

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

**DATABASE SYSTEMS**

Thursday 25<sup>th</sup> September 2014 – 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 **NOT** allowed in this examination.

**Section A**

Answer Section A questions in Answer Book A

**A1**

- (a) A company stores employee records in the format shown below. Here we show two such employees.

<b>Employee ID:</b> E05 <b>Name:</b> Fred Shred <b>Job Title:</b> Manager		
<b>Branch Code:</b> B04 <b>Branch Name:</b> London		
<b>Qualification</b>	<b>Level</b>	<b>Year Obtained</b>
BSc	Undergraduate	1986
PhD	Postgraduate	1990

<b>Employee ID:</b> E07 <b>Name:</b> Jim Brown <b>Job Title:</b> Assistant		
<b>Branch Code:</b> B04 <b>Branch Name:</b> London		
<b>Qualification</b>	<b>Level</b>	<b>Year Obtained</b>
BSc	Undergraduate	1995

- (i) Identify the repeating group of attributes and transform the above unnormalised table into tables that are in 1<sup>st</sup> Normal Form. **(5 Marks)**
- (ii) Identify any partial dependencies and transform into tables that are in 2<sup>nd</sup> Normal Form. **(5 marks)**
- (iii) Identify any transitive dependencies and transform into tables that are in 3<sup>rd</sup> Normal Form. **(5 marks)**

- (b) A company lists staff rooms and telephone extensions in the table below. Each room has a single telephone extension.

**Staff**

<u>StaffID</u>	Name	Room	Extension
S001	Smith	A7	3142
S002	Jones	B3	4500
S003	Brown	A7	3142
S004	Khan	B4	4501

- (i) Explain what is meant by an *anomaly* in a table. **(2 marks)**
- (ii) List three kinds of anomaly, and give an example of each with reference to the above table. **(6 marks)**
- (iii) Explain what needs to be done in order to remove any potential anomaly in the table. **(2 marks)**

## A2

Refer to Figures A1.1 and A1.2 listed below representing a Tool Hire database.

- a) Identify and explain the SQL code that implements 'referential integrity'. **(4 marks)**
- b) In what order must these Tables be populated in order to preserve referential integrity? **(3 marks)**
- c) Identify and explain the effect of three further data integrity constraints present in the script. {Hint think about how these constraints are invoked} **(6 marks)**
- d) Using the tables in fig A1.1 explain the function of each of the following SQL keywords using sample SQL queries (or a single SQL query if you prefer). Show what output is produced by running each of your queries (query).

COUNT  
GROUP BY  
HAVING  
INNER JOIN  
IN  
LIKE

**(12 marks)**

**Fig A1.1 Tool Hire database sample data**

(note Primary Keys are in bold and Foreign Keys are in italics).

**TOOLAccessory**

<b><u>ToolID</u></b>	<i>AccessoryName</i>
3215	Blades
3225	7a PowerPack
3299	Bit set
3377	Sanding Disc
3377	Polishing Disc
3377	7a PowerPack

**TOOL**

<b><u>ToolID</u></b>	ToolName	<i>ToolCat</i>
3215	Circular saw	Joinery
3299	Drill	Building
3371	Hammer	Misc
3377	Sander	Decorating
3379	Wallpaper Stripper	Decorating

**HIRERATE**

<b><u>ToolCat</u></b>	HireRate	Deposit
Joinery	31	50
Building	31	60
Decorating	20	40

**CUSTOMER**

<b><u>CustID</u></b>	CustSname	CustTitle	CustPhone
43	Mogul	Mr	07422971
51	Dannisake	Ms	06454853
127	Borge	Dr	16468191

**HIRE**

<b><u>ToolID</u></b>	<b><u>CustID</u></b>	HireStart	HireEnd	Quantity
3225	43	13/02/13	14/02/13	1
3377	43	13/02/13	15/02/13	2
3377	51	14/02/13	15/02/13	1
3299	127	26/02/13	29/02/13	2
3299	127	28/02/13	29/02/13	3
3229	51	28/02/13	29/02/13	1

**Fig A1.2 SQL script used to (partially) create Tool Hire tables.**

```
CREATE TABLE tool (ToolID INT NOT NULL PRIMARY KEY,...);

CREATE TABLE hire (ToolID INT NOT NULL,
                    CustID INT NOT NULL,...
                    Quantity NUMBER DEFAULT(1),
                    CONSTRAINT PK_hire PRIMARY KEY ToolID),
                    CONSTRAINT FK_hire_customer FOREIGN KEY (CustID)
                    REFERENCES customer (CustID),...);

CREATE TABLE toolaccessory (ToolID int NOT NULL,
                             AccessoryName VARCHAR(25) NOT NULL,
                             CONSTRAINT PK_Toolsaccessory PRIMARY KEY
                             (ToolID,AccessoryName),...);

CREATE TABLE customer(CustID INT PRIMARY KEY,...);

CREATE TABLE hirerate (ToolCat VARCHAR(25)...,
                        Deposit NUMBER(5,2)
                        CONSTRAINT ck_deposit CHECK (deposit > 0 AND deposit < 50));
```

### A3

A University has adopted a personal identity card (**PID**) system to improve security and to restrict access to certain **groups** of people (such as students, teachers, professors , secretaries, managers etc) and at certain times and dates. A person is issued a PID card as soon as they become part of the University community (either employed or on a course of study). Each person belongs to only one group which determines what buildings they can access.

To enter a building, a person (each having a unique personID) must have permission which is established when their PID card is swiped through a PID card reader outside the **building** they wish to enter. A **PID card reader** is located outside the door of a building users wish to access. Permission is granted only if their access credentials are successful. If access is allowed, the captured data is logged, recording the date, personID (from the PIDcard) and the PIDreaderID.

- a) Produce an ERD of the above scenario using the highlighted keywords as Entity Types. State the notation you used and include in your ERD model :
    - Cardinality expressed as either 1:many or many to many.
    - Primary keys and sample attributes.
    - Any assumptions that do not contradict the discourse

**(15 marks)**
  
  - b) Derive from your ERD a set of normalised tables populated with sample data
- (10 marks)**

**Section B**  
**Answer Section B questions in Answer Book B**

**B4**

This question uses the 'Professionals' relation below...

Professionals

ID	Name	Profession	Age	Salary
1	Billy Builder	Architect	45	75,000
2	Steve Surfer	Swimming Instructor	21	13,000
3	Frankie Fetch	Lorry Driver	33	24,000
4	Brian Brush	Dentist	45	75,000
5	Nicky Nurse	Midwife	38	32,000
6	Roger Road	Lorry Driver	27	25,000
7	Fiona Floss	Dentist	52	120,000
8	Colin Crawl	Swimming Instructor	24	13,000

- (a) Based *solely on the 'Professionals' relation*, write down the answer to the following calculation...

$$\frac{(\text{DEGREE} \times \text{CARDINALITY}) + (\text{NUMBER OF DOMAINS})}{(\text{NUMBER OF CANDIDATE KEYS})}$$

*Hint: For full marks you must show all working out and all intermediate figures.*

**(5 Marks)**

- (b) *Using the 'Professionals' relation and Venn diagrams (or any other suitable diagrams)*, explain how the following relational algebra operations are processed. You must explain the *key concepts*, provide an *actual example* and a *suitable diagram* for each.

- |                          |                  |
|--------------------------|------------------|
| (i) UNION                | <b>(3 Marks)</b> |
| (ii) INTERSECT           | <b>(3 Marks)</b> |
| (iii) MINUS (DIFFERENCE) | <b>(3 Marks)</b> |
| (iv) SELECTION           | <b>(3 Marks)</b> |
| (v) PROJECTION           | <b>(3 Marks)</b> |

- (c) For each of the following relational concepts, explain the key ideas behind it. Provide a suitable example and/or diagram and compare/contrast their application.

- UNION COMPATIBILITY and its importance for set operations
- JOIN CRITERIA and its importance for seeing if two or more tables are joinable

**(5 Marks)**

**B5**

- (a) Using your own examples, describe the various different types of *user interfaces* and *development environments* that may be employed to access a database, taking care to discuss the key features, strengths and limitations of each. **(10 marks)**
- (b) Describe, with the aid of a well annotated diagram, how and where the following three concepts are implemented across a three-tier web-database architecture. You should take care to clearly explain the key concepts, potential problems and implementation options available for each.
- (i) Persistent, stored data **(5 marks)**
  - (ii) Presentation of output **(5 marks)**
  - (iii) Business logic **(5 marks)**

**B6**

- a) Transaction processing is one of the main features of any DBMS. Explain the following concepts:
- Transaction
  - Transaction scheduling
  - Serializability
- (9 marks)**
- b) Describe two kinds of problems (giving examples) that might appear when transactions run concurrently.
- (8 marks)**
- c) A university is considering using spreadsheets to record the details of its students and courses. Discuss the disadvantages of this solution and whether it would be best using a database.
- (8 marks)**