BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Thursday 23rd April 2026 – Morning

Answer **any** FOUR questions out of SIX. All questions carry equal marks.

Time: TWO 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.

a) Define the concepts of table, entity and attribute in the context of relational databases. Give examples for **each**.

(5 marks)

b) Consider the following requirements for football club management and create an Entity Relationship Diagram (ERD). Ensure that you show entities and attributes as well as their relations and the cardinalities of the relations. You should make sure you model according to the stated requirements and not your own understanding of football clubs.

Requirements:

1. Football clubs have an ID, a name and an address.
2. Each football club is organised by seasons; a season represents a year, and players and managers at each club are hired for the season. A club exists for many seasons.
3. Each football club has one manager in one season and each manager can only manage one club in one season.
4. A manager has an ID and a name.
5. The club hires players for each season; players are only allowed to play for one club in each season.
6. A player has an ID, a first name and a last name; they also have a position that they play in (such as forward or goalkeeper).
7. A player might have an additional role as a buddy, to help new players settle in.
8. A buddy supports one or more players and a player is supported by one buddy. However, a player might not be assigned to a buddy.

(12 marks)

c) Building on your design in part b), extract the physical database design. Ensure that you identify tables and their attributes and include required primary and foreign keys.

(8 marks)

A2.

A delivery company delivers fresh fruit from a market by collecting items from various retailers and bringing the products to their customers. They are currently managing orders on a spreadsheet and would like to move to a database.

Here is their spreadsheet:

Order ID	Customer Name	Customer Address	Product	Quantity	Market Stall	Market Phone No
1	Person A	123 Tree Street	Apples Oranges	10 5	FreshFruits CitrusCo	555-1234 555-5678
2	Person B	456 River Road	Bananas Apples	8 6	YellowThings FreshFruits	555-8765 555-1234

Consider the table and answer the following questions:

a)

i. Is the table in 1st Normal Form? Justify your response.

(2 marks)

ii. Using the table, give an example of how loss of data can occur.

(1 mark)

b) Normalise the above table to 1NF.

(3 marks)

c) Identify the partial dependencies in the 1NF table from part b) and convert the table to 2NF.

(5 marks)

d) Convert the table from part c) to 3NF.

(7 marks)

e) Define the SQL DDL statement that creates these tables (remember to include the required primary and foreign key constraints).

(7 marks)

[Turn Over]

A3.

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

Students

StudentID	FirstName	LastName	DateOfBirth	Email
1	Alice	A	2002-05-10	alice@example.com
2	Bob	B	2001-09-21	bob@example.com
3	Cindy	C	2000-08-05	cindy@example.com

Courses

CourseID	CourseName	Description	Credits
101	Introduction to Math	Basic math principles	3
102	Biology 101	Introduction to biology	4
103	Computer Science I	Basic programming concepts	3

Enrolments

EnrolmentID	StudentID	CourseID	EnrolmentDate	Grade
1	1	101	2023-01-10	A
2	1	102	2023-01-12	A
3	2	101	2023-01-15	B
4	2	103	2023-01-16	C

i. Write a query in SQL that calculates the total number of credits for which each student is enrolled and shows student ID, student name (first and last) and the number of credits they are enrolled on.

(4 marks)

ii. Write a query in relational algebra that shows the student name, course name and email for students enrolled on course with course ID 101.

(3 marks)

iii. Convert your query from part ii. into SQL.

(2 marks)

b) Using the sample tables from part a), consider the following query and answer the questions below:

```
SELECT s.StudentID, s.LastName, c.CourseName
FROM Students s
LEFT OUTER JOIN Enrolments e ON s.StudentID = e.StudentID
LEFT OUTER JOIN Courses c ON e.CourseID = c.CourseID
ORDER BY s.StudentID;
```

i. Show the resulting table.

(3 marks)

ii. Explain how an inner join is processed and describe how the result of the query would differ if the left outer joins are replaced by inner joins.

(3 marks)

c) Explain what cartesian products (⋈) in relational algebra (or a cross join in SQL) are. Your answer should explain what they return and a brief commentary on whether they are a good join to use.

(4 marks)

d) Returning to the example given in part b) (students and courses), consider the following relational algebra query and answer the questions below:

$$\pi_{\text{Name,CourseName}}\left(\sigma_{\text{StudentAEnrollments.CourseID=Courses.CourseID}}\left(\sigma_{\text{Grade='A'}}\left(\sigma_{\text{Enrollments.StudentID=Students.StudentID}}(\text{Students}\times\text{Enrollments})\right)\times\text{Courses}\right)\right)$$

i. What information does the query return?

(2 marks)

ii. Draw the query tree represented in the relational algebra term.

(4 marks)

[Turn Over]

Section B
Answer Section B questions in Answer Book B

B4.

a) 3-tier architectures are very common for accessing database systems and they typically include a presentation tier, application (or logic) tier and data tier. In this context, answer the following:

i. Define logical data independence and explain its importance in the context of database management.

(2 marks)

ii. Describe how logical data independence is achieved in a 3-tier architecture.

(3 marks)

iii. Discuss a scenario where changes in the logical structure of the database (e.g. adding a new attribute to a table or changing a relationship between tables) should be handled to ensure minimal impact on the other tiers.

(3 marks)

b) Relational Database Management Systems (RDBMS) provide the concept of a view. Define what a view is and show how views assist in ensuring data independence.

(4 marks)

c) NoSQL databases are now being used frequently. Explain what a NoSQL database is. Your answer should include **three** main characteristics of a NoSQL database with a short explanation of **each** and an example of a situation in which they are especially useful.

(13 marks)

B5.

a) In the context of database security:

i. Define database auditing and, using an example scenario, explain why it is essential in modern database management.

(3 marks)

ii. Describe **three** common types of database auditing activities and give an example for **each**.

(6 marks)

b) You are the database administrator for a large retail company that stores sensitive customer information, product details and sales data in a database. The company has three main roles that require different levels of database access: data analyst, application developer and database administrator.

Describe the specific privileges you would assign to **each** role based on the following requirements:

i. Data analysts need to generate reports based on customer and sales data but should not modify any data.

ii. Application developers need access to create and test new application features that interact with product and sales data.

iii. Database administrators are responsible for overall database maintenance, including backup, user management and auditing.

(6 marks)

c) Assuming we have tables named Patients (containing patient information), PatientStatus (tracking e.g. vital signs or care plan), Medications (containing medication records) and the following GRANT statements for a Nurse role in SQL:

```
GRANT SELECT ON Patients TO Nurse;
GRANT SELECT ON Medications TO Nurse;
GRANT SELECT, UPDATE ON PatientStatus TO Nurse;
```

Explain in plain English what these rules allow a Nurse to do with regards to patient data in the database.

(3 marks)

d) Consider the following scenario in a hospital setting:

One day, an administrator discovers suspicious activity in the database logs. Upon investigation, they find that a nurse's user account was used to access the billing data of several patients over the past week. However, nurses typically have only limited access rights that allow them to view patient status and treatment records, not billing nor personal financial details. Further investigation showed that the nurse's password was weak and had been compromised; the attacker then used privilege escalation to gain access to the financial data exploiting a misconfigured permission.

i. Explain the consequences of the breach in terms of data exposure, the legal and financial repercussions and patient trust.

(3 marks)

ii. Identify **four** steps that could be used in response to the above.

(4 marks)

[Turn Over]

B6.

a) Describe the concept of a transaction in databases.

(2 marks)

b) Transactions in RDBMS are governed by the so-called ACID principles. Expand the letters in the acronym ACID and very briefly explain what **each** of the **four** ideas mean.

(4 marks)

c) Consider the following scenario and answer the questions below:

A large online retailer operates a high-volume warehouse where inventory levels are tracked in real time. Multiple processes are constantly updating inventory levels as products are received, stored, packed and shipped. At any moment, inventory adjustments might result from incoming shipments, returns, cancellations and sales orders.

i. Describe how a database implementation without a concurrency control mechanism could lead to a loss of sales in this example.

(2 marks)

ii. Define the concept of pessimistic concurrency control and why it is particularly useful in this scenario.

(4 marks)

iii. Explain the concept of dirty read, showing how it can occur in the scenario (in the absence of any concurrency control). The example needs to explain the actions of the conflicting transactions on an item.

(6 marks)

d) RDBMS can use different backup strategies, such as incremental backup, differential backup or full backup. Note, we are focusing on backup and not complete recovery in this question.

i. Explain how differential (sometimes called cumulative) backups work. Your answer should include an elaboration of why incremental backups are more space-efficient than full backups.

(3 marks)

ii. Imagine you work in a bank as a database administrator. Describe a backup strategy that you would recommend to ensure minimal data loss and quick recovery. Justify your answer.

(4 marks)

END OF EXAMINATION