BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Thursday 5th October 2023 - Morning

Answer <u>**any**</u> FOUR questions out of SIX. All questions carry equal marks.

Time: TWO 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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i. At the moment, Sam has all privileges on the three tables.
Write SQL statements to…

A) restrict Sam from accessing and or changing any guest details.
B) allow him to only read the details of any payments received.

(4 marks)

ii. Allow Jane permission to enter and maintain all guest information.

(2 marks)

iii. Allow Joe to see only the names of guests that are currently staying at the hotel along with the number of the room that they are currently occupying.

(3 marks)

END OF EXAMINATION

B6.

a) Consider the following schedule of two concurrent transactions and the answer questions below.

Tx1	Tx2
Read (x)	
x := x - 5	
	Read (x)
	x := x + 8
Write (x)	
COMMIT	
	Write (x)
	COMMIT

    i.   What problem occurs in the example?

(2 marks)

    ii.   What is 2 phase locking?

(4 marks)

    iii.   How would 2 phase locking avoid the problem described in part i.?

(3 marks)

b) Briefly explain the concept of a database backup and why it is required.

(3 marks)

c) Explain why a database audit might investigate failed logins and schema changes.

(4 marks)

d) A hotel has a number of users established for its database to ensure that guest data is held safely. The users are:

Sam - a finance administrator who needs to check that payments have been received.

Jane - a check-in clerk who will need to enter guest information and their payment details into the database.

Joe - a concierge who will need to view customer names and their allocated rooms.

The database is designed as follows:

Guests (GuestID, Name, Address)
Stay (StayID, Room No, GuestID, Check-in Date, Check-out date, credit-card-number)
Payments (PID, StayID, DateCredited

Note: The Payments table will have a row for every stay but will not have a DateCredited value until the payment has been received.

Create SQL queries to achieve the objectives on page 11. You will need to use GRANT and REVOKE statements in combination with VIEWS for some of these tasks:

Section A
Answer Section A questions in Answer Book A

A1.

NoSQL databases are seen as an alternative to traditional Relational databases. Relational databases support a structured data model based on Relations, whereas NoSQL databases handle non-structured data, often based on the Key-Value pair data model.

a) Explain, using an example relation, what is meant by the term "structured" data in the Relational data model.

(4 marks)

b) Discuss the benefits of using a Relational Database to store and process "structured" data.

(5 marks)

c) Explain, using an example JSON data element, what is meant by the term "non-structured" data in a NoSQL database supporting the Key Value pair data model.

(4 marks)

d) Discuss the benefits of using a non-relational data model to process "non-structured" data using the following criteria to guide you.

    i.   Data storage and retrieval;
    ii.   Caching;
    iii.   Scalability.

(6 marks)

e) Describe the characteristics of a Big Data application using an application (for example, Facebook) with which you are familiar.

(6 marks)

[Turn Over]

A2.

a) Fig A2.1 shows a table holding details of employees and the projects on which they work. Each project has a name (Pname) and its own unique project number (PNo). Each employee has a unique employee number (ENo), name (Ename) and a job classification (JobClass). The hourly rate (ChrgHr) is the rate per hour that each employee earns on a particular project, which is dependent on JobClass. The number of hours that each employee works on a particular project is recorded in HrsWorked.

Fig A2.1 Project table

| PNo	Pname	ENo	Ename	JobClass	ChrgHr	HrsWorked
1	Meteor	101	Davis	CEng	250	13
1	Meteor	102	Anders	TechE	125	16
1	Meteor	104	Ramora	TechE	125	19
2	Sonic	101	Davis	CEng	250	15
2	Sonic	103	Patel	Graduate	75	17
3	Range	104	Ramora	TechE	125	18
3	Range	102	Anders	TechE	125	14

i. The Project table above (Fig A2.1) is susceptible to update anomalies. Give **ONE** example of an update anomaly that would occur if a row is deleted.

(2 marks)

ii. Explain what is meant by the term Functional Dependency? Illustrate your answer with an example.

(5 marks)

b) Describe and illustrate the process of transforming the Project table (Fig A2.1) into a set of 3rd Normal Form tables.

(11 marks)

B5.

a) Consider the following notations used in Entity Relationship Diagrams (both a 'Crow's foot' and a Chen notation/symbol are provided where they differ) and explain their meaning.

i.

ii.

iii.

iv.

(6 marks)
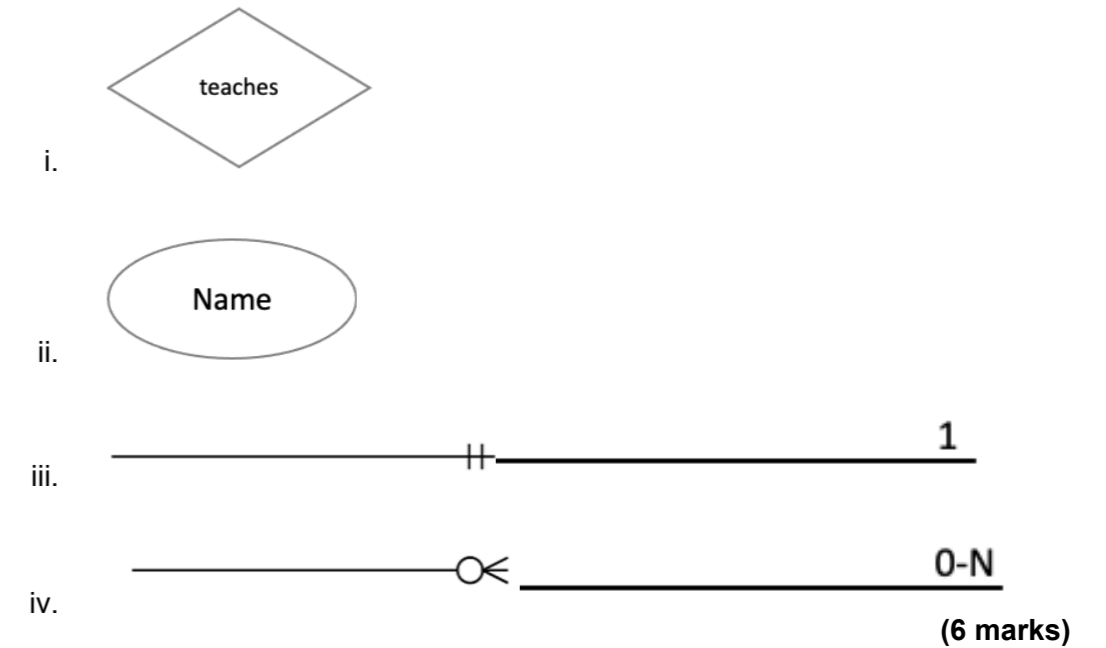
b) Consider the following ERD model. Map the model into the relevant physical design, showing keys as required. You do not need to provide sample data.
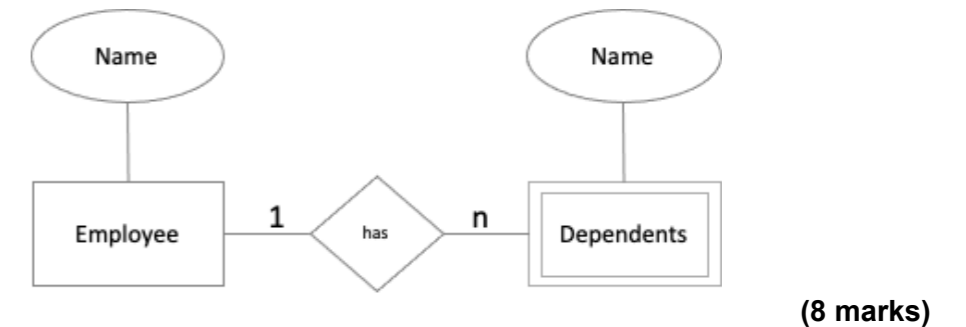
(8 marks)

c) Using your physical design from the previous question (B5, part b), develop the respective SQL DDL statements for creating the tables in an RDBMS. Ensure that all keys are implemented.

(7 marks)

d) Consider the following extract from a SQL table creation statement. Explain what it means and give an example of when you might use it.

```
Age INT,
CHECK(Age >= 18)
```

(4 marks)

[Turn Over]

Section B
Answer Section B questions in Answer Book B

B4.

Relational Databases are very efficient for specific tasks, but there are situations in which other approaches are more suitable. Consider the following case and answer the questions below.

You have a collection of classic comics, with just under 1000 comic books. You like to store information about your collection on your computer and you want to be able to query and maintain the data when you look for a specific comic or add to you collection. You also want to store photos of the cover pages in jpeg format and link these to the relevant entries.

a) Compare a database approach and a spreadsheet-based approach for the above data management need considering the following:

    i. Data representation (how are the needed types of data stored and viewed).
        (4 marks)

    ii. Data manipulation (how do you edit, search and update data).
        (4 marks)

b) Why could a file-based approach be better for managing the data in this example?
        (4 marks)

c) You are starting to trade in comics and need a system that stores customer information and sales transaction data. Why is a database better than a file-based system with regards to the following criteria:

    i. Scalability;
        (3 marks)

    ii. Validation and data integrity;
        (3 marks)

    iii. Authentication.
        (3 marks)

d) Using a DBMS provides physical and logical data independence. What benefit can a developer gain from these two types of data independence in the context of the above scenario and how is it achieved?
        (4 marks)

c) The Teaches relation given below (Fig A2.2) has the following functional dependencies.

```
{Student, Teacher} ⟶ Subject
{Student, Subject} ⟶ Teacher
Teacher ⟶ Subject.
```

Fig A2.2 Teaches

StudentID	TeacherID	SubjectID
John	P.Gray	Database
John	K.Smith	C++
Steve	P.Gray	Database
Steve	R.Ahmed	C++

    i. Give a definition of Boyce Codd Normal Form.
        (3 marks)

    ii. Explain why relation Teaches satisfies 3NF.
        (2 marks)

    iii. Explain why relation Teaches DOES NOT satisfy BCNF.
        (2 marks)

[Turn Over]

A3.

a) Show and explain the information contained in the result obtained by executing **each** of the following three queries (A3a, A3b, A3c) against the Loan and Borrower tables shown in Figs A3.1 and A3.2

NOTE : You should assume that the current date is 29-JAN 2023

Fig A3.1 Table Borrower

BORROWERID	BORROWERFNAME	BORROWERLNAME
874	Leon	Small
875	Gary	Lowe
876	Marik	Ahmed
877	Clywd	Morgan

Fig A3.2 Table Loan

LOANID	BOOKID	BORROWERID	LOANDATE	DUEDATE	RETURNDATE
122	3932	874	15-NOV-2022	14-DEC-2022	24-JAN-2023
123	3944	874	23-DEC-2022	24-JAN-2023	24-JAN-2023
124	3906	874	23-DEC-2022	03-JAN-2023	30-DEC-2022
125	3944	876	29-JAN-2023	28-FEB-2023	-
126	3932	874	25-JAN-2023	21-FEB-2023	-
127	3945	876	25-JAN-2023	21-FEB-2023	-

Query A3a

```
SELECT    BorrowerLname
        , BorrowerFname
            , BookID
            , Duedate
            , returndate
FROM Borrower
INNER JOIN Loan
     ON Loan.BorrowerID = Borrower.BorrowerID
     WHERE Returndate > Duedate
```

(4 marks)

Query A3b

```
SELECT COUNT(*) B_TOTAL
     ,BorrowerLname
FROM Loan
INNER JOIN Borrower
     ON Borrower.BorrowerID = Loan.BorrowerID
GROUP BY BorrowerLname
HAVING COUNT(*) > 2
```

(5 marks)

Query A3c

```
SELECT A.LoanID
          ,A.BookID
          ,A.BorrowerID
          ,A.Returndate
          ,C.BorrowerLname
FROM Loan A
INNER JOIN Loan B
        ON B.BookID <> A.BookID
        AND A.Returndate = B.Returndate
        AND A.BorrowerID = B.BorrowerID;
INNER JOIN Borrower C
    ON C.BorrowerID = B.BorrowerID;
```

(5 marks)

b) Explain, using the following SQL statement the differences between a LEFT OUTER JOIN and an INNER JOIN.

Include in your answer **TWO** result sets that show the effect of replacing the INNER JOIN with a LEFT OUTER JOIN.

(6 marks)

```
SELECT   BorrowerLname
       , BorrowerFname
           , Duedate
           , returndate
FROM Borrower
INNER JOIN Loan
     ON Loan.BorrowerID = Borrower.BorrowerID
     WHERE Returndate IS NULL
```

c) Views are an integral and essential part of most database systems. What is a VIEW? Give an example SQL statement that would create a VIEW involving data from both the `Loan` and `Borrower` tables above. Provide a SQL `SELECT` statement that uses the view.

(5 marks)