

BCS THE CHARTERED INSTITUTE FOR IT

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

ADVANCED DATABASE MANAGEMENT SYSTEMS

Friday 13th November 2020 - 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.

- a) Consider the following table:

customers (custid, name, city).

The table is stored in 100 blocks in a disk file and the primary key index is a B-Tree with 4 levels and 10 leaf nodes.

For each of the following queries, state how the query is to be executed (e.g., full table scan, full index scan, etc.) and calculate the associated cost (in number of blocks):

- i) `SELECT custid
FROM Customers;`
- ii) `SELECT name
FROM customers
WHERE Custid = 10;`
- iii) `SELECT *
FROM customers
WHERE city = 'London';`

(9 Marks)

- b) There is an index on the column “City” of the “Customers” table from part a) above. Explain how this index could be used when executing each of the following queries:

- i) `SELECT name
FROM customers
WHERE city = 'London';`
- ii) `SELECT name
FROM customers
ORDER BY city;`
- iii) `SELECT COUNT(city)
FROM Customers;`

(10 Marks)

- c) Describe **TWO** possible security controls for each of the following threats to database security:

- i) Loss of confidentiality;
- ii) Loss of integrity;
- iii) Loss of availability.

(6 marks)

A2.

Using appropriate example code and diagrams, explain how the following database concepts are implemented and used.

- a) Outer Join. (5 Marks)
- b) Database Trigger. (5 Marks)
- c) Star Schema. (5 Marks)
- d) Data Replication. (5 Marks)
- e) Query Optimisation. (5 Marks)

A3.

- a) Threats to databases can result in the loss or degradation of some or all of the following commonly accepted security goals: integrity, availability, and confidentiality. Explain **EACH** of these goals and why it is very important to achieve them. Discuss the impact of the loss of **EACH** on data security. (13 Marks)
- b) To protect databases against the loss of integrity, availability and confidentiality, it is common to implement some control measures. Explain the following security measures from a database perspective:
 - i) Access control;
 - ii) Data redaction;
 - iii) The granting of privileges and roles;
 - iv) Encryption.(12 Marks)

[Turn Over]

Section B
Answer Section B questions in Answer Book B

B4.

- a) Describe the following types of data models regarded as alternatives to the relational model. Include in your answer an explanation of the type and nature of the data they model; how data is stored, processed and presented. Provide examples to illustrate your answer.
- i) Object oriented;
 - ii) Graph;
 - iii) Hierarchical or Tree structured.

(18 marks)

- b) An alternative to using these data models involves adapting existing Relational Database Systems (RDBMS) to accommodate the modelling requirements of data having a non-relational structure.

Choose **ONE** of the above data models and discuss how this might be achieved in practice.
(7 marks)

B5.

- a) Describe, using example transaction schedules, **EACH** of the following problems that occur when transactions run concurrently in a multi-user database.
- i) Inconsistent (dirty) reads;
 - ii) Cascading rollbacks/aborts.

(8 marks)

- b) State the Two Phase Locking (2PL) protocol.

(2 marks)

- c) Explain using example transaction schedules how the 2PL protocol can prevent **ONE** of the following problems.

- i) Inconsistent (dirty) reads;
- ii) Cascading rollbacks/aborts.

(2 marks)

- d) Explain briefly what is meant by blocking (of transactions).

(2 marks)

e)

- i) Explain why row level locking is generally preferred to table level locking.
- ii) Row level locks can be regarded as being weaker than table level locks. Describe a situation in which row level locking can give rise to problems when compared to table level locking.

(5 marks)

- f) An end user of a database informs the database administrator (DBA) that he ran a transaction around a week ago that committed some changes to the data in the database.

He is now saying that this transaction was run in error and the changes were wrong.

Outline the options and steps that the DBA might take to analyse and try to handle this situation and mitigate any problems.

(4 marks)

- g) Explain the use of savepoints when designing and executing large transactions that affect database data.

(2 marks)

END OF EXAMINATION