BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Thursday 24th April 2025 – 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 following concepts that occur in database design and provide an example for **each**:

i. Entity.
ii. One-to-many relationship.
iii. Recursive relationship.
iv. Foreign key.
v. Partial dependency.

(10 marks)

b) Web-based systems are common in e-commerce and make use of a three-tier architecture. The data tier is typically a database.

i. Give **three** reasons why a three-tier architecture is more suited to web-based systems than client-server setups.

(3 marks)

ii. Briefly explain the concept of logical data independence.

(2 marks)

iii. Consider an example where a company needs to add a new attribute called Email to the customer entity. Describe any changes that need to be made in **each** of the three tiers (if any) and explain why they are required.

(6 marks)

c) Consider a database that stores customer information. Initially, customer records might be stored in a simple heap file structure. Later, to improve query performance, the database administrator decides to switch the physical storage of the data to a B-tree index structure.

What is physical data independence and how does it support the change outlined above?

(4 marks)

A2.

a) Consider the following table called Orders and answer the questions below:

Orders

Order ID	Customer Name	Customer Address	Product ID	Product Name	Quantity	Unit Price	Total Price
1	JD	123 Elm St	101	Widget A	3	10.00	30.00
1	JD	123 Elm St	102	Widget B	2	15.00	30.00
2	JS	456 Oak St	101	Widget A	1	10.00	10.00
2	JS	456 Oak St	103	Widget C	5	20.00	100.00

i. Decide whether the table is in normalisation or in first normal form (1st NF) and justify your answer.

(2 marks)

ii. Storing **Total Price** in the database is not required. Briefly explain why.

(1 marks)

iii. Bring the table to 3rd NF. Highlight the decisions you need to make and show the intermediate steps (for example 2nd NF tables) as you undertake the normalisation process.

(10 marks)

b) Create the SQL DDL statements to produce the 3rd NF tables. Ensure that referential integrity requirements are defined and include other data integrity constraints as needed.

(9 marks)

c) Provide the SQL statement for a query based on the 3rd NF tables that returns all the data in the original table in the question, including the Total Price.

(3 marks)

[Turn Over]

A3.

a) A charity has set itself the goal of making sure that no child goes without a present on their birthday.

It uses a database to track its clients (children who want a present), toys and requests (the ask for a toy by a child). Consider the following database schema and sample data sets and answer the questions below:

Toys (id, name, colour, minimum_age, weight, number_available)
Clients (id, name, age, address, city)
Request (client_id, toy_id)

Toys

Id	name	colour	minimum_age	weight	number_avaliable
1	spiderman figure	red	3	100g	50
2	trainset	multiple	12	1000g	25
3	easybake oven	pink	4	2000g	3

Clients

id	name	age	address	city
22	A	6	A Street	London
33	B	14	B Street	London
44	C	5	C Street	London
55	D	11	D Street	London

Requests

client_id	toy_id
22	1
33	2
44	3
55	2

i. Write an SQL query that finds the client id, client_name and toy_id, where the age of the client is less than the minimum_age specified for the toy.

(2 marks)

ii. Create a relational algebra query that is equivalent to the query in part i.

(3 marks)

iii. Write a query that identifies the most popular toy and returns its name and id. 'Most popular' means the toy with the most requests (or if there is a tie, the toy with the highest number of requests).

(3 marks)

iv. Explain the purpose of the following SQL query, explaining what the query does overall, not how it works in detail.

```
SELECT c.city, count(*), average(weight)
FROM Toys t, Requests r, Clients c
WHERE c.id = r.client_id AND t.id = r.toy_id
GROUP BY c.city
```

(2 marks)

b) The charity from part a) has some older programmes that stored requests in a table with the following schema:

```
ToyList (client_id, client_name, client_age, toy_id)
```

i. Explain briefly how a 'view' would allow you to ensure that old programmes still work on the new schema presented in part a).

(2 marks)

ii. Write the SQL statement that creates a view to define ToyList.

(3 marks)

c) Expansion of activity for the charity from part a) means that many workers are now testing and preparing toys in several workshops. You need to design a database for this. Create an ER diagram for the following requirements (note the details captured for toys differ from part a):

- Each worker has a unique staff id, name and is assigned to a workshop.
- Some workers are supervisors; supervisors might supervise one or more staff and might also not yet have any supervisees (if they were just promoted).
- Each workshop has a unique name and has a location.
- Each workshop prepares and tests one or more toys and has at least one worker working in it.
- Each toy has a unique id and a name and is prepared or tested in one or more workshops.

(10 marks)

[Turn Over]

Section B
Answer Section B questions in Answer Book B

B4.

a) Relational databases are centred around well-defined schema that organise data with a focus on improving maintainability, providing reliability, and providing standardised data access to applications. Other options for storing data exist.

Explain **each** of the following, providing an example scenario where they would be more appropriate than a relational database and justify your answer

i. Graph-based approach.
ii. Object oriented database.

(16 marks)

b) Key-value databases have been gaining in prominence.

i. Describe what a key-value database is and provide an example application where it would be used.

(5 marks)

ii. Describe **four** characteristics of a good key naming convention.

(4 marks)

B5.

a) Define the concepts of authentication and authorisation in database security and discuss **two** key techniques used in **each**.

(8 marks)

b) A football club has a database that stores details of its players, such as the games they have played and their performance and injury data and also their salary. The database is used by the club manager and the trainer.

They also have a database administrator supporting the system.
These are the tables in use:

- Player (basic player data such as their name)
- Performance (containing information on games played and goals scored)
- Salary (containing details of each player's salary)

Specify the required grant statements to control access for the following three cases:

i. The club manager needs to be able to see all the details in all the tables above, but they should not be able to make any changes.

(2 marks)

ii. The database administrator needs to be able to change table structures but cannot query or update data.

(3 marks)

iii. The trainer should be able to read and update the performance data for players.

(2 marks)

c) What is meant by database auditing, and why is it important?

(3 marks)

d) Provide the process you would undertake to develop an auditing strategy. Your answer should identify the steps to be taken and a rough scope of the activity at each step.

(7 marks)

[Turn Over]

B6.

a) Define the concept of a database transaction and provide an example.

(3 marks)

b) Database transactions ensure integrity by adhering to the ACID properties. Name the **four** properties and explain briefly what they are.

(5 marks)

c) Consider the following transcript of a conversation with a hotel booking agent and answer the questions below.

Customer: "I would like to book two family rooms on 12th September please, for 1 night."
Agent: "Thank you, we have beach view and mountain view rooms available."
Customer: "What are the respective costs?"
Agent: "100USD for a mountain view and 140 for a sea view."
Customer: "Great, can I book two sea view rooms then?"
Agent: "My screen just updated, there is only one sea view room available now."
Customer: "That is a pity; I'll take one room of each kind then. Please."
Agent: "The sea view room is booked, but the other room has now changed price to 120."
Customer: "That is frustrating, but go on and book."
Agent: "OK, all booked now at 260 total price."

i. Use the example to explain why concurrency control is essential in databases.

(2 marks)

ii. Describe the following anomalies and discuss, using evidence from the scenario, how they can manifest themselves:

- Lost update. **(3 marks)**
- Unrepeatable read. **(3 marks)**
- Dirty read. **(3 marks)**

d) Data Centres can be affected by natural catastrophes such as flooding or fires. A data recovery plan helps manage the consequences. Name and briefly explain **four** criteria that a recovery plan ensures.

(6 marks)

END OF EXAMINATION