

BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 6 Professional Graduate Diploma in IT

ADVANCED DATABASE MANAGEMENT SYSTEMS

Wednesday 30th March 2016 - Afternoon

Answer **any** THREE questions out of FIVE. All questions carry equal marks.

Time: THREE 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

The hosting of database services on the 'Cloud' is representative of a Service Oriented Architecture (SOA). The SOA Company that hosts a client's database distributes their database physically and geographically, replicating their data across multiple database servers.

- a) Outline the benefits of the distributed database architecture described above as opposed to a database that is centralised and not hosted. Illustrate your answer with a scenario of your choice that describes a database application that would benefit from this approach.

(7 marks)

- b) Describe the concept of **data replication** as a particular technique for distributing data and explain using your application as a source of examples how this is achieved.
(Hint: use diagrams and examples to illustrate how a distributed database is configured and accessed)

(9 marks)

- c) Given that the fundamental principle of a distributed system is that to a database user a distributed database system should behave exactly like a non-distributed system. Discuss the implications of the above statement on database integrity and the consistency of distributed queries and transactions in a distributed database that supports replication.

(9 marks)

A2

- a) Draw a Class diagram using a stated notation, for example UML, derived from the following schema.

(8 marks)

```
Class Furniture (  
String furniture_id ;  
String furniture_model;  
String furniture_maker;  
Date   date_of_purchase;  
String colour;  
String setFurniture_id (string furniture_id);  
String getFurniture_id ();  
)
```

```
Class table inherits from furniture (  
Number leg;  
Number drawer;  
Number setLeg (number leg);  
Number getLeg ();  
Number getDrawer();  
)
```

```
Class coffee_table inherits from table;  
String material  
String setMaterial (string material)  
String getMaterial();  
)
```

```
Class dining_table inherits from table (  
String shape;  
String dimensions;  
String setShape (string shape);  
String getShape();  
String getDimension (string shape);  
String setDimension(string dimension);  
Boolean CheckInStock(string shape);  
)
```

```
Class chair inherits from furniture (  
String style;  
String setStyle (string style);  
String getStyle();  
)
```

b) Explain each of the following Object Oriented data modelling concepts providing an example of each concept.

- Object Identity
- Object Relationships
- Object State

(8 marks)

c) There are a number of problems that arise in connection with the mapping of an object oriented system to a relational database and vice versa. These problems are referred collectively as *object-relational impedance*.

Explain the problems associated with object-relational impedance. Give particular regard to mapping the schema in part a) above to a Relational database.

(9 marks)

A3

(a) Consider the following three linked tables that contain information about students, the modules they are studying, and results of assessments for those modules:

```
students (studID, name, course)
modules (modNbr, title, credits)
results (studID*, modNbr*, date, grade)
```

Consider the following query:

```
SELECT M.title, S.name
FROM students S, modules M, results R
WHERE S.studID = R.studID
AND M.modNbr = R.modNbr
AND S.course = 'Computing'
AND M.credits = 15
AND R.grade = 'A';
```

Draw a query tree that corresponds to the most efficient way of processing this query.

(12 marks)

(b) Securing a database aims to achieve the following objectives:

- Confidentiality
- Integrity
- Availability

(i) Briefly describe what is meant by each of the above objectives.

(3 marks)

- (ii) For each objective, describe two appropriate security controls. **(3 marks)**
- (c) Malicious users, such as hackers, can use some of the characteristics of the SQL language to their advantage.
- (i) SQL is case-insensitive. Discuss why this fact makes it more difficult to defend against SQL injection attacks. **(2 marks)**
- (ii) SQL imposes a precedence rule on the use of logical operators: the AND operator has precedence over the OR operator. Using an example of your choice, illustrate how this precedence works. **(2 marks)**
- (iii) Explain how a hacker could take advantage of this precedence rule during an SQL injection attack. **(3 marks)**

Section B

Answer Section B questions in Answer Book B

B4

- (a) The design of data warehouses extends and enhances the underlying concepts from database design. For each of the following three approaches, using appropriate supporting examples of your own choosing, explain and discuss the essential concepts and design issues of each.
- (i) Entity and Enhanced Entity Relationship Diagrams **(5 marks)**
- (ii) Star Schemas **(5 marks)**
- (iii) Snowflake Schemas **(5 marks)**
- You should particularly address the roles of primary and foreign keys, normalized & de-normalized data. Good diagrams are essential.
- (b) By their very nature, data warehouses get bigger over time. As the search space increases, the query performance decreases and tuning techniques are required. For each of the two approaches listed below, using your own appropriate diagrams and examples, explain and discuss the essential concepts and techniques.
- (i) Aggregation & Summary Data **(5 marks)**
- (ii) Indexing & Optimization **(5 marks)**

B5

Ensuring data integrity and consistency is of vital importance to a DBMS during the application of transactions to the database, particularly concurrent transactions. Using your own suitable examples and diagrams, explain and discuss the following transaction-related concepts. Five marks each.

- (i) ACID Properties **(5 marks)**
- (ii) COMMIT & TWO-PHASE COMMIT **(5 marks)**
- (iii) ROLLBACK & CASCADED ROLLBACK **(5 marks)**
- (iv) Locking – Optimistic & Pessimistic **(5 marks)**
- (v) Checkpoints & Savepoints **(5 marks)**