



**UNIVERSITY OF COLOMBO, SRI LANKA**

**UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING**

**DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY ( EXTERNAL)**

*Academic Year 2025 – 3<sup>rd</sup> Year Examination – Semester 6*

***IT6405(R) – Database Systems II (Repeat)***  
***Structured Question Paper***

**(TWO HOURS)**

**To be completed by the candidate**

BIT Examination Index No: .....

**Important Instructions:**

- The duration of the paper is **2 (Two) hours**.
- The medium of instruction and questions is English.
- This paper has **4 questions** and **12 pages**.
- **Answer all questions.** All questions carry **equal** marks.
- **Write your answers** in English using the space provided **in this question paper**.
- 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.
- Note that questions appear on both sides of the paper.  
If a page is not printed, please inform the supervisor immediately.
- All kinds of electronic devices including programmable calculators are **not** allowed.
- Non-Programmable calculators are **allowed**.
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**Questions Answered**

Indicate by a cross (×), (e.g. ☐) the numbers of the questions answered.

| To be completed by the candidate by marking a cross (×). | Question numbers |   |   |   |
|----------------------------------------------------------|------------------|---|---|---|
|                                                          | 1                | 2 | 3 | 4 |
| To be completed by the examiners:                        |                  |   |   |   |
|                                                          |                  |   |   |   |
|                                                          |                  |   |   |   |

- 1) (a) Write the SQL query to create the Student table with the following constraints.

Student (StudentId, Name, Address, Telephone, Age)

- StudentId is a number used as the primary key
- Name cannot be null
- Default Address to be 'Colombo'
- Telephone specifies a unique number
- Age should be a number between 5-18

[6 marks]

**ANSWER IN THIS BOX**

```
CREATE TABLE Student (
    StudentId int Primary Key,
    Name CHAR(20) NOT NULL,
    Address CHAR(25) DEFAULT 'Colombo',
    Telephone INT UNIQUE,
    Age INT CHECK (Age BETWEEN 5 AND 18));
```

- (b) Consider the following relational schema to answer the question below.

Employee (eno, ename, hiredate, salary, saldifference)

Write a trigger to calculate and update the *saldifference* field (difference between the old and the new salary) when the salary is updated.

[6 marks]

**ANSWER IN THIS BOX**

```
DELIMITER //
CREATE TRIGGER SalUpdate
AFTER UPDATE ON Employee
FOR EACH ROW
BEGIN
    DECLARE sal_dif INT;

    IF NEW.salary > OLD.salary THEN
        SET sal_dif = NEW.salary - OLD.salary;
    ELSE
        SET sal_dif = OLD.salary - NEW.salary;
    END IF;

    UPDATE Employee SET saldifference = sal_dif WHERE eno =
NEW.eno;
END//
```

DELIMITER ;

Suitable Answer

- (c) Write down **two (02)** differences between triggers and stored procedures.

[4 marks]

**ANSWER IN THIS BOX**

- Triggers are implicitly called by database itself while Stored Procedure has to be manually called by user.
- Stored Procedure can pass the parameters which is not a case with Triggers.
- While creating a Trigger, triggering event and action have to be specified, which is not a case with Stored Procedure.
- A Trigger can call the specific Stored Procedure in it but the reverse is not true.

Any two of the above.

- (d) Suppose relation R1 (A,B) has tuples {(a,b), (a,b), (c,d)}, and relation R2 (B,C) has tuples {(b,e), (b,e), (d,f), (g,h)}. Consider the following SQL query.

```
SELECT * FROM R1 RIGHT OUTER JOIN R2 ON R1.B = R2.B;
```

How many tuples are in the result of the above SQL query?

[4 marks]

**ANSWER IN THIS BOX**

6 tuples

- (e) Consider the relations Employee and Evaluation as given below used to keep track of employees, and their job evaluation records.

Employee (Empid, First\_name, Job\_id, Salary, Department\_id )

Evaluation (Empid, Evaluation\_date , Job\_id, Department\_id, Score )

Write down a trigger named **Salary\_Increment** to increase salary of an employee as given below (based on the Score value) upon insertion of his/her evaluation record into the Evaluation table.

- 15% salary increment if score is  $\geq 9$
- 10% salary increment if score  $\geq 7$  and score  $< 9$

[5 marks]

**ANSWER IN THIS BOX**

DELIMITER \$\$

```

CREATE TRIGGER Salary_Increment
AFTER INSERT ON Evaluation
FOR EACH ROW
BEGIN
    IF (NEW.Score >= 9) THEN
        UPDATE Employee
        SET Salary = Salary * 1.15
        WHERE Empid = NEW.Empid;
    ELSEIF (NEW.Score >= 7 AND NEW.Score < 9) THEN
        UPDATE Employee
        SET Salary = Salary * 1.10
        WHERE Empid = NEW.Empid;
    END IF;
END$$

DELIMITER ;

```

Suitable answer

- 2) (a) Suppose that we have an ordered file with  $r = 30,000$  records stored in a disk with block size  $B = 1024$  bytes. File records are of fixed size and unspanned, with record size  $R = 100$  bytes.

- (i) Calculate the blocking factor (BFR).

[2 marks]

**ANSWER IN THIS BOX**

$BFR = \lfloor 1024/100 \rfloor$   
 $= 10$  records per block.

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

[2 marks]

**ANSWER IN THIS BOX**

The number of blocks needed for the file is  $b = \lceil (r/bfr) \rceil$   
 $= \lceil (30,000/10) \rceil = 3000$  blocks.  
 A binary search on the data file would need approximately  $\lceil \log_2 b \rceil$

$$= \lceil (\log_2 3000) \rceil = 12 \text{ block accesses.}$$

- (iii) Suppose that the ordering key field of the file is  $V = 9$  bytes long, a block pointer is  $P = 6$  bytes long, and we have constructed a primary index for the file. How many block accesses are required to search a record using the primary index?

[4 marks]

**ANSWER IN THIS BOX**

Size of index entry is  $9+6 = 15$  bytes.

Blocking factor for index =  $\lfloor 1024/15 \rfloor = 68$

Number of index entries is 3000

The number of index blocks is  $= \lceil (3000/68) \rceil = 45$

To perform a binary search on index file would need  $\lceil (\log_2 b_i) \rceil = \lceil (\log_2 45) \rceil = 6$  block accesses.

Total number of block access =  $6 + 1$  block accesses = 7 block accesses

- (b) “Selection of certain indexes may cause excessive overhead on the Database Management System and lead to poor performance.” Is this statement correct or incorrect? Justify your answer.

[4 marks]

**ANSWER IN THIS BOX**

Correct

Every insert, update, or delete operation on the table also requires corresponding updates to the indexes, leading to slower write performance.

Creating too many or poorly chosen indexes (e.g., on columns rarely queried or updated frequently) leads to inefficient query plans and can even slow down query execution.

- (c) Briefly describe the *Primary Index* and the *Secondary Index* types.

[4 marks]

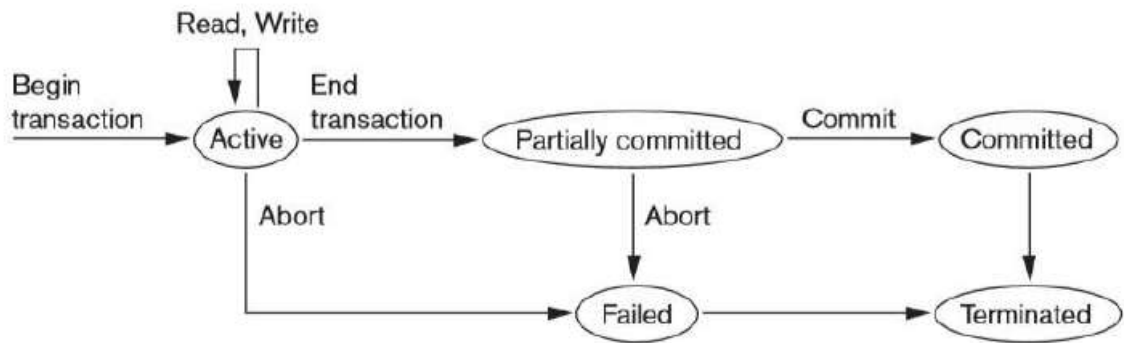
**ANSWER IN THIS BOX**

Primary index is defined on an ordered data file. The data file is ordered on a key field. The key field is generally the primary key of the relation.

Secondary index may be generated from a field which is a candidate key and has a unique value in every record, or a non-key with duplicate values.

- (d) Illustrate the flow of **transaction states** using a diagram.

[6 marks]

**ANSWER IN THIS BOX**

- (e) Briefly explain using a suitable example, the **Dirty Read problem** that can occur due to the concurrent execution of transactions.

[3 marks]

**ANSWER IN THIS BOX**

This problem occurs when one transaction updates a database item and then the transaction fails for some reason. Meanwhile, the updated item is accessed (read) by another transaction before it is changed back to its original value.

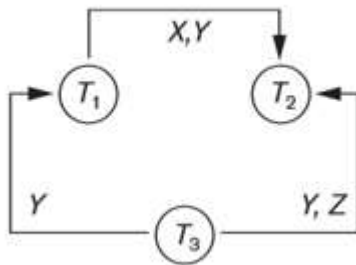
| T1                                  | T2                                  |
|-------------------------------------|-------------------------------------|
| READ(X)<br>$X = X - N$<br>Write (X) |                                     |
|                                     | READ (X)<br>$X = X + M$<br>Write(X) |
| READ(Y)<br>ROLLBACK                 |                                     |

- 3) (a) 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   |
|------|------|------|
|      |      | R(Y) |
|      |      | R(Z) |
| R(X) |      |      |
| W(X) |      |      |
|      |      | W(Y) |
|      |      | W(Z) |
|      | R(Z) |      |
| R(Y) |      |      |
| W(Y) |      |      |
|      | R(Y) |      |
|      | W(Y) |      |
|      | R(X) |      |
|      | W(X) |      |

- (i) Draw the precedence graph for S.

[5 marks]

**ANSWER IN THIS BOX**

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

[3 marks]

**ANSWER IN THIS BOX**

Yes. Because the graph did not contain cycles.  
 $T3 \rightarrow T1 \rightarrow T2$

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

[3 marks]

**ANSWER IN THIS BOX**

Yes. Since this is conflict serializable, this should be view serializable.  
 All the conflict serializable schedules are view serializable too.

- (b) Consider the following T1 and T2 transactions. Note that each Lock-s and Lock-x denotes shared lock and exclusive lock respectively.

| T1        | T2        |
|-----------|-----------|
| Lock-s(A) | Lock-s(A) |
| Read(A)   | Read (A)  |
| Lock-x(B) | Lock-x(B) |
| Unlock(A) | Read(B)   |
| Read(B)   | Write(B)  |
| Write(B)  | Commit    |
| Commit    | Unlock(B) |
| Unlock(B) | Unlock(A) |

- (i) What is the concurrency control protocol used in transaction T1?

[3 marks]

**ANSWER IN THIS BOX**

Strict 2PL

- (ii) What is the concurrency control protocol used in transaction T2?

[3 marks]

**ANSWER IN THIS BOX**

Rigorous 2PL

- (c) Write two (02) limitations of *Two Phase Locking protocol*.

[4 marks]

**ANSWER IN THIS BOX**

Does not permit all possible serializable schedules  
 Cascading Rollback  
 Deadlocks



- (d) Briefly explain the *Wait-Die* deadlock prevention protocol.

[4 marks]

**ANSWER IN THIS BOX**

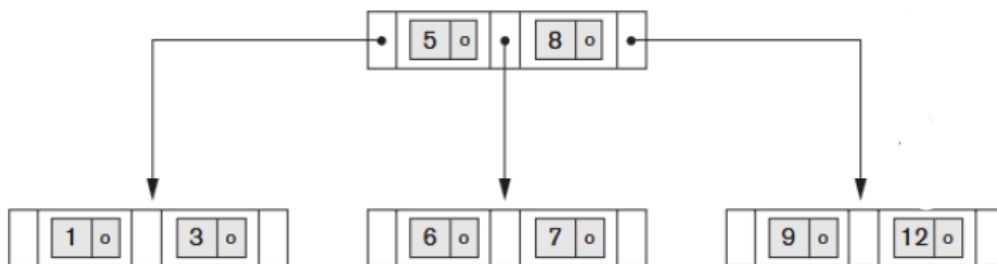
An older transaction is allowed to wait on a younger transaction,  
Younger transaction requesting an item held by an older transaction is aborted and restarted.

- 4 (a) Construct a B-tree of order three by inserting the following eight key values sequentially.  
Draw the final B-tree after all insertions are completed.

Key values: 8, 5, 1, 7, 3, 12, 9, 6

[5 marks]

**ANSWER IN THIS BOX**



- (b) State two (02) disadvantages of *distributed databases*.

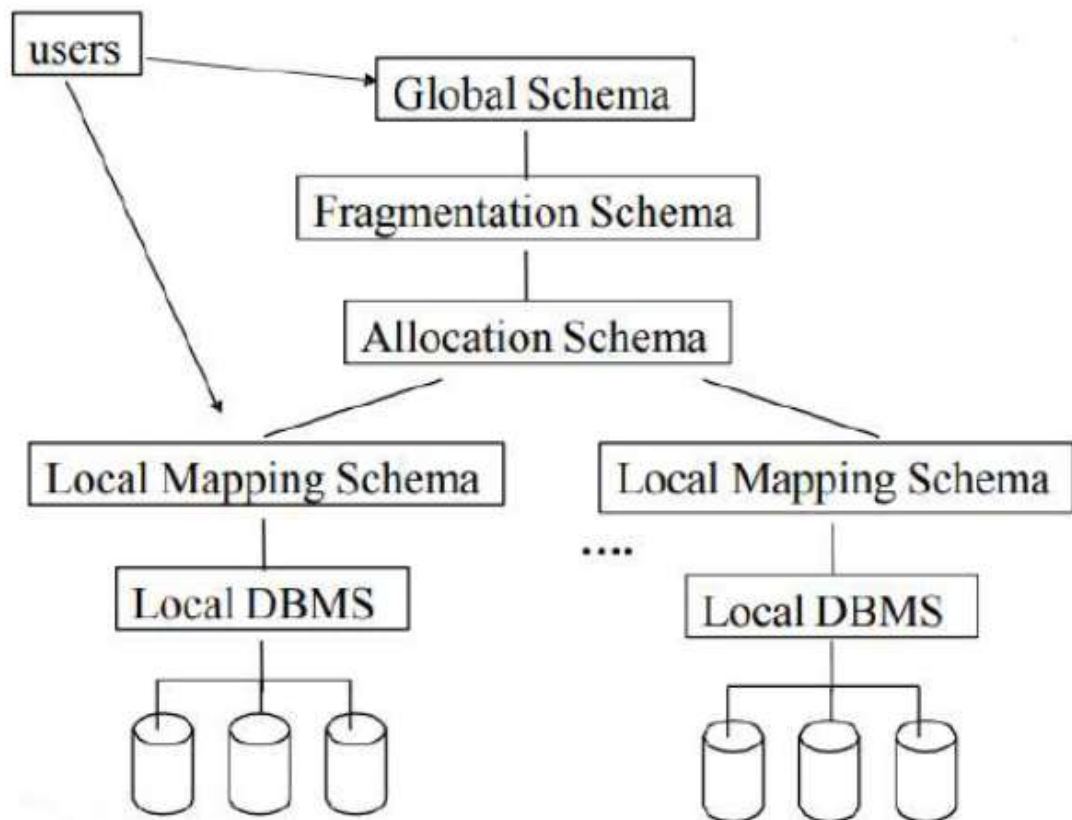
[4 marks]

**ANSWER IN THIS BOX**

Complexity  
Economics  
Security  
Difficult to maintain the integrity  
Inexperience

- (c) Draw the architectural diagram for a distributed database management system and identify its key components.

[7 marks]

**ANSWER IN THIS BOX**

- (d) Consider the following relational schema.

Employee (EmpId, Fname, Lname, Address, Gender, Salary, Bdate)

Project (Pnumber, Pname, location)

Works\_on (Pno, Empid,)

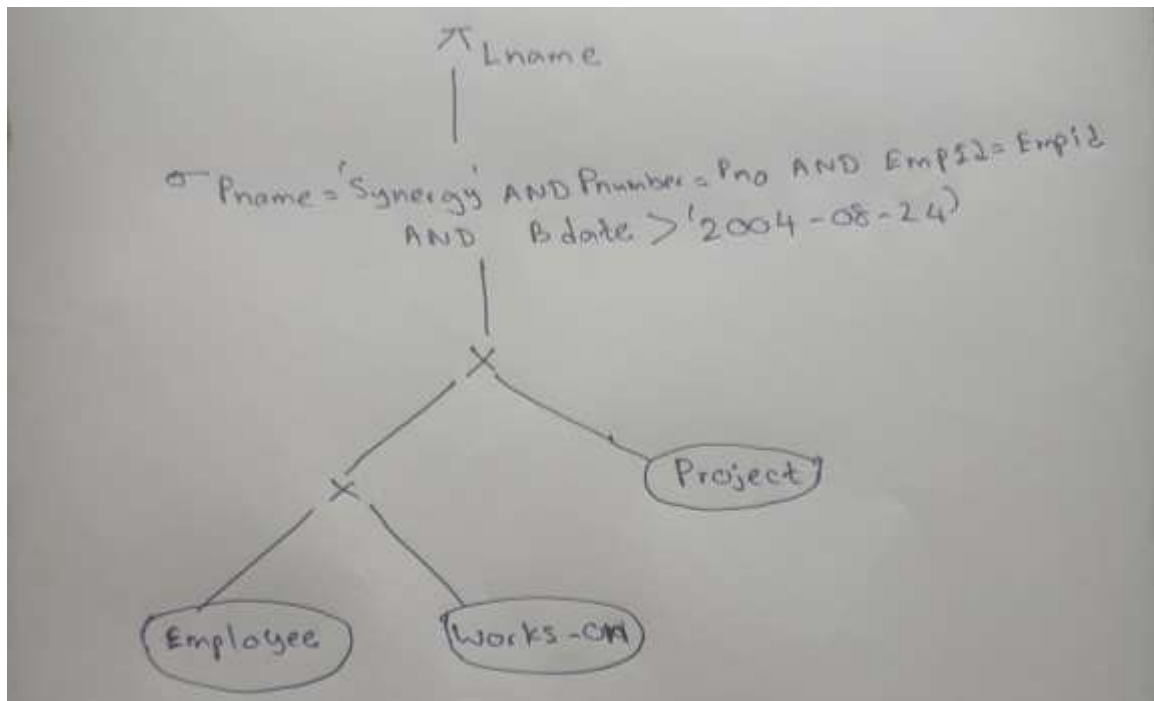
Consider the following SQL query.

```
Select E.Lname
From Employee E, Works_on W, Project P
Where P.Pname = 'Synergy' And
P.Pnumber= W.Pno And E.EmpId=W.Empid
And E.Bdate > '2004-08-24';
```

- (i) Draw the initial query tree for the SQL query given above.

[4 marks]

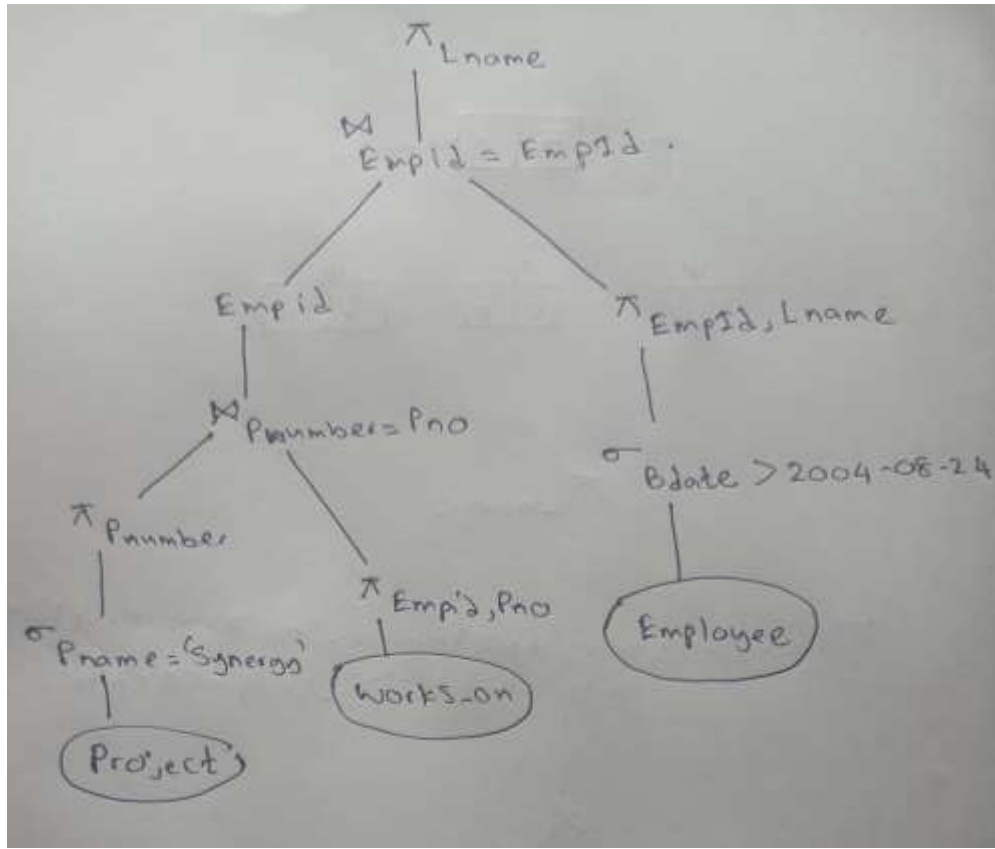
**ANSWER IN THIS BOX**



(ii)

Draw the optimized query tree for the SQL query given above.

[5 Marks]



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