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University of Ruhuna- Faculty of Technology

Bachelor of Information & Communication Technology Honours Degree
Level 3 (Semester II) Examination, October 2022
Academic year 2020/2021

Course Unit: ICT 3273 Advanced Database Management Systems (Theory) **Duration: 2 hours**

IMPORTANT INSTRUCTIONS:

1. The medium of this examination is English.
2. This is a closed book examination.
3. This question paper contains **eight (08) pages** including this instruction page.
4. This examination consists of **four (04) questions** that are given equal marks.
5. You must answer **all four (04) questions** in this examination.

01.

a.

i. Illustrate the ***pile file method*** in sequential file organization.

[10 marks]

ii. Write down two (02) advantages and two (02) disadvantages of ***heap file organization***.

[10 marks]

b.

i. Consider the following SQL query command:

```
CREATE TABLE College{
col_name TEXT
col_code CHAR(3)
col_address TEXT
col_city CHAR(5)
col_phone TEXT
col_enrolled INTEGER
}
```

Compute the size of the smallest possible record in bytes.
Assume that the record header gets 4 bytes and integers take 4 bytes in length.

[20 marks]

ii. Differentiate ***static hashing*** and ***dynamic hashing*** using two (02) key points.

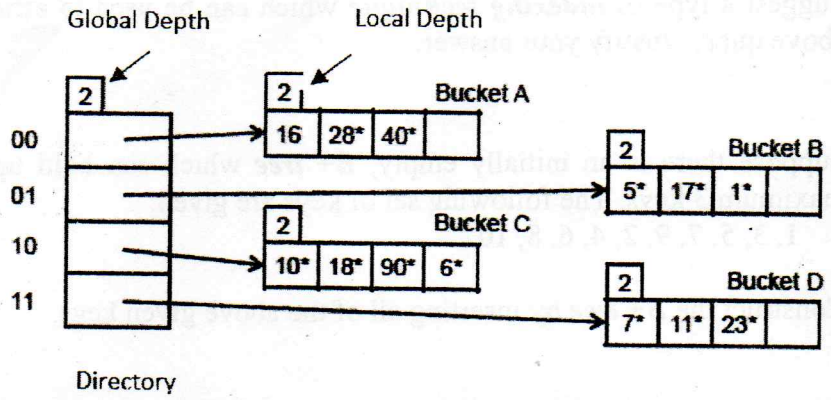
[10 marks]

c.

i. Given the key values as **4371, 1323, 6173, 4199, 4344, 9679, 1989** and the hash function **x mod 10** is used here. Show the output of the ***hash table*** using linear probing corresponding to given key values and the hashing function.

[25 marks]

ii. Consider the ***extendible hash table*** given below:



Construct the ***extendible hash table*** after the keys inserted given below:

4*,21*,25*

Clearly show the directory expansion, split buckets, changes in local and global depth. The hash function considers the last two digits of the binary representation.

[25 marks]

02.

a.

i. Write down two (02) advantages and two (02) disadvantages of ***indexing***.

[8 marks]

ii. Consider the following relational schema with the primary key SID:

Student (SID, SName, City, Marks)

Suppose you are newly appointed as the DBA (Database Administrator) of a company and you are going to introduce indexes for the following types of queries.

SELECT * FROM Student WHERE SID = 1;

From ***SPARSE*** or ***DENSE*** primary index on SID, which of the most suitable indexing techniques is for executing the above types of queries efficiently? Justify your answer with reasons.

[15 marks]

b.

i. Consider the following query given:

```
SELECT employee_id
FROM EmployeeTable E
WHERE E.employee_salary <= 150000 AND E.employee_salary >= 50000
```

Suggest a type of ***indexing technique*** which can be used to efficiently evaluate the above query. Justify your answer.

[10 marks]

ii. Suppose there is an initially empty, ***B+ tree*** which can hold up to 4 pointers and maximum 3 keys. The following set of keys are given:

1, 3, 5, 7, 9, 2, 4, 6, 8, 10

Construct the ***B+ tree*** by inserting all of the above given keys.

[25 marks]

c.

i. Discuss three (03) important steps involved in ***query processing*** in the form of a string in the order which they are performed.

[12 marks]

ii. Consider the following relations with the given properties below:

r(P,Q,R)	**s(X,Y,Z)**
20000 tuples	**50000 tuples**
20 tuples fit on 1 block	**25 tuples fit on 1 block**

(1) Compute the number of disk block accesses required for a natural join of *r* and *s* using a ***nested-loop join*** if ***r*** is used as the outer relation.

[15 marks]

(2) Compute the number of disk block accesses required for a natural join of *r* and *s* using a ***nested-loop join*** if ***s*** is used as the outer relation.

[15 marks]

03.

a.

i. Considering the following concurrent transactions on ***Table 01*** and ***Table 02*** below, discuss the ***concurrent transaction issues*** in each scenario.

(1)

T_1	T_2
read_item(A) A:= A-N; write_item(A); read_item(B) B := B+N; write_item(B)	 read_item(A) A:= A+M write_item(A);

Table 01

[8 marks]

(2)

T_3	T_4
READ X READ X	 UPDATE X

Table 02

[8 marks]

ii. Consider the two (02) transactions T_1, T_2 and the schedule given below.

Transaction T_1	Transaction T_2
$r_1[A]$ $w_1[A]$ $r_1[B]$ $w_1[B]$	 $r_2[A]$ $r_2[B]$

Table 03

(1) Construct a ***precedence graph*** for above given schedule in Table 03.

[10 marks]

(2) Analyze whether the above given schedule is ***conflict-serializable*** or not.

[5 marks]

(3) Show how ***2 Phase Locking(2PL)*** can ensure a conflict-serializability for the schedule transactions given above in (03)(a)(ii).

Use the notation given below to denote lock and unlock on elements.
Example: *Li [A]* to indicate that transaction *i* acquires the lock on element A.
Ui [A] to indicate that transaction *i* releases its lock on element *A*.

[10 marks]

b.

i. Differentiate ***serial schedule*** and ***serializable schedule*** with two (02) key points.

[8 marks]

ii. Evaluate whether the following given schedule is ***view serializable*** or not.

S = R2(B); R2(A); R1(A); R3(A); W1(B); W2(B); W3(B)

[10 marks]

iii. If the above schedule is a view serializable then provide the ***view equivalent serial schedule***.

[5 marks]

c.

i. Differentiate the ***wait die*** and ***wound die*** protocols with two (02) key points.

[8 marks]

ii. Assume that there are some problems occurred in a database, due to some transactions are waiting for locks held by other transactions infinitely. The followings are some instances what each transaction is waiting for:

- T1 is waiting on T4
- T2 is waiting on T7
- T3 is waiting on T2
- T4 is waiting on T1
- T5 is waiting on T8
- T6 is waiting on T2
- T7 is waiting on T6
- T8 is not waiting

(1) Construct the ***Wait-For graph*** for the transactions T1–T8 by analyzing the above instances.

[20 marks]

(2) According to the wait-for graph created in above (03)(c)(ii)(1), write down the transactions which are in a ***deadlock situation***.

[8 marks]

04.

a.

i. Differentiate ***deferred update technique*** and ***immediate update technique*** using two (02) key points.

[8 marks]

ii. Consider the following relations that represent a part of database of a real estate business named "Sakura":

S_Agent(A_ID, Agent_Name)
S_House(Address, OwnerID, AgentID)
S_Amenity(Address, Feature)

The "S_Agent" relation keeps the tracks of real estate agents, the "S_House" relation stores information on who is selling the house and agent involved in the business, and the "S_Amenity" has the data on the features of each house.

Consider the query given below:

```
SELECT X.OwnerID, Y. Agent_Name
FROM S_House X, S_Agent Y, S_Amenity Z
WHERE X.Address=Z.Address AND Y.A_ID = X.AgentID
AND Z.Feature = '4BR' AND X.AgentID = '009'
```

Construct an ***operator tree*** for the above given MySQL query.

[25 marks]

b.

i. Differentiate ***granting a privilege*** and ***revoking a privilege*** with the use of MySQL code examples.

[9 marks]

ii. Consider a magnetic disk with a sector size of 512 bytes, 128 tracks per surface, 256 sectors per track and 16 surfaces.
If the disk has average rotational speed of 4200 RPM (Revolutions Per Minute), calculate the ***average access time*** with a seek time of 10 msec.

[25 marks]

c.

i. Discuss the concept of ***fragmentation transparency*** and ***replication transparency*** used in DDBMS.

[8 marks]

ii. Consider a database consisting of a single relation named R as given below:

R:

X	Y
1	10
2	0

Table 04

The two transactions given below run concurrently on this database:

T1	T2

Begin transaction;
Update R set Y = Y – 10
where X = 1;
Update R set Y = Y + 10
where X = 2;
Commit;
	Begin transaction;
	Select sum(Y) from R;
	Commit;

Table 05

According to the above transactions in Table 05, do you think that T2 can see a value of zero in its input? Justify your answer.

[25 marks]

.....End of the paper.....