

THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATIONS BCS Level 6 Professional Graduate Diploma in IT

ADVANCED DATABASE MANAGEMENT SYSTEMS

30th April 2007, 10.00 a.m.-1.00 p.m.

Answer THREE questions out of FIVE. All questions carry equal marks.

Time: THREE 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.
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1. a) The definition of a relation in the entry for “Relational Database” in Wikipedia is: “A *relation* is defined as a set of tuples that all have the same attributes. This is usually represented by a *table*, which is data organized in rows and columns.”

Explain this definition. Your explanation should include a discussion on the difference between relations and tables. **(10 marks)**

- b) SQL is not completely faithful to the relational model of data. Describe THREE ways in which SQL diverges from the mathematical theory of relations. Discuss the importance of each of these variations. **(15 marks)**

2. a) Describe FIVE relational algebra operations. For each relational algebra operation you list, illustrate the result of applying it to a relation. **(10 marks)**

- b) Although it is theoretically possible to query a relational database using relational algebra, in practice the vast majority of users use a language based on relational calculus. Describe the main features of relational calculus and its relationship to relational algebra. **(15 marks)**

3. In a paper entitled “The Object-oriented Database System Manifesto”, Atkinson et al state: “An object-oriented database system must satisfy two criteria: it should be a DBMS, and it should be an object-oriented system, i.e., to the extent possible, it should be consistent with the current crop of object-oriented programming languages.”

Discuss the implications of this statement. **(25 marks)**

- 4 a) In the context of query optimisation explain the following terms and describe the effect each will have on the query optimiser's decision as to whether or not to use an index. Give suitable examples from the sample tables to illustrate your answers.
- i) Selectivity (4 marks)
 - ii) Density (4 marks)
- b) Explain, for a stated DBMS, the indexing strategy that you would recommend for the Customer table in **Figure 1** below. The table has a primary key called *custId* and indexes are required to support the following queries:
- i) `SELECT custLName, custFName
FROM Customer
ORDER BY custLName, custFName;` (6 marks)
 - ii) `SELECT custLName, custFName
FROM Customer
ORDER BY custId;` (6 marks)
- c) Explain how the DBMS query processor would retrieve the rows returned by each of the queries in b) above. As part of each explanation draw a suitable diagram. (5 marks)

custId	custEmail	custPassword	custTitle	custFName	custLName
1234	fredjones@hotmail.com	freddie806	Mr	Fred	Jones
1235	annekrakowski@demon.net	kraKKers	Ms	Anne	Krakowski
1236	jones9004@aberdovey.com	Blaenau	Mrs	Myfanwy	Jones
1237	gerhartshcroeder@hotmail.com	Chancellor	Herr	Gerhart	Shroeder
1238	thesmiths@marske.com	seaSide567	Miss	Jane	Smith

Figure1: Sample Extract of a Customers Table containing Millions of Rows

- 5 a) The convergence of database and Internet technologies has meant that major database vendors are required to support software components that handle distributed data in their flagship products.
- Two important software components in this convergence are *Web Services* and *Data Replication*.
- i) What is a Web Service?
 - ii) What is Data Replication? (8 marks)
- b) Refer to the scenario on the next page. This describes the requirements of a mobile internet application.
- Explain how web services and data replication could be used in combination to support the application requirements described. Use diagrams and examples to illustrate your answer wherever possible and state any assumptions you make. (10 marks)
- c) In order for web services and data replication to work various software standards (such as SOAP and XML) have to be built into software products. Describe ONE of these standards and discuss why this particular standard is important. Use examples from the scenario to assist in your answer. (7 marks)

Scenario: Requirements of a Mobile Internet Application (for use in Question 5)

The 'GP Out-of Hours Service' is a service run by a local health authority whereby patients can request medical treatment outside the normal visiting times of a GP practice. GPs (also known as Doctors) are on call to visit patients usually at their home. A GP practice may have many GPs on call at the same time and the practice area may cover large rural areas.

A patient's medical records (including diagnosis and treatment history) are located at the national central database called SPINE. Specific image-based medical data such as X-ray photographs are stored in the database located at the hospital that carried out the test (for example an X-ray), this database is called TRUST. In order to monitor the location of GPs and the status of the GP (for example they may be free, attending a call etc) another database called CENTROL records the geographical location of every doctor who is on call.

Each GP has a driver who drives the GP to the patient's address. The GP/driver can at any time receive instructions to visit other patients who need treatment. GPs carry with them a hand-held device called a PDA that has a small database capable of storing a small amount of patient medical data. GP's use the local PDA database to input data following a visit. (For example the GP may record the patient's diagnosis and treatment). It is important that the GP has an up-to-date medical history of the patient and that any drugs dispensed do not conflict with existing medications. Medical data should be removed from the PDA database after the GP has finished his calls.

Brief specification of the PDA

The PDA is a hand-held computer that runs a mini version of the Windows operating system. It has 128K Ram and has a removable 1GB memory card. The PDA has a built-in mobile phone, supports wireless internet connections using GPRS. The PDA can also connect to a location tracking device called a GPS receiver. The PDA transmits its location data to the CENTROL database every 2 minutes.