



**Indian Institute of Technology Bhilai**  
**Department of Computer Science and Engineering**  
**Database Management Systems**  
**(CSL303/MAL505/CS254)**  
End-Semester, Date: December 01, 2025

Timing: 09:30 AM to 11:30 AM

2025-26-M Semester

Max mark: 60

1. A university database has the following relations:

Student(Roll, Name, Dept), Course(CID, Title, Dept), Registered(Roll, CID, Semester)

Write relational algebra expressions to find:

- (a) Names of students registered in all courses offered by their own department. (3)
- (b) Students who are registered for more than three courses in a semester. (3)

2. A school maintains the relation:

(4)

ClassInfo(ClassID, TeacherName, Subject, RoomNo, TeacherPhone)

Given:

TeacherPhone  $\rightarrow$  TeacherName, TeacherName  $\rightarrow$  Subject, ClassID  $\rightarrow$  RoomNo, TeacherName

Normalize the relation to BCNF and show each decomposition step.

3. Given the schema of a ride-sharing service:

Driver(DID, Name, Rating)

Ride(RideID, DID, Source, Destination, Fare, Date)

Write SQL queries to:

- (a) Display drivers who have completed more than 10 rides in the last month. (3)
- (b) Display drivers who have the highest average fare across all their rides. (2)

4. In a movie-booking platform:

(3)

Movie(MID, Title, Genre, ReleaseYear)

Show(SID, MID, Theatre, ShowTime)

Booking(BID, SID, UserID, SeatsBooked)

Write an SQL query to list the top 5 movies with the highest number of total seats booked, ordered by popularity.

5. A logistics company wants to track vehicles, drivers, shipments, and delivery times.

- Each shipment is transported by one vehicle and one driver.

- A driver can drive multiple vehicles over time.
- A shipment may pass through multiple hubs with timestamps.

Tasks:

- Draw an ER diagram capturing these constraints. (4)
- Convert the ER diagram to relational schema. (3)
- Identify anomalies and normalize the schema to 3NF. (3)

6. A food-delivery company stores orders in:

Order(OID, CustomerID, RestaurantID, OrderTime, TotalAmount)

OrderItem(OID, ItemID, Quantity, Price)

- Write a relational algebra query to find restaurants with average order value greater than Rs. 500. (3)
  - Write an SQL query to list the top 3 restaurants with the highest revenue in the last 7 days. (4)
  - Suggest indexing strategies to optimize both queries. (3)
7. What are the advantages of Reader-Writer locks for latches compared to simple blocking OS mutexes. (4)
8. Consider an implementation of 7-way external merge sort.
- How many buffer pool pages are required for a basic implementation. (2)
  - Consider that the I/O cost of 1 page is  $k$  times the amount of time required in computation (merge) of the tuples in page. What would be the theoretically optimum number of buffer pool pages required? (3)
  - If you decide to implement double buffering with the basic implementation of 7-way external merge sort, what would be the number of buffer pages required? (2)
  - If you have  $B$  buffer pages available, derive an equation for finding out the optimum value for  $m$  for doing  $m$ -way merge sort with double buffering. (2)
9. Consider executing a join operation on two tables  $R$  and  $S$ .  $R$  has 800 pages and 75000 tuples whereas  $S$  has 450 pages and 42000 tuples. The cost for index lookup on join attribute is 20 unit for  $R$  and 18 units for  $S$  on an average.
- Find the minimum cost of I/O required, when Naive Nested loops are used to perform join. (3)
  - Find the minimum cost of I/O required, when Block Nested loops are used to perform join. (3)
  - Find the minimum cost of I/O required, when Index Nested loops are used to perform join. (3)