BCS THE CHARTERED INSTITUTE FOR IT

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

ADVANCED DATABASE MANAGEMENT SYSTEMS

Wednesday 16th April 2025 – Afternoon

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

Time: THREE hours

Answer any <u>Section A</u> questions you attempt in <u>Answer Book A</u>
Answer any <u>Section B</u> questions you attempt in <u>Answer Book B</u>

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

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

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Section A
Answer Section A questions in Answer Book A

A1.

a) Describe the functions that Online Analytical Processing (OLAP) and Online Transaction Processing (OLTP) systems perform in the domain of commerce.

(2 marks)

b) Describe the differences in OLAP and OLTP systems from the perspective of data models, data architecture and performance.

(8 marks)

c) Consider a data cube that stores revenue information.

The dimensions are:

- Product (with values of jeans, t-shirts, shirts)
- Store location (with values of China, India, UK, USA)
- Month (with values of January – December)

Explain the following operations, and provide an example for **each**, based on the above data cube.

i. Drilldown.
ii. Slicing.

(8 marks)

d) Describe the ETL process for populating a data warehouse, highlighting the roles of each phase in the process, and discuss **three** areas in which problems may be encountered.

(7 marks)

[Turn Over]

A2.

a) Consider the following tables and answer the questions below:

Film

FID	Title	Year
1	Film 1	2003
2	Movie 2	2007
3	Play 3	2003

Actor

AID	Name	Surname
1	Actress	One
2	Actor	Two
3	Player	Three

PlayedIn

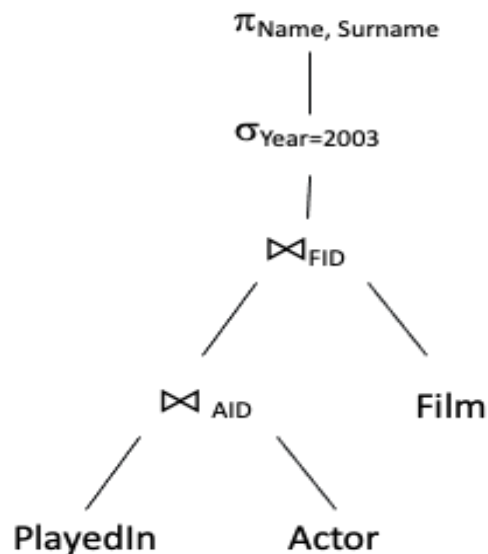| FID	AID	Character
1	2	Aniya
1	1	Andrea
2	3	Sahil
3	1	Brian

Using the number of rows examined and rows returned as well as columns examined and columns returned consider the efficiency of…

    i.   the following query

```
SELECT aid
    ,COUNT(*)
FROM Actor
WHERE Surname = 'Three';
```

(3 marks)

    ii.   the query expressed by the following tree:

$$\pi_{\text{Name, Surname}}$$

$$\sigma_{\text{Year}=2003}$$

$$\bowtie_{\text{FID}}$$

$$\bowtie_{\text{AID}} \qquad \text{Film}$$

$$\text{PlayedIn} \qquad \text{Actor}$$

(5 marks)

iii. Create an optimised version of the search tree in question ii) which minimises the access to rows and columns.

(5 marks)

iv. Explain what the following SQL statement does and what benefits can be gained in terms of query performance.

```
CREATE INDEX idx_role
ON PlayedIn(Role);
```

(4 marks)

b) Describe uses for hashing techniques in database tuning, focusing on their use in retrieval and indexing, load balancing and caching.

(8 marks)

[Turn Over]

A3.

a) You are a database administrator responsible for ensuring the physical security of a critical database system in a large organisation. The organisation's database contains sensitive and confidential information, and its availability is crucial for daily operations.

In the context of the above scenario, discuss and provide recommendations for enhancing the physical security of the database server infrastructure.
Consider various aspects, such as data centre security, server room access, hardware protection, and disaster recovery.

(12 marks)

b) Consider a healthcare database that contains sensitive patient information, including medical records, diagnoses and treatment plans. Privacy is a critical concern, and the organisation is committed to ensuring the confidentiality and protection of patient data.

Design a set of privacy measures to be implemented in the healthcare database. Include access controls, encryption methods, and anonymisation techniques. Explain how each measure contributes to protecting patient privacy.

(7 marks)

c) You are the database administrator for a company that manages a customer relationship database. The database contains tables for customer information, orders, and inventory, called `customers`, `orders` and `inventory` respectively.

The company has recently hired a new employee, Sarah, who will be responsible for managing customer data. Your task is to grant appropriate rights to Sarah using ANSI SQL.

Write SQL statements to give the necessary rights to Sarah to allow the actions based on the following requirements:

    i. Sarah should have the ability to query customer information from the `customers` table.
    ii. Sarah should be able to insert new customer records into the `customers` table.
    iii. Sarah should have the authority to update customer contact information in the `customers` table.
    iv. Currently, Sarah has the ability to delete records from the `customers` table.
        Write a SQL statement that will prevent Sarah from deleting records from the `customers` table.

(6 marks)

Section B
Answer Section B questions in Answer Book B

B4.

a) NoSQL Databases feature four types of data models: Document Databases, Key-Value Stores, Wide Column stores and Graph Databases. Discuss the concept of a Document Database in contrast to a Relation Database (RDBMS), considering storage of data, what type of data it might be best used for and disadvantages when it comes to data retrieval.

(12 marks)

b) Explain the following concepts in the context of Distributed Databases.

  i.   Location Transparency.
  ii. Distributed Transaction Management.

(8 marks)

c) Explain the concept of horizontal fragmentation in a RDBMS and provide a simple example which shows the usefulness of this approach.

(5 marks)

B5.

a) Briefly explain the concept of a transaction.

(2 marks)

b) Describe the two-phase locking protocol.

(4 marks)

c) Outline the essential differences between the following concurrency control systems:

  i.   Committed read systems.
  ii. Repeatable read systems.

(4 marks)

d) Data in a database can be locked at both the row and table level. Explain why row-level locks applied to data in a table are considered to be weaker than table-level locks.

(4 marks)

e) Describe the concept of a serialisable schedule when dealing with concurrent transactions.

(4 marks)

f) Compare and contrast the use of database triggers and database constraints in the maintenance and protection of data integrity in the database.

(7 marks)

END OF EXAMINATION