID,
Gallery_Name, Location, Exhibition_ID, Exhibition_Date, Price)
Art_ID → Title, Year_Created, Style
Artist_ID → Artist_Name
Gallery_ID → Gallery_Name
Exhibition_ID → Exhibition_Date
Gallery_Name → Location
Art_ID, Exhibition_ID → Price

05. Consider the following functional dependencies:

A → B
A → D
B → D
A → D
AC → E
AB → F
BD → C

- a) Find the minimal cover from the functional dependencies by removing the extraneous attributes and redundancies. (6 Marks)
b) Imagine you are a database designer tasked with ensuring the integrity of data in a new database system. Explain how you would use Armstrong's Axioms (Reflexivity, Augmentation, and Transitivity) to validate and derive additional functional dependencies from the minimal cover you found in subdivision 5(a) and specify the order in which the axioms are used. Justify your answer. (4 marks)

06. Consider the employee relation

Employee ID	First Name	Last Name	Department	Position	Salary
11	John	Doe	Sales	Sales Manager	75000
12	Jane	Smith	Marketing	Marketing Specialist	65000
13	Alice	Johnson	HR	HR Manager	70000
14	Bob	Brown	IT	Software Engineer	80000
15	Charlie	Davis	Sales	Sales Associate	55000
16	Eve	Wilson	IT	System Administrator	60000

Use both dense and sparse indexing for each of the following updates in the index (5*2=10 Marks)

- a) create an ordered index for the *department* domain.
b) Add a record for the department 'Music'
c) Add a record for the department 'IT'
d) Delete the employee 'Jane' who belongs to the 'Marketing' department
e) Delete the System 'Administrator' position from the 'IT' department

07. Consider the following schedules:

Schedule 1 - T1: W(X)T2: R(X)T2: W(Y)T2: CommitT1: Abort
Schedule 2 - T1: W(X)T2: R(X)T1: W(Y)T3: R(Y)T1: Abort
Schedule 3 - T1: W(X)T1: CommitT2: R(X)T2: W(Y)T2: Commit
Schedule 4 - T1: W(X)T2: R(X)T3: R(X)T1: W(Y)T2: W(Z)T1: Abort
Schedule 5 - T1: W(X)T2: R(X)T2: W(Y)T3: R(Y)T2: CommitT1: Abort

- a) Determine whether each schedule is recoverable or non-recoverable. Explain your reasoning for each schedule. (5 Marks)
b) Analyze whether the given schedules are cascading or not. If a schedule is cascading, explain what that means in terms of transaction management. (5 Marks)

08. You are a database administrator for a banking application that manages account transactions. Two users, Alice and Bob, are attempting to transfer money between their accounts simultaneously. Alice wants to transfer Rs.1000 from her account (Account A) to Bob's account (Account B), while Bob is trying to transfer Rs. 500 from his account (Account B) to his own savings account (Account C). Given this scenario,

- a) Discuss the Two-Phase Locking (2PL) protocol for concurrency control in database systems based on the phases of 2PL, advantages, and potential drawbacks. (6 Marks)

b) Illustrate the interactions between Alice and Bob's transactions with shared data items using the 2PL protocol. (4 Marks)

09. a) Consider a MongoDB collection called students that stores student data with fields: name, age, grade, and subjects (an array of subjects they are enrolled in). Write the MongoDB queries for the following operations:

(i) Insert a new student document. [1 Marks]

(ii) Update the grade of a student named "Jack" to "A+". [1 Marks]

(iii) Delete a student record where the name is "Jill". [1 Marks]

(iv) Retrieve a list of students sorted by age in descending order. [2 Marks]

b) A social media platform stores user profiles, posts, and comments. Every user has a profile with information like username, bio, and friends. Each post contains text content, timestamps, and embedded comments that include a user, text, and timestamp. Design a suitable MongoDB schema for user profiles, posts, and comments. [5 Marks]

BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)

