T/K/TY

Reg. No: 23BCT0133

Final Assessment Test - November 2025

VIT
Vellore Institute of Technology

Course: BCSE302L - Database Systems
Class NBR(s):1326/1330/1335/1341/1349/1353/1360/ 1366/1370/1372/1374/1377/1379/1383/1386/1389/ 1393/1402/1406
Slot: B2+TB2
Time: Three Hours
Max. Marks: 100

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

General Instructions:

1. Assume values when not given.
2. Draw diagrams wherever necessary.

COs	CO Statements
CO1	Comprehend the role of database management system in an organization and design the structure and operation of the relational data model.
CO2	Develop a database project depending on the business requirements, considering various design issues.
CO3	List the concepts of indexing and accessing methods.
CO4	Explain the concept of a database transaction processing and comprehend the concept of database facilities including concurrency control, backup and recovery.
CO5	Review the fundamental view on unstructured data and describe other emerging database technologies.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. "The three schema architecture is considered the backbone of data abstraction in database systems" CO1 BL2
Justify this statement by explaining the three levels of database architecture and discuss how this model ensures logical and physical data independence with suitable examples.

Design an ER diagram for a bank database system indicating entities, attributes, relationships and cardinalities. The bank maintains details of accounts, customers, loans, and payments. Each account has an account number and balance. Accounts are of two types: Savings Account and Current Account, which are specializations of the Account entity. Each customer has a unique customer ID, name, and address. A customer may hold multiple accounts, and an account may be jointly owned by more than one customer. Loans are identified by a loan number, amount, and type. A loan can have multiple payments, and each payment (with payment ID, amount, and date) is associated with exactly one loan. CO1 BL2

3. Elucidate the systematic steps involved in translating an ER diagram into its equivalent relational schema, supplementing your explanation for the question 2. CO1

4. Given a relation STUDENT_COURSE (StudentID, StudentName, CourseID, CourseName, InstructorID, InstructorName, InstructorDept). CO2
Normalize this relation step by step up to Third Normal Form with proper explanation clearly showing the functional dependencies at each stage and explaining the decomposition process. Illustrate the final set of relations obtained in 3NF. Justify your answer.

5. Examine multilevel indexing techniques employed in database systems, and illustrate each with appropriate real-world examples to demonstrate their practical application. CO

6. Consider the following database schema for a library: CO
   - BOOK(BookID, Title, PublisherID, Year)
   - PUBLISHER(PublisherID, PublisherName, Address)
   - MEMBER(MemberID, MemberName, MemberType)
   - BORROW(BookID, MemberID, BorrowDate, ReturnDate)

Using the above schema, express the following queries in Relational Algebra:

i. Retrieve the names of members who have borrowed the book titled "Database Systems".
ii. List all book titles published by the publisher named "Pearson".
iii. Find the names of members who have borrowed at least one book but have not yet returned it.
iv. For each publisher, display the publisher name and the total number of books published.
v. Retrieve the titles of books that have never been borrowed by any member.

7. Consider the following schedules of transactions in a database system: C
   i. S1 = r1(A); r2(A); w1(A); w2(A)
   ii. S2 = r1(X); w2(Y); w1(Y); r2(X)
   iii. S3 = r1(A); r2(B); w1(B); w2(A); r3(A); w3(B)

Transactions:

(T1: r(A); w(A); r(B); w(B))
(T2: r(B); w(B); r(A); w(A))

a) For each schedule, determine whether it is conflict-serializable.
b) For the schedules that are conflict-serializable, draw the precedence (serializability) graph and provide an equivalent serial schedule.
c) For the transactions T1 and T2, construct a conflict-serializable schedule and explain the steps you used to ensure serializability.
d) Explain the concept of conflict-serializability and how precedence graphs are used to verify it.

8. a) Illustrate the various states involved in database transaction. [5] CO4
b) Discuss the Shadow Paging technique in database management systems, elaborating on its working and significance in detail. [5]

9.a) A database system uses the Two-Phase Locking (2PL) protocol to manage concurrent transactions. Consider the following transactions:

- T1: Read(A); Write(A); Read(B); Write(B)
- T2: Read(B); Write(B); Read(C); Write(C)
- T3: Read(C); Write(C); Read(A); Write(A)

i. Draw a possible schedule of these transactions under 2PL.
ii. Show where deadlock can occur, if any.
iii. Suggest how deadlock can be avoided or resolved in this case.

OR

9.b) A database system implements multi-granularity locking (MGL) with lock modes: IS, IX, S, X, and uses a lock hierarchy (Database → Table → Page → Tuple).

Two transactions are running concurrently:

- T1: Needs to update a set of tuples in Table A.
- T2: Needs to scan Table A in shared mode to read all tuples.

i. Show the sequence of lock requests for both T1 and T2 under multi-granularity locking.
ii. Illustrate how intention locks help avoid deadlocks in this situation.
iii. Explain why MGL improves concurrency compared to simple table-level locking.

10.a) Explain the CAP Theorem in the context of NoSQL databases. How does it influence the design trade-offs in distributed systems?

OR

10.b) Differentiate the major types of NoSQL databases in terms of their data models, usage scenarios, and advantages, illustrating how each type serves specific application needs.

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