UNIVERSITY OF BARISHAL

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

FINAL EXAMINATION

2nd Year 1st Semester, Session: 2021-22

Course Title: Database Management System

Course Code: CSE-2101

Time: 3 hours Marks: 60

Instructions:

- ✓ Answer any **FIVE** questions from the followings.
- ✓ All the parts of a question must be answered sequentially.
- ✓ Figures in the right margin indicate full marks.
- ✓ Keep your answer script clean and free from overwriting.

---

1. a) Define a database and explain its advantages over traditional file systems. [3]

b) Differentiate between database schema and database instance with an example. [3]

c) Describe the role of a database administrator (DBA). What are their key responsibilities? [3]

d) Suppose you are tasked with designing a food delivery platform similar to "Foodpanda." Consider the disadvantages of using a file-processing system to manage the platform's data. Discuss the relevance of each disadvantage to the storage of: [3]

1. Actual food images and menus uploaded by restaurants.
2. Metadata about orders, such as customer details, delivery addresses, order history, and payment status.

2. a) What are the constraints used in E-R model? Explain the participation constraints in E-R model. [3]

b) We can convert any weak entity set to a strong entity set by simply adding appropriate attributes. Then, why do we have weak entity sets? [3]

c) Let R = (P, Q, S, T). If **PQ** and **QS** can uniquely identify a tuple in the relation ***r(R)*** separately, then find out the super keys, candidate keys and primary keys. [2]

d) Consider two E-R models X and Y. Model X consists of two entities and one relationship joining them. The entities are **student** and **course**, and the relationship is **enrolls_in**. Model Y consists of three entities; the first and the third are the same as above, but the second entity is called **enrollment**. The first and second entities are joined by a relationship called **registers**, while the second and the third entities are joined by a relationship called **belongs_to**. [4]

Which of the following statements are correct? Briefly justify your answers:

(i) Both models allow a student to enroll in the same course multiple times (e.g., in different semesters).

(ii) Model Y is more appropriate if information about enrollment date and semester needs to be stored.

(iii) Model X does not allow storage of additional details about each enrollment, such as grades or payment status.

(iv) Model Y leads to more tables than Model X does when translated to the relational model.

3. Universities in Bangladesh are facing challenges in appointing Vice-Chancellors (VCs) due to the lack of a systematic and transparent process. To address this issue, a database system is proposed to manage a **VC Pool**, from which suitable candidates can be identified and appointed. This system should store comprehensive information about potential Vice-Chancellors to ensure they meet the necessary academic, administrative, and ethical standards. [12]

The database must capture the following details:

1. Candidate Information:
    - Each candidate has a unique ID, name, date of birth, and contact details.
    - Educational qualifications, including degrees, institutions, years of graduation, and specializations.
    - A record of their academic designations (e.g., Lecturer, Associate Professor, Professor) and the years they served in each role.
2. Research and Publications:
    - Details of research projects, including project title, funding source, duration, and outcomes.
    - A list of publications, including titles, publication dates, journal names, and co-authors (if any).
3. Administrative Roles:
    - Information about administrative positions held, such as Dean, Department Head, or Committee Chair, including the start and end dates for each role.
    - Achievements or initiatives undertaken during these roles.
4. Voluntary Services:
    - Participation in voluntary services, including events, organizations, and social contributions.
    - Awards or recognitions for their service.
5. VC Appointments:
    - A history of prior VC appointments, if applicable, with the university name, appointment duration, and key achievements.
6. University Requirements:
    - Each university has a unique ID, name, and type (e.g., public, private).
    - Requirements for appointing a VC, such as minimum qualifications, years of experience, and key skills needed.

The system must allow searching for suitable candidates based on their qualifications, research expertise, administrative experience, and availability. It should also maintain a log of candidates who have previously been considered or appointed.

Develop a complete E-R diagram (including cardinalities and participation). Make reasonable assumptions during your development phases, if needed and state them clearly.

4. a) Is it important to have a FD in each table? Why or why not? [2]

b) Consider a relational schema R with attributes A, B, C, D, E, and the ***F1*** are:

$A \rightarrow B$

$B \rightarrow C$

$A, C \rightarrow D$

$D \rightarrow E$

(i) Find Out the Candidate Keys? [2]

(ii) Prove whether the following functional dependencies (F2) are equivalent to the given set of functional dependencies (F1). ***F2*** *are:* $A \rightarrow C$; $A \rightarrow E$; $B \rightarrow D$; $A,B \rightarrow E$ [3]

c) Consider the following relation: [5]

Book_Seller (ISBN_No, salesman, sold_date, commission, discount_amount)

Assume that a book may be sold by multiple salesman and hence (*ISBN_No, salesman*) is the primary key. Additional dependencies are-

ISBN_No → sold_date
ISBN_No → discount_amount
Sold_date → discount_amount
Salesman → commission

Based on the given primary key and functional dependencies, is the relation in 1NF, 2NF, 3NF? Why or why not? How would you successively normalize it completely?

5. a) Consider the following schema and give an expression in SQL for each of the following queries: [10]

courses(<u>id</u>, title, course_code, course_level, credits, *instructor_id*)
instructors(id, name, email, designation, phone, salary)
learners(<u>id</u>, name , roll, email, date_of_birth, city)
enrollments(<u>id</u>, *students_id, course_id,* enroll_date, status)
assessments(<u>id</u>, *course_id,* assessment_title, total_marks)
results(<u>id</u>, *student_id, assessment_id,* obtained_marks)

I. Find the list of students who enrolled in Database course.

II. How many students enrolled in all courses?

III. How many students enrolled for course having id 2?

IV. Find the list of senior trainers who get salary more than 50,000.

V. Retrieve the list of learners and show them sorted alphabetically by their city.

VI. Increase the salary by 5% for those instructors who earn less than 50,000.

VII. What are the total marks for the students with id 3?

VIII. What are the mark assessment criteria?

IX. Show the list of all basic courses that are taken by instructor with id 1.

X. Find the list of employees who get more than average salary.

b) Explain the difference between GROUP BY and ORDER BY clauses in SQL. [2]

6. a) Consider a banking system where transactions are used to process customer deposits and withdrawals. Each transaction involves updating customer balances in the database. The system must ensure that the ACID properties are adhered to during these operations. [6]
In the system, the following operations are performed:

1. A customer deposits money into their account.
2. A customer withdraws money from their account.
3. If a transaction fails during any of the above operations (due to system crash, network issue, or power failure), the system must revert to its previous state before the transaction.

Analyze the following scenarios and discuss how each ACID property is maintained or violated:

(i) A transaction involving a deposit of $1000 is recorded, but due to a network failure, the withdrawal step is not completed. The system must ensure that either the entire transaction is committed or none of it is.

(ii) After a customer withdraws $500, the system must ensure that the account balance remains consistent with the defined business rules (e.g., no overdraft beyond the allowed limit). If a withdrawal leads to an inconsistent state (e.g., negative balance), the transaction must be rolled back.

(iii) Two customers attempt to withdraw money from the same account simultaneously. One transaction reads the current balance, but before updating, the second transaction reads the same balance, leading to an incorrect withdrawal amount. How does the isolation property ensure these transactions do not interfere with each other?

(iv) After a successful transaction that deposits $2000 into an account, the system crashes. Upon restarting, the database must reflect the transaction as committed, ensuring that the deposited amount is still recorded. How does durability ensure that once a transaction is committed, it is not lost?

b) Consider two transactions T1 and T2. T1 transfer $50 from account A to account B and T2 transfers 10% of the balance from account A to account B. Complete Transactions T1 and T2. [3]

c) Check whether the schedule is conflict serializable or not? [3]
S : R2(A); W2(A); R3(C); W2(B); W3(A); W3(C); R1(A); R1(B); W1(A); W1(B)

7. a) The following set of key values are given for constructing B+ tree: [6]

(3, 10, 17, 23, 28, 31, 41, 45, 51, 59, 61, 65, 70)

Assume that the tree is initially empty and values are added in ascending order. Now construct B+ tree such that maximum three pointers are fitted in each node.

b) Consider an **online ticket reservation system** where two users, Alice and Bob are trying to reserve tickets for the same program. The program has a total of 100 tickets available, and the current number of available tickets is 50. [4]

The following sequence of events occurs:

1. **Transaction T1**: Alice starts the process of reserving 30 tickets. The system reads the available ticket count (50), and Alice's reservation request is logged. However, before the transaction is committed, Alice's session is interrupted.
2. **Transaction T2**: Bob starts the process of reserving 20 tickets. The system reads the available ticket count (50) (since Alice's transaction hasn't been committed), and logs Bob's request. Bob's reservation is successfully committed, reducing the available tickets to 30.
3. **Transaction T1**: Alice's transaction now resumes and tries to commit her reservation of 30 tickets. However, the system attempts to reduce the available ticket count from 50 to 20, even though Bob has already committed his transaction, which has reduced the tickets to 30.

Analyze the scenario above and identify whether it represents a **dirty read** problem or a **lost update** problem. Briefly explain your reasoning for each problem and the issues that arise from them.

c) When is it preferable to use a dense index rather than a sparse index? Explain your answer. [2]

8. a) How many attributes you can use in a table? Is there any limitations? Why you need to split the attributes in multiple tables? [4]

b) Describe the states of a Transaction. [4]

c) Define primary indexing. Differentiate between secondary and clustering indexing. [4]

Good Luck!!!