THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATIONS
BCS Level 5 Diploma in IT

DATABASE SYSTEMS

30th April 2007, 2.30 p.m.-4.30 p.m.
Answer FOUR questions out of SIX. All questions carry equal marks.
Time: TWO hours

*The marks given in brackets are **indicative** of the weight given to each part of the question.*

Calculators are NOT ALLOWED in this examination.

Attached Appendices A and B, for use in Question 5 and 6.

1. Database Access control, database privileges and SQL views are three main techniques for maintaining database security.

    a) Explain how EACH technique can be used to maintain data security.   **(15 marks)**
    b) Provide SQL examples to illustrate each of these techniques.   **(10 marks)**

2. Relational theory and relational algebra are the foundation of modern relational databases. Describe and discuss the following: atomicity; entity integrity; referential integrity; union; project.   **(25 marks)**

    You should support your answer to *a)* and *b)* with your own simple examples and any appropriate diagrams.

3. The table below represents a sample report layout for a construction company that manages several projects. Each project has its own number (P-No), name (P-Name), and employees assigned to the project. Each employee has an employee number (E-No), name (E-Name), and a job classification (Job-Class).

    The company charges its client by billing the hours spent on each contract. The charge per hour (Chrg-Hr) rate is dependent on the employee position or job classification (Job-Class). The total charges (Tot-Chrg) is the product of hours billed (Hrs-Billed) and charges per hour (Chrg-Hr).

A Sample Report Layout

P-No	P-Name	E-No	E-Name	Job-Class	Chrg-Hr	Hrs-Billed	Tot-Chrg
1	Harricane	101	John News	Elect. Eng.	65	13	845
		102	David Senior	Comm. Tech.	60	16	960
		104	Anne Ramoras	Comm. Tech.	60	19	1,140
2	Coast	101	John News	Elect. Eng.	65	15	975
		103	June Arbough	Biol. Eng.	55	17	935
3	Satellite	104	Anne Ramoras	Comm. Tech.	60	18	1,080
		102	David Senior	Comm. Tech.	60	14	1,920

A database designer was asked to develop a database from which the information contained in the above Sample Report could be generated. For this, he/she designed the **Project** table whose structure matches the above report formats. He/she omitted the total charge attribute because he/she thought that it could be calculated using charge per hour (Chg-Hr) and Hours billed (Hrs-Billed).

Turn over]

Project

P-No	P-Name	E-No	E-Name	Job-Class	Chrg-Hr	Hrs-Billed
1	Harricane	101	John News	Elect. Eng.	65	13
		102	David Senior	Comm. Tech.	60	16
		104	Anne Ramoras	Comm. Tech.	60	19
2	Coast	101	John News	Elect. Eng.	65	15
		103	June Arbough	Biol. Eng.	55	17
3	Satellite	104	Anne Ramoras	Comm. Tech.	60	18
		102	David Senior	Comm. Tech.	60	14

Answer the following *a)* and *b)* questions:

a) As the above **Project** table developed by the database designer is susceptible to update anomalies, provide ONE example of EITHER an insertion, deletion, OR update anomaly. **(10 marks)**

b) Using the functional dependency diagrams (fd1, fd2, etc…), describe and illustrate the process of normalisation from First Normal Form to Third Normal Form for the above **Project** table. In this process of Normalisation, we assume that the **Project** attributes P-No, E-No and Job-Class could be used to determine the values of (P-Name), (E-Name and Job-Class), and (Chrg-Hr) respectively. **(15 marks)**

4. Consider the following scenario:

"A high performance bicycle manufacturing company has two engineering departments one based in London and one in Manchester, and three manufacturing plants, one in Swindon, one in Hong Kong and one in Taipei. Each bike model is produced at only one manufacturing plant. To allow for sharing of data, the company has one database located in the London engineering department. Applications at the manufacturing plants access this database via a communication network for whatever data they need. One of the relations in this centralised database system is the MODEL relation, where data about the manufactured bike models are kept. The attributes of this relation MODEL are: the model's code (Model#), model's name (Name), manufacturing cost (Cost), the drawing number that specifies its design (Drawing#), the name of the engineering department that engineered the model (Eng_Dept), the name of the plant where the model is manufactured (Plant), and the quantity manufactured up to now (Qty). An instance of the MODEL relation is the following:

MODEL						
Model#	Name	Cost	Drawing#	Eng_Dept	Plant	Qty
P2	Solo	£200.00	123-7	London	Taipei	50,000
P7	Sprinter	£600.00	501-9	Manchester	Hong Kong	1,000
P3	Interlude	£100.00	238-2	Manchester	Hong Kong	2,000
P1	Scarlet	£1,000.00	310-0	Manchester	Swindon	10
P8	Pelican	£150.00	400-6	London	Taipei	3,000

The company has decided to move to a distributed database system where each of the sites (engineering and manufacturing) has its own database."

a) Propose a fragmentation design of the MODEL relation that reflects the distribution of the company's sites and their functionality. **(7 marks)**

b) Justify your proposal. **(3 marks)**

c) For each fragment, give an SQL statement that defines it. Finally, give an SQL statement that reconstructs the original MODEL relation from its fragments. **(15 marks)**

5. Refer to the tables listed in **Appendix A** at the end of this paper.

a) Write SQL code that will create the Tables **Copy** and **OnLoan**. **(5 marks)**

b) Explain the function of the ALTER TABLE statement in SQL and explain how it would be used to add referential integrity between Tables **OnLoan** and **Copy**. **(6 marks)**

c) List the **dvdName** and **dvdGenre** of DVD's with dvdGenre = Animation that were ranked amongst the top 5 rentals last week and are still ranked in the top 5 for this week. **(8 marks)**

d) The Table **TopTenRentalsThisWeek** could be derived from existing data rather than be persisted as a Table. Explain how you would achieve this in SQL. **(6 marks)**

6. Refer to **Appendix B** at the end of this paper.

a) Produce an Entity Relationship (ER) diagram that models the discourse and supports the requirements given in **Appendix B**. Include the following in your model:

- Entity Types (these are referenced by the bold typed names in **Appendix B**)
- Relationship Types
- Relationship Degrees (1 to Many for example) **(9 marks)**

b) Draft out a set of Tables derived from your ER model clearing showing the primary keys, foreign keys and attribute/column names assigned to each table. **(10 marks)**

c) Demonstrate that your Tables can support *AT LEAST THREE* of the requirements specified. **(6 marks)**

You should:
STATE any assumptions made in your modelling and
STATE the diagram notation you have used in part *a)*.

Appendix A: Sample Tables for use in Question 5

DVD

dvdId	dvdName	dvdDirFName	dvdDirLName	dvdGenre	DvdYear
00601	Groundhog Day	Harold	Ramis	Comedy	1993
10406	MASH	Robert	Altman	Comedy	1969
20467	Curse of the Were Rabbit	Nick	Park	Animation	2005
77890	Crash	Paul	Haggis	Drama	2004
00056	Boogie Nights	Paul Thomas	Anderson	Comedy	1997
34211	Kati Patang	Shakti	Samanta	Drama	1970
45609	Corpse Bride	Tim	Burton	Animation	2005
76213	Ladies in Lavender	Charles	Dance	Drama	2004
88609	A Bout De Souffle	Jean Luc	Goddard	Drama	1959
00003	Jhankaar Beats	Sujoy	Ghosh	Drama	2003

Copy

copyId	dvdId	status
00001	00601	On loan
00002	00601	Available
00003	00601	Available
00004	20467	On loan
00005	20467	On loan
00006	20467	Damaged
00007	34211	Available
00008	34211	Available
00009	77890	Available

OnLoan

copyId	custId	despatchDate	returnDate
00002	1234	20/02/06	26/02/06
00003	1234	20/02/06	26/02/06
00001	1237	21/02/06	27/02/06
00005	1235	21/02/06	27/02/06
00004	1238	24/02/06	28/02/06
00006	1238	24/02/06	28/02/06
00001	1236	27/02/06	
00004	1236	27/02/06	
00005	1237	28/02/06	

TopTenRentalsThisWeek

topTenNo	dvdId
1	20467
2	77890
3	50976
4	45609
5	63211
6	88543
7	90256
8	20567
9	78453
10	90087

TopTenRentalsLastWeek

topTenNo	dvdId
1	20467
2	90455
3	87654
4	77890
5	45609
6	76213
7	45399
8	50976
9	10043
10	00003

Appendix B: Car Hire Company

Discourse
- *PCM Hiring* is a nationwide car hire company that provides **cars** for **customers** to hire. A hire agreement between the company and the customer, called a "**hire contract**" sets out the terms of the hire such as the hire period, hire charges and the restrictions of use. The hire charge depends on the hire period and the hire class of the car.
- *PCM Hiring* has one **depot** and one "**hire point**" in every major city. Cars are stored at a depot unless they are on hire to customers. A hire point is a place where a customer collects and returns their hire car.
- One hire point has access to several depots and each depot may supply cars to many hire points.
- **Employees** of *PCM Hiring* work at either a depot or at a hire point. Depot employees are mainly employed preparing cars for hire which may involve repairing or maintaining cars. Hire point employees are mainly office staff involved with sales and marketing. Depot employees do not usually move but hire point employees frequently move from one hire point to another as demand for workers varies. There is also a small pool of employees who can be employed at either a depot or a hire point depending on demand.

Requirements A relational database is required that can support the following:

1. List the Registration No, Hire Class, Car Make, Model, Date of last service, Year Made, Odometer reading for each car held at a particular depot.

2. For a particular hire point, list the details of cars, the date of return for those cars that are currently on hire.

3. List the history of car hires for a particular hire point over a given period, the list should include the employee (ID and name) who arranged the hiring, the hire date and the date it was returned from hire.

4. List the details of customers (Name, Address) who have hired more than 5 cars within the last year.

5. Produce an employment history report, restricted to those employees who have moved their employment within the company. The report must include the Employee Name, Starting Date, Leaving Date, Depot, Hire point, Job Title.

6. For each Hire point list its location (the city), the number of cars available for hire, the Hire Class and the number of cars that were hired over the last month.

7. For a particular car list its history of hiring including the contract number, the depot it was based, the periods it was on hire, the dates it was at the depot, the mileage for each hire period.