BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Thursday 26th September 2013 – 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.

Only **non-programmable** calculators are allowed in this examination.

Section A

Answer Section A questions in Answer Book A

A1

a) The results of a multiple choice quiz are recorded in the format shown below.

CandidateID: C103	Name: Billy Smart	Address: 17 Union Street	
Question No	**Question Text**	**Correct Answer**	**Candidate's Answer**
Q1	What is the capital of France?	C	C
Q2	Who wrote *Moby Dick*?	B	A

All candidates sit exactly the same test. The questions are always presented in the same order, as are the answers for each question. The candidate must choose between four answers, labelled A-D, for each question. Only one label represents the correct answer.

In the above table, the candidate answered question Q1 correctly and question Q2 incorrectly.

i) Identify the repeating group of attributes and transform the above un-normalised table into tables that are in 1st Normal Form.

(5 marks)

Turn Over]

ii) Identify any partial dependencies and transform into tables that are in 2nd Normal Form.

(5 marks)

iii) Identify any transitive dependencies and transform into tables that are in 3rd Normal Form.

(2 marks)

b) The table below stores details of students and the overall grade each student obtained in different modules. The table has a composite primary key (StudentID, ModuleID).

Results

StudentID	StudentName	ModuleID	ModuleName	Grade
S001	Smith	M01	Java	A
S001	Smith	M02	Databases	B
S002	Ford	M01	Java	B

i) Which Normal Form does the above table violate and why?

(3 marks)

ii) Normalise the table up to the normal form identified in question i).

(5 marks)

c) Describe the main characteristics of the database approach and contrast it with the file-based approach.

(5 marks)

A2

Read through the following discourse then answer the questions that follow

A company transport many chemical **PRODUCTS** from one location to another on behalf of a registered **CUSTOMER**. Each transport operation is called a **JOB**, which involves picking up one or more **LOADS** of the same product from a customers requested start location and delivers it to a customers requested destination. A unique number is given for each **JOB** and for each **LOAD** when they are created. A Load is transported using a particular **TRANSPORT UNIT**, which consists of a *lorry, a driver, a container* (for carrying the product) and occasionally specialist *loading equipment* (such as Jacks and Pumps). A container is fixed to a trailer so it needs to be coupled to a lorry at the start of a Job. Transport operations are run from 5 regional **DEPOTS**. Jobs are allocated to individual depots to service. Depots are usually located near to pick up points such as chemical plants. Depots hold, manage and maintain their own transport units which are permanently allocated to them to service Jobs. A container, and sometimes associated loading equipment, may on occasions be left at destinations or pick-ups after a Job is finished. But normally transport units are held at the base Depot they belong.

Turn Over]

a) Produce an ER Model using the Entity Types identified above in bold font using the following notation:

CUSTOMER ←R1→ **JOB**

(10 marks)

YOU MUST STATE ANY ASSUMPTIONS YOU MAKE CLEARLY AND PRECISELY AND NOT CONTRADICT THE DISCOURSE

b) For Relation R1: Assume a Customer requests ONE or Many jobs. A Job is requested by only ONE Customer.

Express **TWO further** relationships from your ER Model as sentences explaining degree/cardinality and participation (ie 0..1 to 1..Many)

(6 marks)

c) Produce tables, populated with sample data, that are derived from the relationship R1 and the two relationship you used in your answer in part b)

(9 marks)

B3

The following table called Employees records employees membership of a particular team.

```
employeeID membership
---------- ----------
E1         AshForce
E2         Vallance
E3         Bass
E4         Mission
E5         Bass
E6         NULL
```

The following table called Teams records the budget of each team

```
mname     budget
--------- --------------------
Bass      675.00
Vallance  348.00
Mission   250.00
Ashforce  NULL
```

a)

Showing any working, determine what output is produced by each of the following queries:-

Query1:
```
SELECT distinct t.*
FROM employees as e
RIGHT JOIN teams as t
ON e.membership = t.mname
```

Query2:
```
SELECT SUM(budget) as totalbudget, Mname
FROM employees as e
INNER JOIN teams as t
ON e.membership = t.mname
GROUP BY Mname
```

Query3:
```
SELECT F.EmployeeID, S.EmployeeID, F.membership
FROM Employees F
JOIN Employees S ON F.Membership = S.membership
WHERE F.EmployeeID < S.EmployeeID
ORDER BY F.EmployeeID, S.EmployeeID;
```

(9 marks)

b) Describe the different types of JOINS present in the above queries.

(6 marks)

c) Write an SQL query that outputs the budget allocated for each employee. The following output would be produced:

```
budgetperEmployee totalbudget team name
----------------- ----------- ---------
0.00              NULL        Ashforce
250.00            250.00      Mission
348.00            348.00      Vallance
337.50            675.00      Bass
```

Hint - Modify Query 2 supplied above.

(6 marks)

d) Explain a problem caused by Null values when using an aggregate or other SET operation in SQL.

(4 marks)

a) *Using your own simple Relational Algebra (RA) examples and any appropriate diagrams (based on the example below or your own)*, list the eight RA operators, explaining the essence of each and providing at least one suitable example based on a sample relation of your own choosing. Good diagrams will gain extra credit. You should also highlight which RA operators originate from mathematics and which were developed specifically for relational databases – and by whom.

As a simple example, the SELECTION operator can be viewed as a 'horizontal slice' through a relation, extracting (whole) targeted rows – as shown by the diagram below…

C1	C2	C3	C4	C5
1	Cat	Green	Male	Katy
2	Dog	Blue	Female	Dug
3	Rabbit	Black	Male	Roger
4	Donkey	Yellow	Female	Dennis
5	Horse	White	Male	Harry

Relation1

```
SELECTION Relation1
WHERE C3 = Black
GIVING RESULT

(RESULT = whole of row 3)
```

Your task here is to describe the remaining RA operators in a similar manner supported by a diagram and pseudo-code or formal RA syntax - as in the example above.

(10 Marks)

Turn Over]

b) *Using your own examples and/or diagrams*, compare and contrast Structured Query Language (SQL) with the Relational Model (RM) and Relational Algebra (RA), paying particular attention to:
- How SQL DDL statements implement RM concepts
- How SQL queries implement RA operators
- How SQL extends and differs from RM and RA

Each item is equally weighted.

(15 Marks)

B5

a) Using a *suitable diagram and any appropriate examples*, describe the ANSI 3-level database architecture and how a database form relates to that model. In particular, at what level would a form sit within the three-level architecture of a typical database system? What other (non-form) techniques or interfaces are available that operate at the same level of this architecture and provide a similar function as a form (hint: think programmatic interfaces)?
(10 Marks)

b) *Data validation* is a key requirement when entering data into a database. Discuss the relative strengths and weaknesses of performing this data validation at the form level (front-end) and at the database level (back-end) as well as briefly explaining the methods that each level uses to ensure that validation is achieved (hint: think on-form logic versus server logic).
(10 Marks)

c) Explain the roles, responsibilities and relationships of forms and databases in a three-tier web-based architecture, taking special care to discuss the concepts of presentation, business logic and data. You are not expected to write any software code but you should support your discussion with a clearly annotated diagram illustrating how all three components of a three-tier architecture interact.
(5 Marks)

B6

a) The following table shows a schedule of three parallel transactions T1, T2, T3.

Time	T1	T2	T3
1	read(X)	read(X)	read(Y)
2	X := X – 3		Y := Y + 1
3		read(Y)	
4		X := X + 2	write(Y)
5	read(Z)	write(X)	read(Z)
6	Z := Z + 1		
7	write(Z)		

Turn over]

(i)   Show that the above schedule is not serializable.

(7 marks)

(ii)   Describe a strategy that ensures the schedule is serializable.

(2 marks)

b) Discuss the difference between pessimistic and optimistic concurrency control?

(6 marks)

c) What is a timestamp? How do timestamp-based protocols for concurrency control differ from locking based protocols?

(6 marks)

d) Discuss how the log file is a fundamental feature in any recovery mechanism.

(4 marks)