



VIT
Vellore Institute of Technology
(Promoted by the Vellore Education Trust, Vellore, Tamil Nadu)

Final Assessment Test – April 2026

Course: CBS1007 - Database Systems

Class NBR(s): 2069/2071

Time: Three Hours

Slot: A2

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

COs	CO Statements
CO1	Acquire a good understanding of the architecture and functioning of database management systems.
CO2	Ability to construct an ER model and derive the relational schemas from the model.
CO3	Analyse and apply the principles and practices of good database design.
CO4	Use the concepts of data normalization to analyse, measure and evaluate the performance of a database application
CO5	Ability to grant and revoke privileges and comprehend database recovery techniques.
CO6	Construct efficient SQL queries to retrieve and manipulate data as required.

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

Answer ALL Questions

(10 X 10 = 100 Marks)

- A university wants to design a scalable database system for student records, courses, and enrollments. The system should allow easy modification of schema without affecting application programs. Based on this scenario, explain the three-level architecture of DBMS. Illustrate how logical and physical data independence are achieved and why they are important in real-world applications.

CO1 BL1
- Explain the Object-Oriented Data Model with suitable examples. Discuss concepts such as objects, classes, inheritance, encapsulation, and polymorphism. Compare the object-oriented data model with the relational data model in terms of structure, flexibility, and real-world representation. Justify when each model is preferred.

CO1 BL2
- A smart city plans to develop a database system to manage its public transport network with the following requirements:

 - The city has multiple depots. Each depot maintains many buses. Each bus belongs to exactly one depot and has attributes: Bus_ID, Registration_No, Capacity, and Model.
 - The transport authority employs many drivers. Each driver is assigned to one depot, but a depot can have many drivers. A driver can drive different buses on different days, and a bus can be driven by different drivers over time. The system must record Date and Shift for each driver–bus assignment.

CO2 BL6

- The city operates multiple routes. Each route has Route_ID, Source, Destination, and Distance. A bus can operate on many routes, and a route can have many buses. The system records Departure_Time and Arrival_Time for each assignment.
- Passengers can purchase tickets. Each ticket has Ticket_ID, Journey_Date, Seat_No, and Fare. A passenger can buy many tickets, but each ticket is associated with one passenger, one bus, and one route.
- Each passenger has Passenger_ID, Name, Phone, and Email.

Perform the following
Draw a detailed ER diagram clearly showing entities, relationships, cardinalities, and participation constraints.

4. Consider the relation R(Order_ID, Order_Date, Customer_ID, Customer_Name, Product_ID, Product_Name, Quantity, Price, Supplier_ID, Supplier_Name, Discount) with the following set of functional dependencies $F = \{ \{Order_ID \rightarrow Order_Date, Customer_ID\}, \{Customer_ID \rightarrow Customer_Name\}, \{Product_ID \rightarrow Product_Name, Price\}, \{Order_ID, Product_ID \rightarrow Quantity\}, \{Supplier_ID \rightarrow Supplier_Name\}, \{Product_ID \rightarrow Supplier_ID\}, \{Order_ID \rightarrow Discount\} \}$

CO4 BL4

Perform the following:

- Find all the candidate keys for the relation R. Show the steps clearly. [2]
 - Identify the highest normal form satisfied by the relation. Justify your answer. [3]
 - Normalize the relation up to Third Normal Form (3NF), showing all intermediate steps (1NF $\rightarrow$ 2NF $\rightarrow$ 3NF). [5]
5. Consider the following university database schema:

CO3 BL6

STUDENT(SID, Name, DeptID, Year)
ENROLL(SID, CID, Grade, Semester)
COURSE(CID, Title, DeptID, Credits)

Write a query to find the names of students who satisfy the following conditions:

- Enrolled in the course 'DBMS'
- Secured Grade = 'S'
- Studying in the year 2025
- Belong to the same department that offers the course
- The course has credits ≥ 3
- The enrollment is in the Odd semester

Perform the following:

- Write the corresponding SQL query for the above requirement. [2]
- Convert the SQL query into an equivalent Relational Algebra expression. [1]
- Draw the initial query tree for the relational algebra expression. [2]
- Apply heuristic optimization techniques and draw the optimized query tree. [5]

CO4 BL4

6. Explain and compare the working of Nested Loop Join, Block Nested Loop Join, and Index Nested Loop Join. Analyze their cost and identify the most efficient method for large datasets.

CO5 BL5

- 7.a) An online banking system allows customers to transfer money and check account balances simultaneously. Two transactions operate on the same account balance:

- Transaction T1 transfers ₹500 from the account.
- Transaction T2 adds ₹200 as cashback to the same account.
- Both transactions read the same initial balance before updating it.

Perform the following tasks:

- Analyze how this situation can lead to a lost update problem with a suitable example. [3]
- Suggest an appropriate concurrency control mechanism to prevent this issue and explain how it works. [3]
- Explain how the system ensures that the final account balance remains consistent and correct after executing both transactions. [4]

OR

- 7.b) Consider the following schedule involving three transactions T1, T2, and T3 operating on the same data item A:

CO5 BL5

T1: Read(A), Write(A)
T2: Read(A), Write(A)
T3: Read(A), Write(A)

Schedule S:

T1: Read(A)
T2: Read(A)
T3: Read(A)
T1: Write(A)
T2: Write(A)
T3: Write(A)

Perform the following Tasks:

- Determine whether the given schedule is conflict serializable. Show the precedence graph and justify your answer. [3]
- Identify the type of concurrency anomaly that may occur in this schedule. [3]
- Transform the given schedule into an equivalent serial schedule and explain your reasoning. [4]

- 8.a) A hospital information system maintains patient records. Doctors can view and edit records, nurses can only view records, and patients can view their own data. Design a Role-Based Access Control (RBAC) model for this system. Clearly identify roles, permissions, and user-role assignments. Justify how RBAC improves security and management.

CO5 BL6

OR

- 8.b) An e-commerce website builds SQL queries dynamically based on user input as shown below:
SELECT * FROM products WHERE name = ' + user_input + '
A user enters the input: ' OR '1' = '1
As a result, the system returns all products, including restricted items.
- CO5 BL6
- i. Explain what an SQL Injection attack is. [4]
 - ii. Identify the type of SQL Injection used in this scenario. [3]
 - iii. Suggest appropriate techniques to prevent such attacks. [3]
9. A multinational retail company operates in multiple cities. Each branch stores customer and sales data locally, but headquarters needs global access to all data. To improve performance and availability, the system distributes data across locations and keeps some copies in multiple sites.
- CO6 BL2
- i. Describe the architecture of a Distributed Database System. [4]
 - ii. Explain how fragmentation is used to distribute data across branches. [3]
 - iii. Discuss how replication helps in improving system performance and reliability. [3]
10. A retail supermarket wants to analyze customer purchase data to identify which products are frequently bought together. The goal is to improve product placement and increase overall sales.
- CO6 BL6
- i. Identify the most suitable data mining technique for this scenario. [2]
 - ii. Justify why this technique is appropriate. Also, compare it with other data mining techniques and explain why they are less suitable for this task. [8]

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