

**BCS THE CHARTERED INSTITUTE FOR IT**  
**BCS HIGHER EDUCATION QUALIFICATIONS**  
**BCS Level 5 Diploma in IT**

**DATABASE SYSTEMS**

Tuesday 24<sup>th</sup> March 2020 – 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 <b>NOT</b> allowed in this examination. |
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**SECTION A**  
**Answer Section A questions in Answer Book A**

**A1.**

This question relates to the deployment of a traditional database application on a client server platform. Recall that a database system is only one component in a larger IT infrastructure.

- a) Compare and contrast two-tier platforms and three-tier web based platforms.  
**(5 marks)**
  
- b) Describe the advantages of using a 3-tier web-based platform over a two-tier platform.  
**(4 marks)**
  
- c) Explain why a **Form** is regarded as being fundamental in the design of a user interface to a database.  
**(3 marks)**
  
- d) Describe, aided by a drawing, the functionality of a **Form** based user interface to a database. Use as an example a familiar interactive on-line application such as the purchasing of goods using a shopping cart.  
**(6 marks)**
  
- e) Explain, using simple examples of code/pseudocode, how a database server is accessed from a PC client for either a two-tier or a three-tier platform.  
**(7 marks)**

**[Turn Over]**

**A2.**

Relational databases are very effective in situations for which they are appropriate. In other situations, spreadsheets and/or file-based solutions may be sufficient.

Suppose you wanted to store information about a collection of around 5,000 artefacts, such as books, CDs and DVDs on a personal computer. Once you have stored the information in an organised way you then need to query and maintain your collection. You also want to include photos and images in JPEG format that are associated with existing artefacts.

You have the choice of using one of the following approaches to data storage:

- (i) File based approach;
- (ii) Database approach;
- (iii) Spreadsheet based approach.

a) Compare the above approaches in meeting the above requirements under the following headings:

- (i) Data representation (how all types of data is structured and viewed);
- (ii) Data manipulation (such as editing, updating, searching).

**(4 marks)**

b) Why might it be advantageous to use a file based approach rather than a database approach?

**(3 marks)**

c) Why might it be advantageous to use a spreadsheet approach rather than a database approach?

**(3 marks)**

d) Suppose you have now started a business in which you have customers who have paid a subscription to borrow books, CDs and DVDs and can also purchase photos and images. Therefore, you are now required to implement a system for storing additional information about customer accounts/orders/loans and reservations.

Covering **EACH** of the **topics** listed below, explain why a database system would be regarded as being superior to a file-based system for this task. Illustrate your answer with suitable examples.

- (i) Scalability;
- (ii) Data Independence;
- (iii) Validation and data integrity;
- (iv) Recovery;
- (v) Authentication.

**(15 marks)**

**[Turn Over]**

**A3.**

Consider the following scenario of a pizza restaurant.

Servers make sales. Each server has a unique ID and has a name.

Each server can (and is expected to) make many sales, and each sale is made by a single server. The date and time of the sale is recorded.

Each sale involves at least one pizza but may include many. The quantity of each pizza type included in the sale is recorded.

Each pizza has a unique ID, a type (e.g. Margherita) and a cost.

Each pizza contains many ingredients, and each ingredient can be included in many pizzas. Each ingredient has a unique ID and has a type (e.g. Mozzarella cheese).

The quantity (in grams) of each ingredient in each pizza is recorded.

The restaurant uses the services of multiple suppliers. Each supplier has a unique ID, a name and an address. Each supplier can supply many ingredients, and the same ingredient could be supplied by multiple suppliers.

a) Using a recognised modelling notation of your choice, draw an Entity-Relationship model for the scenario above, showing:

- (i) The entity types, with corresponding attributes and primary keys;
- (ii) The relationships between those entities. For each relationship show their degree (One:One; One:Many or Many:Many) and participation (Mandatory or Optional).

State any assumptions you make to fill any gaps in the scenario.

**(13 Marks)**

b) Design a set of tables derived from your Entity-Relationship model in part (i) above. Clearly highlight all primary keys and foreign keys. Fill in the tables with sample data that represents all of the degrees of the relationships. Limit the number of rows in any table to a **MAXIMUM** of 4 rows per table.

**(12 Marks)**

**[Turn Over]**

**SECTION B**  
**Answer Section B questions in Answer Book B**

**B4.**

a) With reference to a sample relation of your own choosing, explain and discuss the following relational model terminology, including its function in query processing and any related concepts. Provide a diagram showing your sample relation.

- (i) Tuple;
- (ii) Attribute;
- (iii) Domain;
- (iv) Degree;
- (v) Cardinality.

**(15 marks)**

b) Using your own simple examples, explain how the four **set** operations work within Relational Algebra and what limitations the concept of **union compatibility** places upon these sets being processed. Use suitable Venn diagrams and sample relations.

**(10 Marks)**

**B5.**

Explain, using your own relations, diagrams and, if appropriate, code samples, how the following database concepts are implemented:

- a) The ACID properties of transactions;
- b) COMMIT;
- c) SAVEPOINT;
- d) ROLLBACK;
- e) TWO-PHASE COMMIT.

**(25 Marks)**

**[Turn Over]**

**B6.**

- a) Describe the concept of full functional dependency and describe how it relates to 2<sup>nd</sup> Normal Form (2NF). Illustrate your answer with an example.

**(3 Marks)**

- b) A hospital uses the “Patient Medication Form”, shown below, to record details of patients and the medication dispensed to them.

| Patient Medication Form |              |             |          |                         |               |            |             |
|-------------------------|--------------|-------------|----------|-------------------------|---------------|------------|-------------|
| PatientNumber: P134     |              |             |          | PatientName: John Smith |               |            |             |
| WardNumber: W17         |              |             |          | WardName: Orthopaedic   |               |            |             |
| Drug Number             | Name         | Description | Dosage   | Method of Admin         | Units per day | Start Date | Finish Date |
| 101                     | Morphine     | Pain Killer | 10mg/ml  | Oral                    | 50            | 14/09/19   | 28/09/19    |
| 101                     | Morphine     | Pain Killer | 0.5mg/ml | IV                      | 10            | 12/09/19   | 19/09/19    |
| 102                     | Tetracycline | Antibiotics | 10mg/ml  | Oral                    | 10            | 14/09/19   | 21/09/19    |

Transform the form above into a set of normalised tables (up to 3NF). You can assume that PatientNumber is the primary key of the un-normalised table equivalent to this form. Clearly indicate the primary key in each table you create.

**(10 Marks)**

- (c) At a summer camp, each assistant is assigned a cleaning job in order to keep the place tidy. The following table is used to record details of jobs.

**Cleaning**

| Assistant ID | Name  | Job    | Room    |
|--------------|-------|--------|---------|
| A1           | Ellen | Sweep  | Kitchen |
| A2           | Tom   | Polish | Kitchen |
| A2           | Tom   | Sweep  | TV Room |

However, one year there are not as many assistants, so some assistants have to carry out several cleaning jobs.

- (i) Explain why the above design is no longer appropriate.  
 (ii) Show how the above table can be transformed so that it can handle the new situation. Clearly indicate, and justify, the choice of any primary keys.

**(5 Marks)****[Turn Over]**

- (d) In a delivery company, each driver may drive any van, and each van may be driven by any driver. The following table records the distance driven by each driver in each van.

**Mileage**

| <b>DriverID</b> | <b>VanID</b> | <b>Driver name</b> | <b>Van make</b> | <b>Mileage</b> |
|-----------------|--------------|--------------------|-----------------|----------------|
| D01             | V03          | Smith              | Ford            | 350            |
| D02             | V01          | Frost              | Mercedes        | 800            |
| D01             | V01          | Smith              | Mercedes        | 200            |

- (i) Explain how update anomalies could arise in the above table.  
(ii) Show how the table can be normalised (up to 3NF). Clearly indicate the primary key in each table you might create.

**(7 Marks)**

**END OF EXAMINATION**