Y/K/TX

Reg. No:

Final Assessment Test – November 2024

VIT® Vellore Institute of Technology

Course: BCSE302L - Database Systems

Class NBR(s): 1509/1516/1527/1532/1536/1543/1547/ 1553/1557/1566/1578/1599/1609/1646/1659/1678/ 1687/1700/1710/1723/1733/1762

Slot: A1+TA1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Discuss three-schema architecture used in database management. What are the key components, and how do they interact with each other? Why do we need mappings between schema levels?

2. Design an Entity-Relationship Diagram (ER Diagram) for a Hospital Management System (HMS) that enables the registration and management of patient information, including demographics, medical history, and current condition, while featuring a doctor directory that maintain details such as specialties, contact information, and availability. The system should assist in room management by identifying available and occupied rooms, and handle nurse information, including departmental assignments and shift schedules. Additionally, it must provide functionality for generating, storing, and retrieving patient test reports with detailed results and dates, while managing records through unique identification numbers for easy reference. Billing functionality is crucial for handling billing information, including bill generation and payment tracking, and the system should support receptionist functions for retrieving patient data and scheduling appointments. Your task is to create an ER diagram that includes relevant entities, attributes and relationships, indicating cardinality and participation constraints.

3. Discuss the concepts of generalization and specialization in database design, using the extended entity-relationship model as a framework. Provide examples to illustrate these concepts and analyze the various types of constraints, including disjointness and completeness, and their impact on subclass relationships and the overall superclass structure.

4. Consider relation R(X,Y,Z,W,V) with the following functional dependencies:

   $X \rightarrow Y$

   $Y \rightarrow Z$

   $Z \rightarrow W$

   $W \rightarrow X$

   The decomposed Relations are R1(X,Y,Z)and R2(Z,W,V). Check if the given dependencies are preserved or not.

5. Consider the relation R(P,Q,R,S,T,U,V,W,X,Y)with the following set of functional dependencies:

PQ→R

P→ST

Q→UV

U→WX

S→Y

Normalize the schema into Third Normal Form (3NF). Provide the resulting relations and explain the decomposition process for any violations encountered.

6. Consider you are the database administrator for an e-commerce platform that processes customer orders and manages payment transactions. When users transfer funds between their accounts, the system ensures that funds are only deducted after the user confirms the transaction. Simultaneously, the platform allows customers to place orders, reflecting inventory changes in real-time to prevent overselling of items. To safeguard against system failures, the application creates backup copies of database pages for quick recovery. This layered database recovery approach aims to maintain data integrity and reliability while providing a seamless user experience, even in the event of a transaction error or system crash.

   i) Identify and describe the approach taken for handling fund transfers and explain why this method is suitable for the above scenario.

   ii) Explain the backup strategy implemented for recovering the database. How does this method enhance the recovery process, and what are its limitations?

7. Identify and justify how the following concurrency control problems affect data integrity and consistency in a multi-user environment.

S1: r1(x);r2(x);w1(x);r3(x);w2(x);c2;r4(x);w3(x);c3;w1(y);c1;

S2: r1(x);w1(x);r2(x);w2(x);c2;r3(x);c3;w1(y);c1;

S3: r1(x); w1(x); r2(x); w2(x); r1(x);

8. Explain the CAP theorem and its implications for distributed system databases. Analyze how the CAP theorem influences the database design choices of an online shopping platform, focusing on the trade-offs between consistency, availability, and partition tolerance.

9.a) Show the B+ tree that would be formed by inserting the month names (12 strings) into a tree in their normal calendar sequence (jan, feb, mar, apr, may, jun, jul, aug, sep, oct, nov, dec). After the construction, delete the entries for dec and mar.

OR

9.b) Insert the elements 15,20,25 and 30 into a hash table of size 10. Assume that the h1(k) = 2K+3. The hash value is calculated from the formula h1(k) % table size. The Tables do not need to be resized. If an element cannot be inserted successfully, state why. You need to display it up to the final table.

i) Perform quadratic probing

ii) Perform Double Hashing by using the secondary hash function h2(k) = 3K+1

10.a) i) Discuss different types of Two-Phase Locking (2PL) algorithms with an example.

Consider the following two transactions and schedule (time goes from top to bottom).

T1	T2
Read A	
Write A	
	Read A
	Read B
	Commit
Read B	
Write B	
Commit	

ii) Demonstrate how Two-Phase Locking (2PL) ensures a conflict-serializable schedule for the transactions mentioned above, using the notation $L_i[x]$ to indicate that transaction i acquires a lock on element x and $U_i[x]$ to indicate that transaction i releases its lock on x.

iii) Illustrate how using locks without 2PL can result in a schedule that is not conflict-serializable.

OR

10.b) Consider the following transactions with their respective timestamps:

T1: Timestamp = 150

T2: Timestamp = 250

T3: Timestamp = 350

Given the schedule of operations:

S: R1(X); R2(Y); W1(Z); R3(Y); W2(X); R1(Y); W3(Z)

i. Apply the Timestamp Ordering Protocol to determine the order of transaction execution.

ii. Identify which operations are allowed and which are aborted based on the protocol rules.

iii. Explain the reasons for any transaction aborts in the schedule and discuss how this affects the overall consistency of the transactions.

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