

**BCS THE CHARTERED INSTITUTE FOR IT**

BCS HIGHER EDUCATION QUALIFICATIONS  
BCS Level 6 Professional Graduate Diploma in IT

**ADVANCED DATABASE MANAGEMENT SYSTEMS**

Tuesday 16<sup>th</sup> April 2024 - Afternoon

Answer **any** THREE questions out of FIVE. All questions carry equal marks.

Time: THREE hours

Answer any **Section A** questions you attempt in **Answer Book A**

Answer any **Section B** questions you attempt in **Answer Book B**

The marks given in brackets are **indicative** of the weight given to each part of the question.

Calculators are **NOT** allowed in this examination.

**Section A**  
**Answer Section A questions in Answer Book A**

**A1.**

In recent years alternative data models to the relational data model have become popular, such as spatial, document oriented and object oriented.

- a) Describe the following data models. Include in your answer how the data modelling concepts (highlighted in bold) differ in the way they model and process data.
- i. Spatial data model (modelling concepts **Vector** and **Raster**)
  - ii. Document oriented (modelling concepts **Graphs** and **Document stores**).  
**(16 marks)**
- b) Describe, using an example, the concepts of Multiple Inheritance and Selective Inheritance, which are characteristics of the Object-Oriented data model. Discuss how an ambiguity can arise in these forms of inheritance and how it can be resolved.  
**(9 marks)**

**B5.**

a) Relational Database Management Systems (RDBMS) are used by many users simultaneously. This can lead to various challenges especially when data is updated. Several techniques and ideas have been developed to manage these. With this in mind, answer the questions below.

- i. Expand the acronym ACID (state what each letter stands for) and briefly explain the concept behind the letter "C".
- ii. NoSQL databases usually use BASE rather than ACID principles. BASE stands for Basically Available, Soft State and Eventually Consistent. Outline why the BASE approach is considered to be of use in some database applications.

**(6 marks)****b)**

i. Briefly explain the concepts of read and write locks – what they are and how they would be used in a transaction to protect the validity of database data?

**(3 marks)**

ii. Briefly explain the concept of table level locking and give an example in which it is preferable to row level locking.

**(4 marks)**

iii. Explain the concept of a deadlock and provide a detailed example of **TWO** transactions that would lead to a deadlock.

**(6 marks)**

iv. Briefly describe 2PL (2 phase locking).

**(3 marks)**

c) Consider the 2-phase commit protocol in distributed databases. Consider a scenario with a Coordinator C and 2 participating RDBMS, R1 and R2. What is the next action to be sent in the following scenario:

- (1) C sends prepare Transaction T1 to R1 and R2.
- (2) R1 sends prepared to C.
- (3) R2 sends prepared to C.

**(3 marks)****END OF EXAMINATION****A2.**

a) Consider the following table definitions representing a many to many relationship between modules and students:

```
students (studID, name, date_of_birth)
modules (modID, title)
results (studID, modID, grade)
```

Note: primary key columns are underlined

And the following query:

```
SELECT s.name
FROM students s
JOIN results r
      ON s.studID = r.studID
JOIN modules m
      ON m.modID = r.modID
WHERE r.grade = 'A'
AND s.date_of_birth >= '01-Jan-2023';
```

Draw a query tree that corresponds to the most efficient way of processing this query.

You may assume there are around 40 rows in the `modules` table; 5000 rows in the `students` table; 60,000 rows in the `results` table.

**(10 marks)**

b) Creating indexes is one way of tuning the performance of a database. There are best practice guidelines on when to build such indexes. Give a brief justification of **each** of the following guidelines:

- i. Avoid indexing small tables.
- ii. Build an index foreign key.
- iii. Avoid indexing a column that is frequently updated.
- iv. Build an index containing multiple columns.

**(8 marks)**

c) The size of the unit of data that is locked during concurrency control refers to the granularity of a lock.

Define the different levels of lock granularity and discuss the trade-offs in choosing an appropriate level of lock granularity.

**(7 marks)****[Turn Over]**

**A3.**

- a) Describe the key differences between **each** of the following pairs of Data Warehouse/OLAP/Data Mining concepts shown below:
- Data Warehouse and a Data Mart.
  - Multi-dimensional OLAP and Two-dimensional OLAP.
  - Data Mining (normally applied to structured data) vs Text Mining (normally applied to unstructured data).

**(18 marks)**

- b) The process of data cleansing is part of the Extract-Transform-Load (ETL) process of populating a data warehouse. Data cleansing causes challenges that can account for delays in, or cancellation of, a data warehousing project.

Briefly describe the main objectives of data cleansing and provide examples of data that needs to be cleansed and discuss the challenges that can arise during the cleansing process.

**(7 marks)**

**Section B**  
**Answer Section B questions in Answer Book B**

**B4.**

- a) Consider the following tasks related to database and cyber security questions and provide answers.
- Name **TWO** common database attacks and briefly describe them.
  - State **THREE** levels at which data can be encrypted in a database context and name an advantage and disadvantage of **each**.
  - Explain how stored procedures help improve database security.

**(12 marks)**

- b) The concept of table fragmentation is used in distributed databases. It divides large tables into smaller segments that can be stored in different locations. The fragmentation is transparent to the user.

- State **TWO** disadvantages of table fragmentation.

**(2 marks)**

- Describe the horizontal fragmentation of tables in a distributed database.

**(3 marks)**

- Consider the following table of registered students (the primary key is underlined; the table is called `STUDENT`) at a university. The Department of Computer Science likes to look after its data locally and horizontal table fragmentation has been identified as a solution. Provide the SQL query that can be used to create the relevant table with its data for the Department of Computer Science.

STUDENT

<u>StudNo</u>	Name	Department	Course	Fees	Marks
2020001	Joe Smith	Computer Science	IT	14000	12, 45, 69
2020002	Jane Doe	Law	European Law	12000	45, 45, 60

**(5 marks)**

- c) Briefly describe the concept of data integrity and explain what you would do to ensure data integrity in your database.

**(3 marks)****[Turn Over]**