BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Wednesday 27th April 2022 – 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) Give a definition of a database transaction.

(2 marks)

b) Describe Transaction Recovery and Transaction Atomicity and explain their importance in the processing of database transactions.

(7 marks)

c) The terms Authorisation and Authentication are associated with techniques that maintain database security and integrity.

Explain the difference between these terms and outline the basic techniques that they use.

(8 marks)

d) Explain what is meant by Auditing in a DBMS, discuss why it is important and outline a strategy or a technique that is used to carry it out.

(8 marks)

B6

Consider the scenario for a book collection and answer the questions in part a) and b) below.

The following rules describe the scenario (Please note, we use the term ‘book’ to refer to a title rather than a single specific copy of a book):

- An author has a name and surname.
- An author authors one or many books.
- A book has exactly one author.
- A book has exactly one publisher.
- A book has a title and ISBN number.
- A publisher has a name.
- A publisher might exist but might not yet have published a book.
- A publisher publishes one or many books.
- A book can occur in various formats (e.g. e-book, hardback, paperback).
- A new format might be established before any books are published using it.
- A book has a price, which depends on the format.
- A category describes the type of book, e.g. children’s book, crime, thriller.
- A book can fit into one or more categories.
- A category contains one or more books.

a) Draw the entity relationship diagram for the scenario provided using a suitable notation.

Your answer must show entities with their attributes and their relationships (including cardinality and optionality).

(15 marks)

b) Using your design from part a) design a set of tables. Clearly identify **all** primary and secondary keys and show a few (up to three) rows of data**.**

(10 marks)

End of Examination

B5

Database design involves a number of key steps, such as identification of entities, identification of relationships, identifying attributes, representing the design as, for example, an ERD diagram and identifying keys and normalisation. Answer the following in this context.

a) Define the following concepts and provide an example for **each**:

i) Attribute

(2 marks)

ii) Derived Data

(2 marks)

iii) One-to-many relationship

(2 marks)

iv) Recursive relationship

(2 marks)

v) Foreign key.

(2 marks)

b) Using an example, explain what a many-to-many relationship is and show how you would resolve this in your design.

(5 marks)

c) Today, databases often support systems with web-based front ends. The architectural style used in this context is a three-tier architecture.

i) Give **THREE** reasons why a three-tier architecture is more desirable for web systems than a traditional client-server setup.

(3 marks)

ii) Using a clearly labelled diagram show a typical three-tier architecture and explain the role of **each** tier.

(7 marks)

A2

a)

i) Define the **FOUR** terms that form the ACID acronym which defines the correct behaviour of transactions on a relational database.

(8 marks)

ii) Which **ONE** of these four terms is most likely to affect the throughput of transactions when multiple users access the database? Justify your answer.

(2 marks)

b) A travel agent has a late booking service in which customers can book available seats on flights a day or so before the departure date. Sales are brisk as there are many bargain-hunting customers trying to get seats at discounted prices.

Consider the following transcript of a telephone conversation between a ticket agent and a customer:

> Customer: "I'd like two tickets to Honolulu for January 15."
> Ticket agent: "OK, I have two seats on flight number 192 leaving at 10 a.m."
>
> Customer: "What is the price?"
> Ticket agent: "£900"
>
> Customer: "Great, I'll take them."
> Ticket agent: "The screen has refreshed and the price now is £920"
>
> Customer: "OK please book them."
> Ticket agent: "Oops – I'm sorry. I just tried to reserve them, and they've been sold by another agent.
> Nothing else seems to be available on that date."
>
> Customer: "Argh – that's frustrating *!*…. "

Study the above transcript and then answer the following:

i) Explain the need for concurrency control given the problems that have occurred above.

(3 marks)

ii) Describe **each** of the following anomalies that can occur in database processing and discuss how they could be the cause of the problems that occurred above:

- Lost Update
- Dirty Read
- Unrepeatable Read.

(12 marks)

[Turn Over]

A3

The following table (Fig A3) shows takings received for films screened at several cinemas at a range of locations. Each cinema has a manager who records the takings at one or more locations in which the cinemas operate.

Fig A3.

Film no	Film Name	Cinema No	Cinema name	Cinema Location	Manager No	Manager name	Takings
15	Stealth	1	Odeon	Newcastle	01	Green	£220
		2	ABC	Hull	01	Green	£170
		3	Embassy	Croydon	03	White	£500
45	Titanic	1	Odeon	Newcastle	01	Green	£600
		2	ABC	Cardiff	01	Green	£880
		3	Embassy	Croydon	03	White	£290
		4	Odeon	Edinburgh	04	White	£430
71	Lion King	1	Odeon	Newcastle	01	Green	£180
		5	Gaumont	York	02	Wood	£125
78	Jaws2	2	ABC	Cardiff	01	Green	£150
		3	Embassy	Croydon	03	White	£200
		6	Gaumont	Bristol	05	Brown	£290
88	Stealth	7	Odeon	Croydon	02	Wood	£225

a) Identify any repeating groups in the above table and explain how the data can be reorganised to produce a relation in first normal form. Identify the key attributes of the resulting relation.

(4 marks)

b) Normalise the data, explaining the progression from 1st Normal Form to 2nd Normal Form to a set of 3rd Normal Form relations.

At each stage, show the functional dependencies along with the primary key and any foreign keys of each relation and state assumptions that you make.

(10 marks)

c) Foreign keys are normally designed to protect data in tables that are in a parent-child relationship.

i) State the integrity constraint that can be imposed when two tables are involved in this type of relationship.

ii) Use an example applied to the 3NF tables you produced above in part b) to explain how this constraint works.

(6 marks)

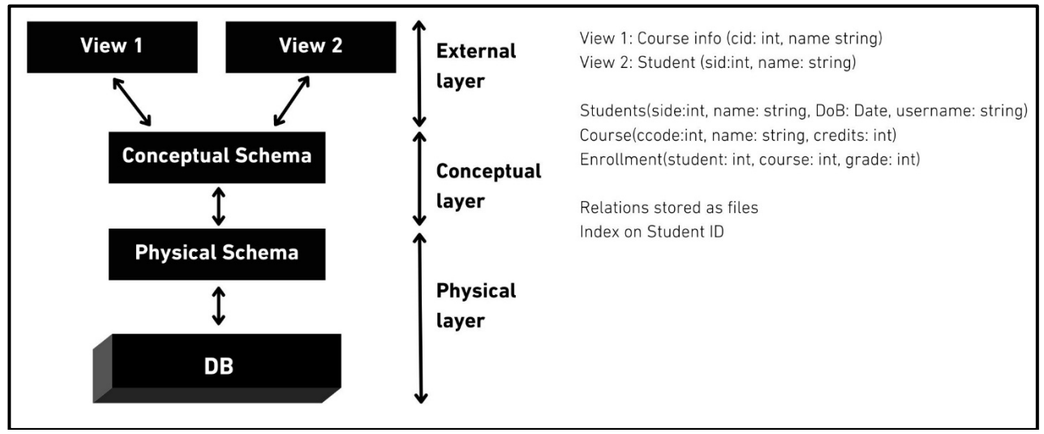
d) Explain the purpose and effects of the SQL clause `ON DELETE CASCADE` that can be added to the foreign key definition.

(5 marks)

Section B
Answer Section B questions in Answer Book B

B4

Database management systems use layered architectures, with layers described by schema ranging from physical schema, via logical schema to external schema. Each such schema captures different aspects. This setup is described in the following figure, together with an example of student enrolment.



a)

i) Briefly explain the concept of logical data independence in DBMS.

(3 marks)

ii) Provide **THREE** examples of changes that can occur under Physical Data Independence.

(4 marks)

iii) Provide **THREE** reasons why data independence is desirable.

(3 marks)

b) Relational database approaches use logically related data items with well-defined schema as the framework for storing data, allowing access to various applications, improving maintainability and providing reliability. Other data storage options exist.

Briefly explain **each** of the following, providing a sample scenario where they are beneficial and justify why they are beneficial in that setting:

i) File-based approach

(7 marks)

ii) Graph-based approach.

(8 marks)

[Turn Over]