

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

**DATABASE SYSTEMS**

**Thursday 27<sup>th</sup> September 2018 - 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

- a) The three-level (or three-tier) system architecture can be interpreted in different ways. Describe, using TWO well-annotated diagrams, the different and distinct meanings of the phrase **three-level architecture** for each of the following system architectures:

(i) Databases and the ANSI-SPARC architecture.

**(5 marks)**

(ii) Web-Database (three-tier) architecture.

**(5 marks)**

- b) Many organisations have a choice to deploy their data resources and services EITHER using their own IT infrastructure, OR by choosing to have their data resources and services managed remotely by hosting databases on the 'Cloud'.

Discuss the key strengths and limitations of these alternative approaches.

**(15 marks)**

#### A2

This question relates to concurrency control in a multi-access online database application, such as order processing or booking appointments.

- a) Define the term database transaction and state the function of the following keywords:

COMMIT  
SAVEPOINT  
ROLLBACK

**(6 Marks)**

- b) Describe how the following anomalies could arise if two or more transactions access the same database table concurrently. Use examples of simple transactions to illustrate your answer.

(i) DIRTY READ.

**(4 marks)**

(ii) NON-REPEATABLE READ.

**(4 marks)**

(iii) PHANTOM READ.

**(4 marks)**

**Turn over**

c) The ANSI/ISO SQL standard has defined four isolation levels that determine whether the anomalies (in part b) are allowed. Describe the effect of the following isolation levels on concurrency.

(i) READ COMMITTED isolation level.

(2 marks)

(ii) SERIALIZABLE isolation level.

(2 marks)

d) How would a DBA recover **transactions** that were lost following a system crash involving loss of memory?

(3 marks)

### A3

A company uses a number of items of equipment to produce goods. Each item has a unique ID, and has a description. Faults on items are identified by unique IDs, have descriptions, and are reported at a time represented by `time_reported`.

Any number of technicians may be assigned to work on a fault until it is fixed. The time at which each fault is fixed is recorded as `time_fixed`. Each technician also records the time spent (hours) on each fault as `time_spent`.

Any number of parts may be used to fix a fault. The `qty_used` of each part is noted against the corresponding fault.

Each part is identified by an ID, has a given name and can have any number of vendors. Vendors are identified by an ID, a name and an address.

Each technician is identified by an ID, has a `full_name` and zero or more qualifications.

Each qualification has a unique ID, name and awarding body. The date when a technician has gained any given qualification is also recorded.

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

- The entity types, with corresponding attributes and primary keys.
- 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.

(16 Marks)

(b) Design a set of tables derived from your Entity-Relationship model in part (a) 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.

(9 Marks)

Turn over

## SECTION B

### Answer Section B questions in Answer Book B

**B4**

This question is based on the following relation, which concerns a veterinary practice, specialising in dogs and general canine care. *The client is the dog, not the owner, so all of the data relates to the dog.*

Relation name: **CLIENT**

Client ID	Client Name	Client Breed	Client Birth Date	Sex	Treatment ID	Owner ID
C1	Bruno	Rottweiler	12-MAR-2013	M	T1114	O102
C2	Angel	Bullmastiff	03-FEB-2014	F	T1223	O112
C3	Ruby	German Shepherd	24-JUN-2011	F	T1443	O347
C4	Crunchy	Labrador Retriever	30-OCT-2012	M	T2998	O732
C5	Karl	German Shepherd	10-AUG-2011	M	T1338	O347
C6	Tamara	Poodle	04-DEC-2015	F	T1664	O223
C7	Rocky	Rottweiler	11-NOV-2009	M	T2998	O102
C8	Bobby	Pitbull Terrier	26-AUG-2013	M	T2034	O734
C9	Charles	Spaniel	08-FEB-2010	M	T2112	O552
C10	Simba	Labrador Retriever	11-MAR-2014	M	T1765	O375

(a) For each of the following descriptions name the correct relational concept and give an example based on the CLIENT relation and show the result when the concept is applied.

- (i) Provides a mechanism for uniquely identifying each row in the relation. **(2 Marks)**
- (ii) Describes the number of rows in the relation. **(2 Marks)**
- (iii) Describes the number of columns in the relation. **(2 Marks)**
- (iv) Describes the permitted values in any given column. **(2 Marks)**
- (i) Provides a mechanism for linking to another relation(s). **(2 Marks)**

(b) For each of the following relational concepts, explain how it is implemented, how it constrains the data and the options available when it is defined. Refer to the CLIENT relation to provide suitable examples.

- (i) Entity Integrity. **(5 Marks)**
- (ii) Referential Integrity. **(5 Marks)**

**Turn over**

(c) Write a single sentence with a basic example (based on *any* relation) to define and illustrate the following relational concepts.

- (i) Candidate Key. (1 Mark)
- (ii) Alternate Key. (1 Mark)
- (iii) Atomic Key. (1 Mark)
- (iv) Composite Key. (1 Mark)
- (v) Primary Key. (1 Mark)

## B5

The directors of an animal welfare practice are keen to push forward with a web-enabled system to allow online self-booking by their (human) customers but, they have need for some technical and expert IT advice.

- (a) Explain to the directors, *using your own examples and code samples*, how the following database concepts are implemented and how they relate to each other:
  - (i) Data integrity. (5 marks)
  - (ii) Data validation. (5 marks)
  - (iii) Data security. (5 marks)
- (b) Explain, using your own examples and code samples, how the following concepts can be implemented into the new veterinary practice web-based IT system. Comment on the usefulness and features of such an approach.
  - (i) Data hiding using views. (5 marks)
  - (ii) Referential integrity. (5 Marks)

Turn over

**B6**

- (a) Explain what is meant by normalisation, then describe ONE advantage and ONE disadvantage of normalisation. **(4 Marks)**
- (b) Consider the following table: Test (A, B, C, D, E). Assume the following dependencies exist amongst its attributes:
- $A, B \rightarrow C, D, E$
  - $A \rightarrow D$
  - $C \rightarrow E$
- (i) Identify and discuss each of the dependencies indicated above. **(3 Marks)**
- (ii) Transform the Test table above into normalised tables (up to 3<sup>rd</sup> Normal Form). The primary key is clearly indicated in each table. **(3 Marks)**
- (c) Discuss whether the following statement is true or false: "An attribute that is part of a composite primary key is also a candidate key". Support your answer with a clear justification. **(3 Marks)**
- (d) Briefly explain why a table that is in 1<sup>st</sup> Normal Form and has no composite primary key is automatically in 2<sup>nd</sup> Normal Form. **(2 Marks)**
- (e) A company uses the following table to record details of invoices, products sold and vendors supplying those products. This table has a composite primary key (InvoiceNo, ProductNo). You can assume that any invoice may refer to more than one product.
- Invoices (InvoiceNo, ProductNo, SaleDate, ProductDescription, VendorCode, VendorName, QuantitySold, ProductPrice)
- (i) Identify any partial dependencies and transform into tables that are in 2<sup>nd</sup> Normal Form. Ensure the primary key is clearly indicated in each potential new table. **(6 Marks)**
- (ii) Identify any transitive dependencies and transform into tables that are in 3<sup>rd</sup> Normal Form. Ensure the primary key is clearly indicated in each potential new table. **(4 Marks)**