University of Colombo, Sri Lanka

University of Colombo School of Computing

BACHELOR OF SCIENCE IN COMPUTER SCIENCE

Second Year Examination - Semester II - UCSC AY19 [held in March/ April/May 2023]

SCS2209 — Database II

(Two (2) Hours)

Answer ALL questions

Number of Pages = 15   Number of Questions = 4

176

Important Instructions to candidates:	To be completed by the examiners

Important Instructions to candidates:

I. Students should answer in the medium of English language only using the space provided in this question paper.

II. Note that questions appear on both sides of the paper. If a page or a part of this question paper is not printed, please inform the supervisor immediately.

III. Write your index number CLEARLY on each and every page of this Question paper.

IV. This paper consists of 4 questions on 15 pages (including the Cover Page).

V. Answer ALL questions.

VI. Programmable Calculators and any electronic device capable of storing and retrieving text including electronic dictionaries, smart watches and mobile phones **are not allowed.**

VII. **Non-Programmable calculators are allowed.**

VIII. Do not tear off any part of this answer book. Under no circumstances may this book, used or unused, be removed from the Examination Hall by a candidate.

To be completed by the examiners

1	
2	
3	
4	
Total	

Question 1

(a) Consider the following SQL table declarations for three tables T1, T2, and T3 to answer questions (i) and (ii).

```
CREATE TABLE T1 (A INT PRIMARY KEY);

CREATE TABLE T2 (B INT PRIMARY KEY, FOREIGN KEY (B) REFERENCES
T1(A) on UPDATE CASCADE);

CREATE TABLE T3 (C INT PRIMARY KEY, FOREIGN KEY (C) REFERENCES
T2(B) on UPDATE CASCADE);
```

Let the initial contents of the tables be:

T1 (A) = {(1), (2), (3), (4), (15), (5), (17), (11), (19)}
T2 (B) = {(1), (2), (4), (5), (15), (17)}
T3(C) = {(1), (2), (5), (15)}

Suppose the following SQL modification command is executed.

```
UPDATE T1 SET A = A + 5 WHERE A < 10;
```

(i) What would be the result if the following command is executed?

```
SELECT SUM(B) FROM T2;
```

[3 Marks]

(ii) What would be the result if the following command is executed?

```
SELECT SUM(C) FROM T3;
```

[3 Marks]

(b) Consider the following University schema. Primary Keys are underlined and Foreign Keys are in italics.

Lecturer (<u>EmpNo</u>, Name, Gender, Salary, Category, *DNo*)
Department (<u>DNo</u>, Dname, *HeadEmpNo*)

Write a SQL query to retrieve the department name and the number of its lecturers who are earning a salary of more than LKR 350000 from the departments that has more than five lecturers.

[3 Marks]

(c) Consider the following database schema. Primary Key is underlined.

Employee (<u>EmpNo</u>, Fname, Lname, Gender, Salary, Address)

The database administrator created an extract copy of the Employee table as **EmployeeNew** to manipulate the employee details (inserting new employees and deleting the existing employees according to the new recruitments, resignations, and retirements) on 31/12/2022. No, update was done for the Employee table afterwards. The database administrator wanted to find out the EmpNo, Fname, and Lname of **newly inserted employees** and **deleted employees** from the EmployeeNew table compared to the Employee table. Write the SQL query to achieve this task.
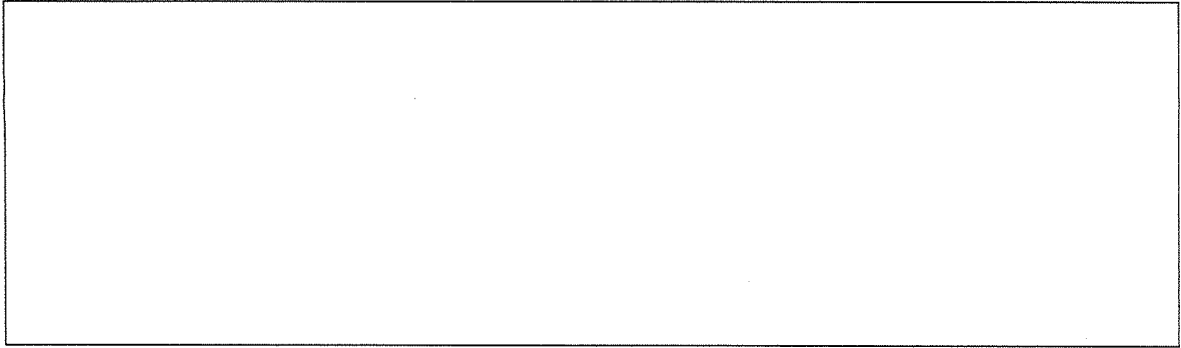
[4 Marks]

(d) Suppose that we have an ordered file with r = 30,000 records stored on a disk with block size B = 512 bytes. File records are of fixed size and are unspanned, with record size R = 150 bytes.
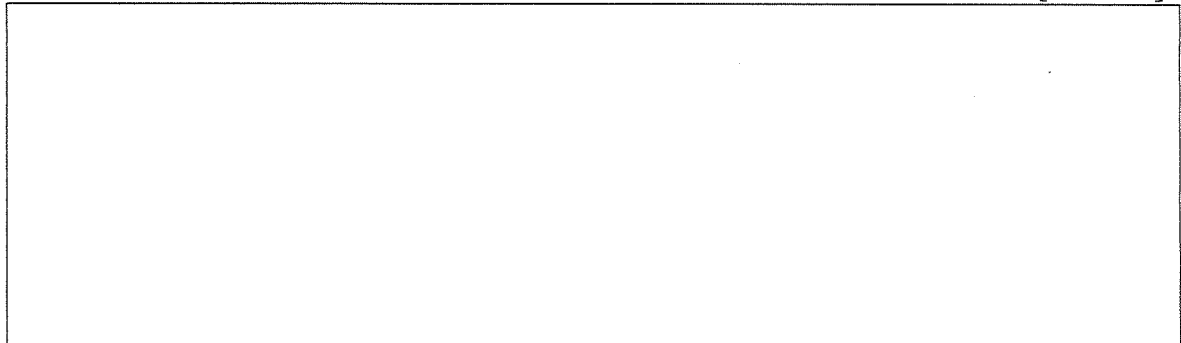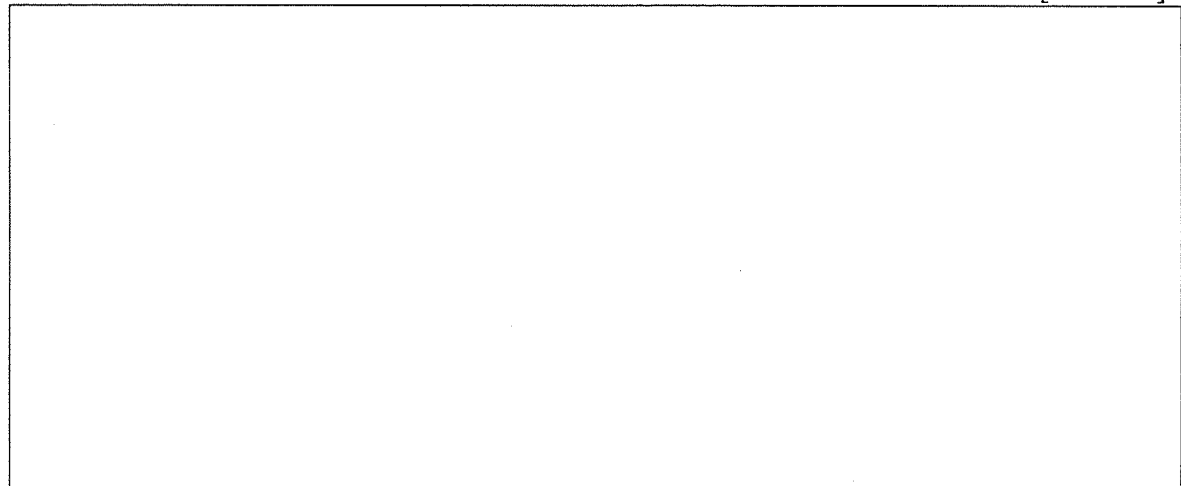
(i) Calculate the blocking factor/ BFR.

[3 Marks]

(ii) How many block accesses are required to search a record on the data file using the binary search?

[4 Marks]

(iii) Suppose that the ordering key field of the file is V = 9 bytes long, a block pointer is P = 7 bytes long, and we have constructed a primary index for the file. How many block accesses are required to search a record using the index?

[5 Marks]

Question 2

(a) Write the SQL query to create the Department table with the following constraints.

Department (deptID, deptName, location, deptHead, numEmployees)
- deptID is a number used as the primary key.
- deptName cannot be null
- Default location to be 'Colombo'
- deptHead specifies a unique number
- numEmployees should be a number between 1-25

[4 Marks]

(b) Consider the following relational schema.

Product (PCode, QOH, PMin, Price, MinOrder, Reorder)

Write a statement-level trigger to execute after an update of QOH or PMin for an existing row or after an insert of a new row in the Product table. The trigger action should execute an update statement that compares QOH with the PMin column. If the value of QOH is equal to or less than PMIN, the trigger should update the Reorder to 1.
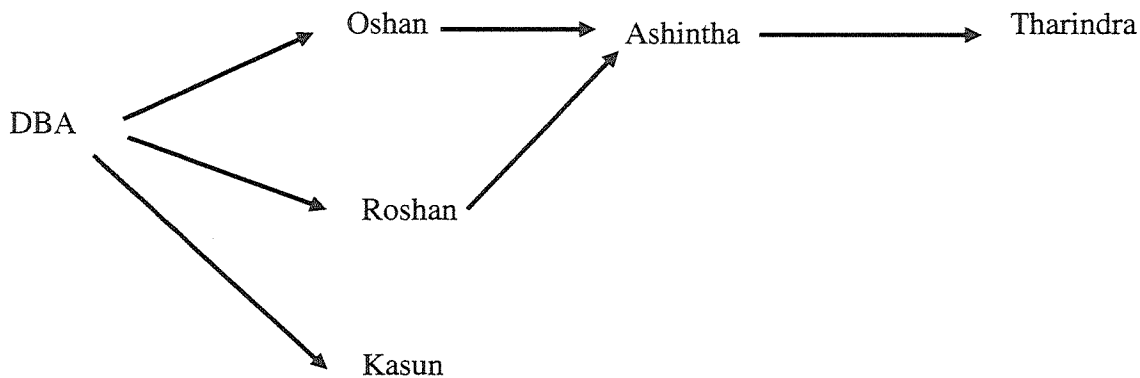
[5 Marks]

(c) Briefly explain the three (3) main goals of database security.

[3 marks]

(d) A bank maintains a database to keep track of customer, branch, account, and loan information. The corresponding bank relational schema is given below. Primary Keys are underlined and Foreign Keys are in italics.

Branch (<u>Code</u>, BranchName, City, Assets)
Account (<u>AcctNo</u>, Balance, Acc-type, BranchName)
Loan (<u>LoanNo</u>, Amount, Loan-type, BranchName)
Customer (<u>CustomerNo</u>, Name, Address, Phone)
C_A (*CustomerNo*, *AcctNo*)
C_L (*CustomerNo*, *LoanNo*)

Privileges are granted to users of the database as shown in the authorization diagram.

(i) Roshan can retrieve the name of each customer and loan details who has a loan but does not have an account at the bank. Write the SQL query to grant that privilege to Roshan.

[4 Marks]

(ii) Ashintha can retrieve the LoanNo, the Name, and the loan Amount of each customer at the Colombo branch who only has loans but no accounts at the bank. Write the SQL query to grant that privilege to Ashintha.

[3 Marks]

(iii) To revoke the privileges of Oshan, the following command is issued

REVOKE SELECT, UPDATE (Address, Phone) ON Customer FROM Oshan RESTRICT;

Explain the impact of it on the users Ashintha and Tharindra.

[3 Marks]

(e) Consider tables R (A) and T (B), both containing {(1), (2)}, and two concurrent transactions T1 and T2:
T1: UPDATE R SET A = 2*A; UPDATE T SET B = 2*B; COMMIT;
T2: SELECT AVG (A) FROM R; SELECT AVG (B) FROM T;

If transaction T2 executes using **READ COMMITTED**, is it possible for T2 to return two different values? Explain your answer.

[3 Marks]

Question 3

(a) Concurrent executions of transactions can cause problems to the database. Briefly explain the **Lost Update problem** and **Temporary Update (Dirty Read) problem** that can occur due to the concurrent execution of transactions. Use appropriate examples to describe the two problems.
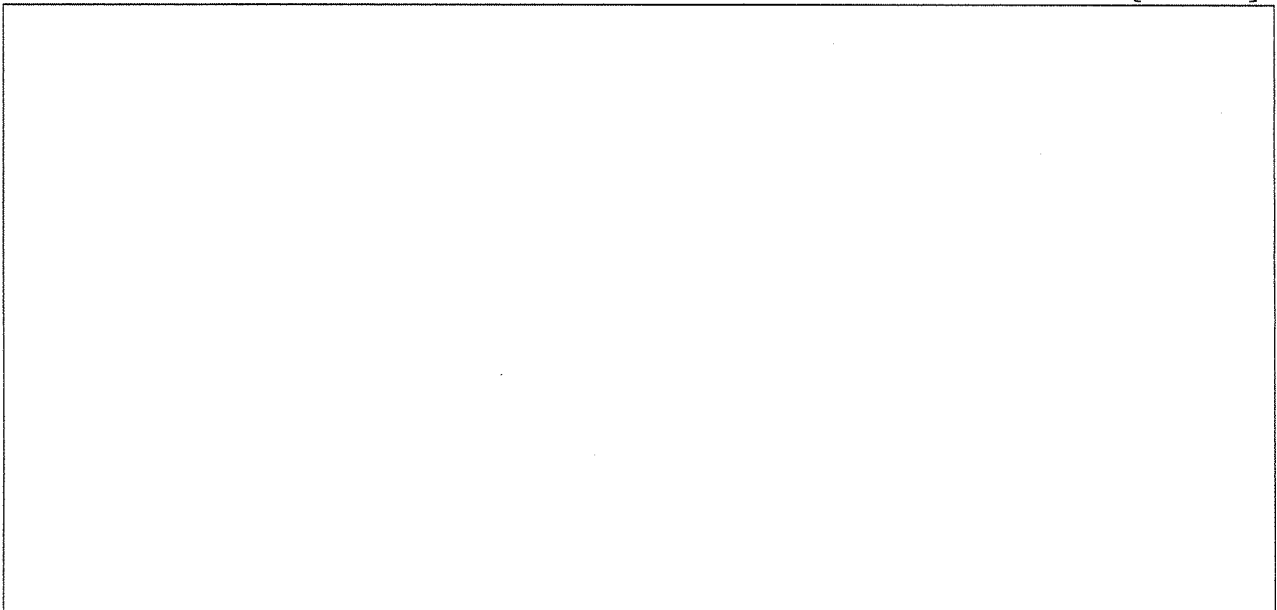
[6 Marks]

(b) Consider the following schedule S, consisting of three transactions T1, T2, and T3. Note that each R and W denotes read, and write operations respectively.

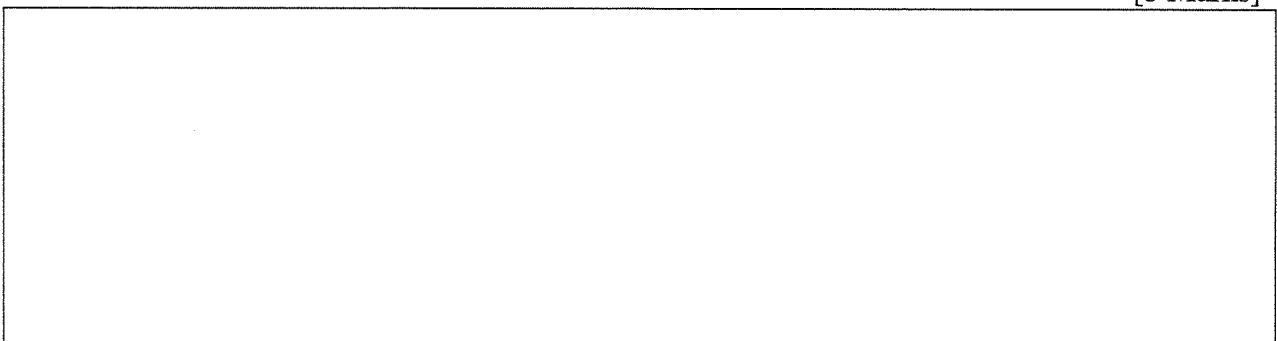| T1	T2	T3
W(A)		
	R(A)	
W(B)		
		W(B)
		W(B)
	W(A)	
		R(B)
	R(B)	

(i) Draw the precedence graph for S.

[5 Marks]

(ii) Is S conflict serializable? Justify your answer.

[3 Marks]

(iii) Is S view serializable? Justify your answer.

[3 Marks]

(c) Consider the Enroll (<u>Sid</u>, <u>Courseid</u>, Mark) table with values (123, 'SCS1203', 82), (234, 'SCS1204', 72), (345, 'SCS1203', 63). The Enroll table is accessed by two transactions T1 and T2 as depicted in the following table.

T1	T2
Set transaction isolation level READ COMMITTED;	
Q1: SELECT Sid, Mark FROM Enroll WHERE Courseid = 'SCS1203';	
	Q2: UPDATE Enroll SET Mark = Mark + 5 WHERE Courseid = 'SCS1203';
Q3: SELECT Sid, Mark FROM Enroll WHERE Courseid = 'SCS1203';	

Write down the possible query results of Q1 and Q3.

[4 Marks]

(d) Consider a table R (A) containing {(1), (2)}, and two transactions T1 and T2.

        T1: UPDATE R SET A = 2*A;

        T2: SELET AVG (A) FROM R;

If transaction T2 executes using READ UNCOMMITTED, what are the possible values it returns?

[4 Marks]

Question 4

(a) Briefly explain what ORM (Object-Relational Mapping) is.

[3Marks]

(b) Write three (3) differences between ORM entities and value objects.

[3 Marks]

(c) Suppose you are designing a social network system to connect university students worldwide to share their experiences and academic achievements. How would you apply the CAP theorem to this? Explain your answer.

[5 Marks]

(d) "The scaling and performance are critical factors for industrial application developments."

(i) Explain how to achieve scaling with the sharding for a NoSQL-based application.

[5 Marks]

(ii) "Sharding is not the optimal solution for the scaling."
Discuss the above statement using two (2) advantages and two (2) disadvantages of sharding.

[4 Marks]

(e) There is a requirement to rebuild the Customer Relations component of an international bank which is having millions of customers. The bank is planning to promote different services.

(i) Rather than RDBMS, a NoSQL solution would be recommended for this purpose. Briefly explain the reason for that.

[2 Marks]

(ii) Explain the steps that you would follow to plan a database solution that can serve the millions of customers for the above requirement.

[3 Marks]

****