BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Tuesday 17th November 2020 - Morning

Answer **any** 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.

A1.

A small company is considering moving its data files onto a database system. Currently, users access data files and applications such as spreadsheets over a local area network.

a) Explain briefly why **EACH** of the following features used within a database approach offers important advantages when compared with a file based/spreadsheet approach.

Provide simple example scenarios where appropriate to assist your answer.

  i) Data Redundancy;
  ii) Data Independence (on Application Programs);
  iii) Data Consistency;
  iv) Data Integrity;
  v) Data Security.

(20 marks)

b) Apart from the recognised benefits above, discuss the challenges the company will encounter when moving from a file-based approach to a database approach.

(5 marks)

A2.

Scenario

AGUK Cycles is a company that manufactures, sells and delivers bicycles to retailers around the world. They have **THREE** manufacturing sites each located at a different site around the world. The headquarters of AGUK is based at their Birmingham (UK) manufacturing site. Currently the company has a centralised database located at its headquarters that handles all the data processing needs of the company. The **MOST** important being purchase orders (of parts), sales orders (of bicycles) and manufacturing data.

a) AGUK are proposing to deploy a ***three-tier web-based architecture*** to support their data processing needs using a centralised Database Management System (DBMS) and various application servers.

Describe, using a clearly labelled and annotated diagram, the overall function of each of the three tiers of this architecture and state **ONE** advantage that the three-tier architecture has over a traditional client server (2 tier) architecture.

(8 marks)

b) Instead of using a centralised database, an alternative approach is to use a Distributed DataBase Management System (DDBMS) where each of the company sites hosts its own database.

c) Assume that AGUK holds its manufacturing data in a table called `Products`. A sample of the data contained in this table is shown below:

`Products` table

ProductID	ProductName	Cost	DrawingID	Plant	Qty
P1233	MN_tourer	400	122-5	Birmingham	49
P1235	FR_city	200	501-5	Mumbai	1092
P1236	MR_city	205	763-8	Mumbai	1789
P1240	MG_electric	950	342-7	Mumbai	56
P1245	FB_foldup	750	341-1	Shanghai	345
P1249	MX-racer	2000	656-0	Shanghai	132

The columns are described below:
`ProductID` is the unique product number.
`Productname` is the name of bicycle manufactured.
`Cost` is the cost of manufacturing.
`DrawingID` is the design drawing used for assembly of the product.
`Plant` is the name of the plant location where the product is manufactured.
`Qty` is the quantity of products that have been manufactured and are ready for selling.

    i) Give a definition of a DDBMS and give **TWO** reasons why AGUK could benefit from using a DDBMS rather than using a centralised DBMS.

    ii) Describe **EACH** of the following approaches that could be used to distribute the data in the `Products` table (given above) across the three manufacturing sites:
        1. Fragmentation (based on values in the `Plant` column).
        2. Replication.

Discuss the advantages and disadvantages of each approach.

(17 marks)
[Turn Over]

A3.

a) Describe the essential characteristics of a database transaction.

(4 marks)

b) A customer's table contains the data shown below in figure F.1:

customers

CUSTOMER_ID	CUSTOMER_NAME	CUSTOMER_INI	CUSTOMERDOB	CUSTOMERPC
56375	Mahrez	I.S.T	12-APR-90	TS14 4AY
85749	Barron	J.P	15-APR-64	KT37 8GR
98546	Morrison	K.L	12-MAY-89	HU2 5TY
98666	Ahmed	I	19-SEP-99	SR4 7GW

Figure F.1 Customers data.

Study the following routine which shows the execution of a sequence of SQL statements that process data in the `customer's` table:

```
SQL> SAVEPOINT sp1;
Savepoint created.

SQL> DELETE FROM customers WHERE customer_id = 98546;
1 row deleted.

SQL> SAVEPOINT sp2;
Savepoint created.

SQL> DELETE FROM customers WHERE customer_id = 85749;
1 row deleted.

SQL> SAVEPOINT sp3;
Savepoint created.

SQL> DELETE FROM customers WHERE customer_id = 98666;
1 row deleted.

SQL> ROLLBACK TO sp2;
Rollback complete.

SQL> COMMIT;
```

Explain the effect of **EACH** of the `SAVEPOINT`, `ROLLBACK` and `COMMIT` commands when the sequence of statements is executed.

(7 marks)

c) Describe the essential characteristics of database views that are created using the `CREATE VIEW` statement in SQL.

Discuss the advantages and drawbacks of using views in a typical database application that involves querying and updating the data on which the views are based.

(8 marks)

d) An accounts table contains the data shown below in Figure F.2:

accounts

ACCOUNT_ID	SORT_CODE	ACCOUNT_TYPE	BALANCE	CUSTOMER_ID
93008	30-54-87	Direct Debit	20	56375
331449	30-54-87	Credit	40	56375
57746	30-54-87	On-line Saver	10	85749
16227	30-54-87	Direct Debit	10	85749
92354	30-54-87	Direct Debit	20	98666
33945	30-54-87	Direct Debit	20	98546

Figure F.2 Accounts data.

Study the following routine which shows a sequence of the execution of SQL statements that handle data in the accounts table:

```
SQL> CREATE VIEW vw_avgbal AS
     SELECT AVG(balance) AS avgbal
     FROM accounts;

     --S1
SQL> SELECT *
     FROM vw_avgbal;

     --S2
SQL> SELECT account_id
          ,balance
          ,balance – avgbal as diff
          ,customer_id
     FROM accounts a CROSS JOIN vw_avgbal vw
     WHERE account_type = 'Direct Debit';

SQL> UPDATE accounts
     SET balance = -50
     WHERE account_id = 16227;

     --S3
SQL> SELECT account_id
          ,balance
          ,balance – avgbal AS diff
          ,customer_id
     FROM accounts a CROSS JOIN vw_avgbal vw
     WHERE account_type = 'Direct Debit';
```

Show the data returned by the **THREE** select statements (labelled s1, s2 and s3) used in the above sequence of operations.

(6 marks)

SECTION B
Answer Section B questions in Answer Book B

B4.

Consider the following scenario about mobile phones and answer the questions in parts (a) and (b) below. The following rules describe the scenario:

- A customer has a name, address and bank details.
- A customer owns one or more devices. Each device is identified by an IMEI number, assigned a phone number and has a make and model.
- A device is registered to a mobile provider. A mobile provider has a name.
- A customer with several devices can have these registered with one provider or they might use several providers.
- A customer makes calls on their device. A call has a start time, date and duration as well as the called number. A customer might not make any calls on a device.
- A call can be started on one device and continued on another.
- Each month a customer receives a bill. A bill is issued by the mobile provider. A bill contains a list of all calls made on a device in said month.
- A customer will only receive one bill from each provider in each month (so if they have several devices with the same provider, the calls will be combined onto one bill).

a) Draw an Entity-Relationship Diagram for the mobile phone scenario using a suitable notation. Your answer must show the entities and their relationships. Cardinalities and optionality between entities must be shown. State any additional assumptions you are making.

(15 marks)

b) Design a set of tables derived from the Entity-Relationship Diagram in part (a). Highlight all primary and foreign keys and show a few rows of sample data (not more than 4 rows per table).

(10 marks)

B5.

Consider the following **TWO** tables and answer the questions below:

Sells

ID	Bar	Drink	Price
1	Mo's	Duff's Beer	2.4
2	Mo's	Coke	2.1
3	Rat and Corn	Buff's Ale	2.7
4	Rat and Corn	Coke	2.0
5	The 3 Swans	Milk	1.0

Bars

Name	Address
Mo's	River Street
Rat and Corn	Back Lane

a) Write SQL Data Definition Statements to create the **TWO** tables above. Choose suitable data types. Ensure that suitable keys are defined.

(10 marks)

b) Consider the following relational algebra queries and answer the questions below each.

   i) σ (name=Mo's) Bars
      1. Show the table that results from executing the query.
      2. Write the matching SQL query.

   ii) π (Drink (σ (name=Mo's)(Sells))) - π (Drink (σ (name=Rat and Corn)(Sells))).
      1. Explain what the query does.
      2. Write the matching SQL query.

   iii) π (ID, Address (⋈ (Sells, Bars)))
      1. Show the table that results from executing the query.
      2. Write the matching SQL query.

(13 marks)

c) Consider the following SQL queries and create matching relation algebra queries:

```
SELECT Drink, Bar
FROM Sells
WHERE Price > 2.1;
```

(2 marks)

[Turn Over]

B6.
   a) Explain the concept of a Surrogate Key in Relational Databases.

(3 marks)

   b) What is the consequence of the SQL clause 'ON UPDATE CASCADE'?

(3 marks)

   c) Describe **ONE** feature that differentiates a table in 1st Normal form from an unnormalised table.

(2 marks)

   d) Consider the following unnormalised table. Using the example table shown below, illustrate the process of normalisation by showing the resultant tables when placed in 1st, 2nd and 3rd Normal Form.

Course Code	Venue	Department	Lecturer	Textbook
CS101	Lecture Room 1	Computing	Prof Miller	"Programming in C"; "Basics of Programming"
CS102	Main Hall	Computing	Dr Green	"Algorithms"; "Data Structures"
MA100	Main Hall	Mathematics	Prof Blue	"Number Theory"
BS300	Lab 3	Biological Sciences	Dr Smith	"Neuro Biology"

(17 marks)

END OF EXAMINATION