Database Systems

A.Y. 2024/2025

Master Degree in Computer Science, written exam 16/01/2025 from 9:30 to 14:00.

	"Brightway"
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11 12 13	The company "Brightway" manages decentralized logistics operations through several operational centers distributed across regions, each responsible for handling local storage and shipments. Each operational center is characterized by a name, address, city/province, and number of employees. The company offers customized warehouse management services, including long-term storage and expedited shipping. Orders can be placed by customers via phone, email, or directly through the company's online platform. Each customer may have one or more business accounts, each identified by a unique code. Every order is associated with a single business account and includes details such as type, date, cost, and customer information. Orders can be of three types: regular, urgent, or bulk (large quantities). Operational centers have management teams, each identified by a unique code, name, and the number of operations handled. Teams consist of specialized personnel, and the number of members may vary depending on the required workload. Additionally, the company maintains a performance evaluation system that assigns a score to each team based on delivery times and customer feedback. Customers can be classified as individual or business, each identified by a unique alphanumeric code, with contact details and order history.

1) analyze these specifications, filtering the ambiguities present and then grouping them homogeneously. Represent the specifications with an ER diagram. Indicate the strategy followed in the conceptual modeling phase. Complete the schema documentation with any constraints not expressed by the conceptual ER schema. Do not report the full process but only the glossary, the skeleton schema and the final schema. *(7 points)*

2) Consider the conceptual scheme defined in the previous exercise. Suppose that the following operations are carried out on this data:
Operation 1: Register a new customer (10 times per day).
Operation 2: Add a new order (1,000 times per day).
Operation 3: Assign an order to a management team (500 times per day).
Operation 4: View the total number of operations handled by a specific team (200 times per day).
Operation 5: Print a list of teams sorted by their performance score (20 times per day).

Given that there are, on average, 150 active teams, each with a maximum of 8 members, and each team manages approximately 300 operations monthly, define the table of volumes and accesses for the conceptual schema. Then, design the logical schema of an object-relational database in UML. *(6 points)*

3) Consider the following relational database schema used to represent university course information:

Course (CourseID, Title, Credits, DepartmentID)
Enrollment (EnrollmentID, StudentID, CourseID, Grade)
Department (DepartmentID, Name, noEnrolledStudents, noCourses)

Define the SQL triggers that:

- Update the noEnrolledStudents field in the Department table whenever a student is enrolled in or removed from a course.
- Update the noCourses field in the Department table whenever a course is added or deleted. *(3 points)*

4) Given the query 4 of exercise 2, show a physical query plan for this query for a DBMS that allows primary heap data structures and secondary dense B+trees, assuming there are no indexes. For each intermediate partial result, report the expected size and for each step, the expected cost. Hint: start from the result of the algebraic optimization. *(6 points)*

5) Considering the database defined at exercise 1, identify some facts, measures and dimensions for possible analysis, and define the schema of a Data Warehouse. *(4 points)*

6) Describe the 2PC protocol *(4 points)*

7) Describe the classes of serializability for the schedules and the relationships among them. In addition, describe pros and cons of the verification of each class. *(3 points)*