University of Colombo, Sri Lanka

University of Colombo School of Computing

BACHELOR OF SCIENCE HONOURS IN INFORMATION SYSTEMS

BACHELOR OF SCIENCE IN INFORMATION SYSTEMS

Third Year Examination - Semester I – UCSC AY21 [held in Sept./ Oct. 2024]

IS3116 - Database Management System II

(Two (2) Hours)

Answer ALL questions

Number of Pages = 15 Number of Questions = 4

To be completed by the candidate								
Index Number:								

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 in **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	

Index No: .....

Question 1

(a) Briefly explain what ***inherent model-based*** constraints are and provide ***two (02)*** examples of such constraints.

[04 Marks]

(b) Imagine you are designing a database system for a bookstore. This system will manage information related to authors, books, orders, and publishers. You need to create the necessary tables and implement constraints to maintain data integrity.

Author

Column	Type	Null	Default
AuthrId	int(11)	No	
Name	varchar(90)	Yes	NULL

Order

Column	Type	Null	Default
OrderNmber	int(11)	No	
OrderDate	date	Yes	NULL
Quantity	int(11)	Yes	NULL
ISBN	varchar(13)	Yes	NULL

Books

Column	Type	Null	Default
ISBN	varchar(13)	No	
Title	varchar(90)	Yes	NULL
Quantity	int(11)	Yes	NULL
CostPrice	decimal(6)	Yes	NULL
SellPrice	decimal(6)	Yes	NULL
AuthrId	int(11)	No	
PublishId	int(11)	No	

Publishers

Column	Type	Null	Default
PublishId	int(11)	No	
Email	varchar(90)	Yes	NULL
Phone	varchar(12)	Yes	NULL
Address	varchar(90)	Yes	NULL
City	varchar(90)	Yes	NULL

In this design:

The primary keys are as follows:

- `AuthrId` for the `Author` table.
- `OrderNmber` for the `Order` table.
- `ISBN` for the `Books` table.
- `PublishId` for the `Publishers` table.

The foreign keys are as follows:

- `AuthrId` in the `Books` table references the `Author` table.
- `PublishId` in the `Books` table. references the `Publishers` table.
- `ISBN` in the `Order` table references the `Books` table.

(i) Based on the provided table details, write the SQL statements to create the structure for each of the specified tables in MySQL.

[08 Marks]

(ii) Add a constraint to the ***Order*** table to ensure that the purchased quantity is greater than 1.

[02 Marks]

(iii) Create a trigger to deduct the order quantity from the Books list once an order is received, ensuring there is sufficient stock available.

[06 Marks]

(iv) Create a stored procedure that shows all book titles with a user-defined profit amount, calculated based on the selling price and cost price.

[05 Marks]

Question 2

(a) Briefly explain ***Interleaved processing*** and ***Parallel processing***.

[03 Marks]

(b) Briefly explain the desirable properties of database transactions

[04 Marks]

(c) Refer to the following transaction schedule (***Sv***) to answer the questions below.

Sv:

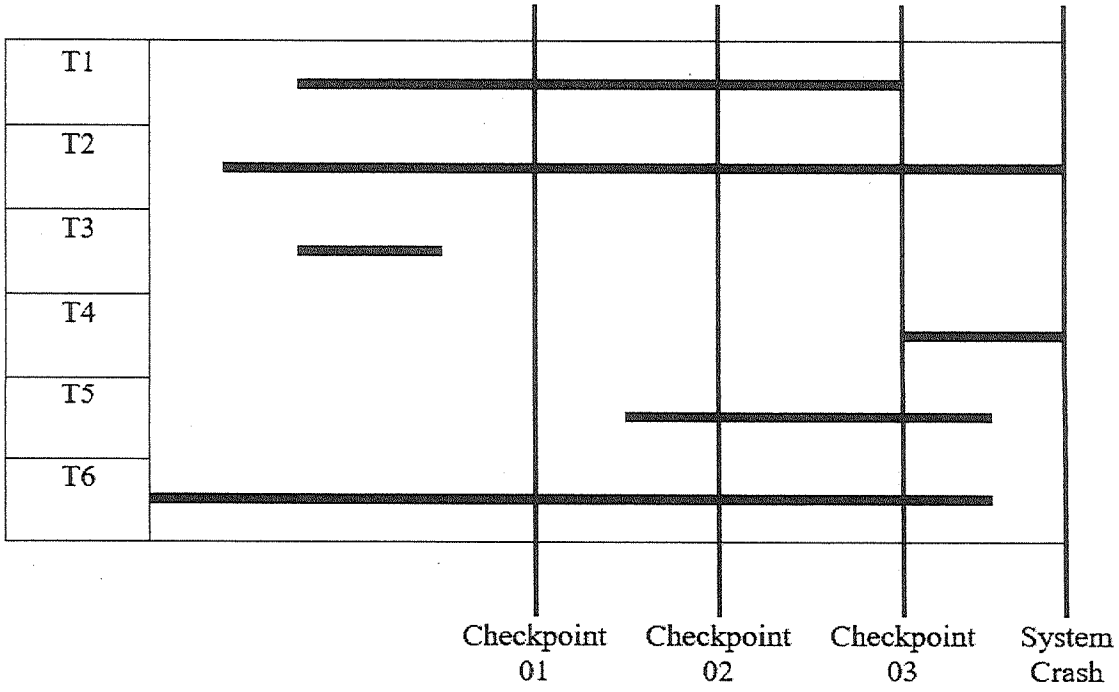
$r_3(X)$; $r_1(X)$; $r_2(X)$; $r_3(X)$; $w_3(X)$; $w_1(X)$; $r_2(Y)$; $w_2(Y)$; $r_3(Y)$; $r_3(Z)$; $r_2(Z)$; $w_3(Y)$; $w_3(Z)$; $w_2(Z)$; a_2

(i) Identify the problems associated with concurrent execution in this transaction schedule, explaining the issues related to the operations involved.

[06 Marks]

(ii) What is the total number of possible concurrent schedules for these transactions?
[06 Marks]

(d) Consider the following concurrent schedule.



(i) If ***deferred update recovery*** is used as the recovery methodology, what is the expected outcome of these transactions?

[03 Marks]

(ii) If ***Immediate update recovery*** is used as the recovery methodology, what is the expected outcome of these transactions?

[03 Marks]

Question 3

(a) Briefly explain how database indexing improves query performance.

[02 Marks]

(b) Briefly explain the difference between the dense index and the sparse index using suitable examples.

[03 Marks]

(c) B+ trees serve as dynamic multi-level indexing structures in database management. Briefly explain the internal node and leaf node structures of B+ trees.

[04 Marks]

(d) Consider the following relation "**Employee**" in an organization database. The primary key is underlined.

Employee (EmployeeID, EmployeeName, DepartmentName, Position, NIC)

- An employee file contains 400,000 employee records stored on a disk with a block size (B) of 2048 bytes. The file records have a fixed size of 100 bytes each and are unspanned.
- The employee records are ordered based on the key field EmployeeID.
- Additionally, the NIC represents the National Identity Card number, unique to each employee.

(i) Calculate the number of blocks needed to store the above relation on the disk.

[03 Marks]

(ii) Assume that we have constructed a single-level index on the key field EmployeeID of the file. Consider that a block pointer is P = 8 bytes, and EmployeeID is 16 bytes long. Calculate block accesses are required to search and retrieve a record for a given EmployeeID using the index.

[05 Marks]

(iii) Suppose another single-level index is created on the non-ordering key field NIC where NIC is 16 bytes, and the block pointer is 12 bytes long. Calculate the number of block accesses required to perform a binary search using the index.

[04 Marks]

(iv) Suppose the index created on the non-ordering key field NIC is converted into a multi-level index. Calculate the number of blocks at each level for the multi-level index on the NIC.

[04 Marks]

Question 4

(a) Briefly discuss the **two (02)** major characteristics of NoSQL databases that address the limitations of relational databases and facilitate the transition from relational databases to NoSQL.

[04 Marks]

(b) Briefly explain **two (02)** required properties for confidentiality in the 'Bell-LaPadula' multilevel security model.

[04 Marks]

(c) Briefly explain the essential steps of public key encryption in data security.

[05 Marks]

(d) Consider the scenario related to a Hospital Management Database.

The hospital database administrator has created the following two (02) relations: Doctor and Patient. Primary keys are underlined, and foreign key is in italics.

Doctor (DoctorID, DoctorName, Specialization, DepartmentName)
Patient (PatientID, *DoctorID*, Diagnosis, Age, Address, InsurancePolicyNumber)

The database administrator has created three user accounts: D1, J1, and J2.
D1 is the doctor in charge.
J1 and J2 are junior doctors.

The database administrator wants to create the following roles and assign the following permissions:

Junior Doctors: SELECT privilege on the relation "Patient" to view patient records.

Doctor in Charge: SELECT privilege on the relation "Patient" and UPDATE privilege on the "Diagnosis" field of patient records.

Write SQL statements to perform the following tasks on the database.

(i) Create a role for junior doctors with the password "HMJunior" and assign them the necessary privileges.

[02 Marks]

(ii) Create a role for the doctor in charge with the password "HMDoctor" and assign the necessary privileges.

[04 Marks]

(iii) Assign the users to the appropriate roles.

[02 Marks]

(iv) Assume that the hospital wants to enhance security by limiting the data accessible to junior doctors. Therefore, junior doctors are now restricted to view only certain fields from the relation Patient: PatientID, DoctorID, and Diagnosis.

[04 Marks]

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