

THE BRITISH COMPUTER SOCIETY
THE BCS PROFESSIONAL EXAMINATION
Diploma

DATABASE SYSTEMS

14th October 2003, 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.*

1. a) What is a transaction? Describe the so-called 'ACID' properties of a transaction. Describe an example of a situation in which transaction processing is required. **(10 marks)**
- b) Describe, with the aid of examples, the following errors that can occur when executing transactions in a concurrent environment.
- i) The lost update problem.
 - ii) The dirty read problem.
 - iii) The incorrect summary problem.
 - iv) The unrepeatable read problem. **(15 marks)**
2. a) Describe the ANSI-SPARC three-level architecture under the following headings.
- i) The external level, the conceptual level, and the internal level.
 - ii) The external schema, the internal schema, and the conceptual¹ schema.
 - iii) The external/conceptual mapping and the conceptual/internal mapping.
- Illustrate your answer with examples. **(9 marks)**
- b) Describe how the three-level architecture provides both logical and physical data independence. Illustrate your answer with an example. **(8 marks)**
- c) What is a data dictionary? What is meta-data? What is the role of the data dictionary and meta-data in a database management system? **(8 marks)**
3. Explain why many organisations elect to outsource their database applications and data to third party computer vendors and software houses. **(4 marks)**
- a) Discuss the impact that outsourcing has on the security policies and security mechanisms of an information system. **(9 marks)**
- b) What mechanisms are provided by DBMS software to protect a multi-user database application from the following?
- i) Potential loss of stored data because of failure of the processor or the hard disk.
 - ii) Potential loss of data integrity because security mechanisms have been breached.
 - iii) Potential loss of transactional integrity because 2 or more users have simultaneously issued a request that updates the same data item. **(12 marks)**

¹ 2 a) ii) In the October 2003 question paper, this line originally read, "The external schema, the internal schema, and the internal schema". This was taken in to account during the marking process.

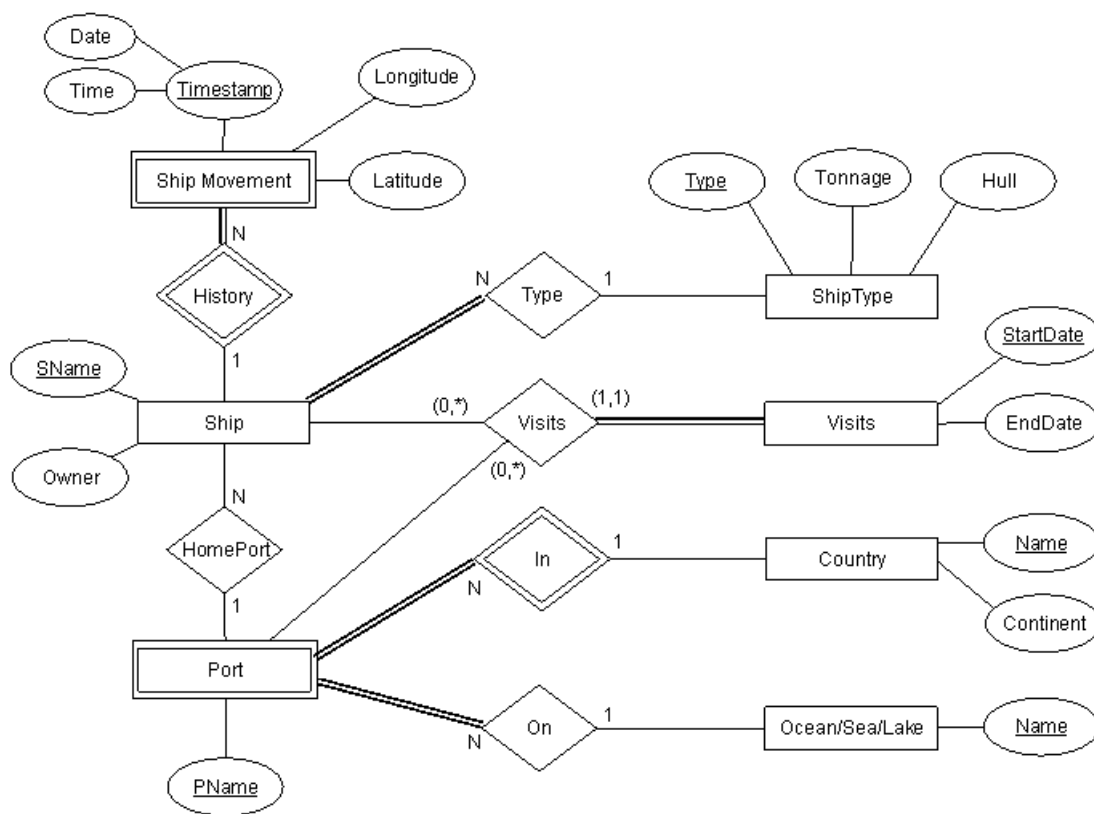


Figure 1

4. a) The diagram in **Figure 1** above shows an ED schema for a database that may be used to keep track of transport ships and their locations. Map this schema into a relational schema, and specify all the primary and foreign keys. **(10 marks)**
- b) Describe the problem of update anomalies under the following headings:
- Insertion anomalies;
 - Deletion anomalies;
 - Modification anomalies.
- (9 marks)**
- c) Are there any update anomalies in the relational schema you created in a)? If so, how would you handle them? **(6 marks)**
5. Read the scenario in **Appendix A** at the end of this paper before answering this question.
- a) In the context of deploying database applications, explain what is meant by a 2-tier client server platform. **(6 marks)**
- b) Discuss why a 3-tier client server platform would be more appropriate than a 2-tier client server platform, if an on-line booking system (such as a hotel booking application) was to be implemented as a web-based application. **(7 marks)**
- c) Whilst staying at a particular hotel a guest might wish to reserve a room at another hotel in the chain using the world wide web. Outline the design of a user interface to support such a task and state what data sources would be bound to data held on the server. **(12 marks)**

6. Refer to the tables given in **Appendix B** at the end of this paper to answer this question.

a) Express the following queries in SQL.

- i) Which borrower(s) have borrowed more than 2 articles?
- ii) Which borrowers have borrowed articles that are due back but are not overdue?
- iii) Which borrowers have NOT borrowed any articles?

(12 marks)

b) Explain how indexes can be used to improve the efficiency of processing queries such as those given above in part a).

Give specific examples of SQL code to illustrate how indexing mechanisms are established on a DBMS you are familiar with.

(13 marks)

APPENDIX A: Hotel Booking Scenario (for use in Question 5)

A company owns a chain of travel lodges/hotels at different locations in a country. Each hotel offers a standardised accommodation package and each hotel has around twenty rooms. These rooms are divided equally between combinations of either twin or double-bedded and either smoking or non-smoking. All rooms sleep a maximum of two adults, and are charged on a room per night basis, regardless of whether they are occupied by one or two guests. The charge per room per night is standard throughout the week.

The current information system requires a stand-alone single user computer located at each hotel. Each PC contains standard database software and accounting software packages and data pertinent to a particular travel lodge/hotel.

Processing in the existing system

At present the majority of room reservations are made via telephone enquiries direct to the hotel. Reservations are also made via fax messages and occasionally by post. All reservations are entered into a diary that simply consists of pages plotting dates horizontally against rooms vertically down the left margin of each page. Each square on the resulting grid is large enough to have the guest's details written in when they reserve a room. Reservations are deemed to be unconfirmed unless a credit card number is supplied. Alternatively business reservations can be confirmed by fax, and personal bookings by sending a deposit in the absence of a credit/debit card number. For accounting purposes all confirmed bookings are entered into a PC database package. An accounting package uses data contained in the database to process monthly accounts and balance sheets entirely for hotel/chain managers and accountants.

Business Rules

- A reservation can exist in one of two states, provisional or confirmed.
- A room can only be subject to one reservation, of either type, on a given day, at any given time.
- Any room not subject to either type of reservation is deemed vacant and available for booking.
- A reservation may involve one or more rooms. However, all rooms in a single booking must have the same arrival and departure dates. If different arrival dates apply then separate reservations must be made.
- A single reservation is made in a single name regardless of how many guests it actually involves.
- When a reservation is made the room allocated should always be the room whose vacant period best matches the requested reservation period, given that the room is of the type requested.
- Prices are calculated on a room per night basis and exclude all extras, including breakfasts.
- All rooms can sleep up to two occupants, either in a double or in twin beds.

Appendix B: Sample Tables from a Journal Library (for use in Question 6)

JOURNAL

| <u>JournalId</u> | JournalName |
|------------------|-------------------|
| 3215 | Database Weekly |
| 3216 | Database Monthly |
| 3217 | RDBMS Quarterly |
| 3218 | SQL Server Weekly |

ARTICLE

| <u>ArticleId</u> | ArticleTitle | AuthorId | JournalId |
|------------------|------------------------------|----------|-----------|
| 3215 | Object-Oriented Optimisation | 23 | 3216 |
| 2409 | SQL Server – A VB Interface | 18 | 3218 |
| 1398 | Relational Algebra Part 4 | 23 | 3217 |
| 1289 | Homage to Dr E F Codd | 23 | 3215 |
| 2554 | TLAs in DBMs | 67 | 3216 |
| 1678 | Functional Data Modelling 2 | 18 | 3215 |
| 4561 | Network Data Manipulation | 18 | 3216 |

AUTHOR

| <u>AuthorId</u> | AuthorFname | AuthorLname |
|-----------------|-------------|-------------|
| 23 | Mich | Murray |
| 18 | Peter | Gardenas |
| 67 | Malcolm | Sancton |

LOAN

| <u>ArticleId</u> | <u>BorrowerId</u> | <u>LoanDate</u> | <u>ReturnDate</u> |
|------------------|-------------------|-----------------|-------------------|
| 2409 | 43 | 3/2/02 | 4/2/02 |
| 1398 | 43 | 3/2/02 | 4/2/02 |
| 1289 | 17 | 6/2/02 | 8/2/02 |
| 2554 | 26 | 11/2/02 | 12/2/02 |
| 2409 | 43 | 14/2/02 | |
| 2554 | 52 | 14/2/02 | |

BORROWER

| <u>BorrowerId</u> | BorrowerFname | BorrowerLname | BorrowerTelNo |
|-------------------|---------------|---------------|---------------|
| 52 | Janet | Greer | 01582-900456 |
| 43 | Fred | Bloggs | 01933-546321 |
| 17 | Himi | Dhura | 01582-453214 |
| 26 | John | Smith | 01923-560087 |